# WOOD MAGIC PROGRAM:

# A DISTANCE EDUCATION PERSPECTIVE

by

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(ABSTRACT)

Research has shown that widespread misperceptions prevail regarding the use and sustainability of America's forest resources. Elementary school students receive only a general foundation in the area of wood science and many elementary school resources have shown to be inadequate. Virginia Tech and a few other universities have adopted Wood Magic (originated at Mississippi State University) which presents active, hands-on, and engaging science-based education to third, fourth, and fifth graders, allowing them the opportunity to obtain both a theoretical and practical knowledge in these areas of study. A distance education version of the Wood Magic Program, utilizing interactive videoconferencing, is the focus of this thesis.

An instructional design model has been developed to meet the needs of designers or instructors looking to expand into the distance education environment. This model describes all steps necessary to develop and implement a distance course or program.

A survey was conducted of all randomly selected third, fourth, and fifth grade elementary school science teachers in Virginia. The intentions of the survey were to discover the barriers to implementing the Wood Magic Distance Education Program into their current curriculum. The three largest barriers to implementation were cost of materials, time, and travel resources.

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# Introduction, Objectives, and Justification

*Chapter One: The Problem*

*Introduction*

Research has shown that widespread misperceptions prevail regarding the use and sustainability of America's forest resources. Elementary school students receive only a general foundation in the area of wood science. Recognizing this problem, Mississippi State University developed and offered the first Wood Magic Program in 1993. Since then, Virginia Tech and a few other universities have adopted Wood Magic to reflect the unique needs and interests of their communities. Very popular with elementary schools, these programs present active, hands-on, and engaging science-based education to third, fourth, and fifth graders, allowing them the opportunity to obtain both theoretical and practical knowledge in these areas of study.

The Wood Magic Distance Education Program (WMDEP) offers an opportunity to educate tomorrow's citizens by extending the reach of traditional Wood Magic Programs that currently exist to a program offered via distance education. Our proposed course of instruction will broaden access to Wood Magic nationwide by providing Wood Magic programs with web-based learning sites, stand alone kits and a Wood Magic program that could be delivered via interactive video conferencing (IVC) technologies. This program will serve as a pilot program for elementary education in order to evaluate the effectiveness of IVC.

Educating children of the importance of wood is crucial. This education should be done as early as possible to benefit future generations, as well as in on-going ways to inform adults of any misperceptions they have obtained over the years. Taking an already established and successful program that is centered around children and the importance of wood, and turning it into a distance education program would greatly increase the number of students exposed to this valuable information. Children who are in areas without such resources would have the opportunity to enjoy and learn from a program of this nature.

*Objectives*

The objectives to this study are the following:

(a) To conduct and analyze a survey of the most influential barriers to adopting the Wood Magic Distance Education Program as viewed by third, fourth, and fifth grade science teachers within Virginia.

(b) To create a distance education program for the department's annual Wood Magic Show.

(c) To create Wood Magic Distance Education Kits for use in distance learning and classroom settings to simulate Wood Magic events.

*Justification*

There are two problems occurring that are interrelated that refer to children and environmental science. The first problem encountered is the widespread misperceptions regarding the use and sustainability of American forests today. The second problem is that the use of hands-on activities as a means of learning, are lacking in children from the ages of seven to eleven.  Why are these problems so evident today?  Research has shown that children are not gaining the knowledge needed to make informed decisions nor are they receiving quality information from their teachers and textbooks.  Scientifically knowledgeable teachers can present factual information to children in a way that they will understand, if the teachers are not knowledgeable in these subjects, it may result in the problems such as those posed above.  Although, casting all the blame on the teachers and textbooks is not the solution to either problem.  Research has shown that many teachers today are not comfortable teaching environmental science to children.  The teachers realize reform efforts can help them help the children.  Reform efforts can come in many forms, ranging from teacher workshops to bringing in outside experts to work with the children over a period of time.  Reform efforts have provided a spark for many teachers who, over time, feel unmotivated and become unaware of their own strengths. The Wood Magic Distance Education Program is part of that reform and can help relieve many teachers who shy away from teaching environmental science in their classroom. The program can also counteract the two problems that are so evident today, by providing factual information to children and teachers in environmental science, particularly Wood Science, and by providing hands-on activities that are so crucial in the development of learning.

# Literature Review

*Chapter Two*

### *Ways in Which Children Learn*

Children learn through many ways, and according to the Cognitive Learning Theory, their minds are advancing through many different stages of development. By using concrete experiences in the area of environmental sciences, children are able to learn and retain more information than they do through printed information and lecture. Within the education profession, teachers encounter difficulties, such as lack of time within curriculum and money, which prohibit them from allowing these children to engage in a substantial amount of concrete experiences in the classroom. Distance education had provided a means for the students and the teachers to become more involved in the area of environmental science.

### *Cognitive Learning Theory*

Cognitive psychologists look at how information is received, processed, and manipulated by learners. They have created mental models of both "short term" memory and "long term" memory theorizing that new information is stored in a person's short-term memory until sufficiently rehearsed, where it is then transferred into a person's "long term" memory. If, however, the information is not rehearsed, it simply fades away. In addition, the information in the long-term memory is organized into "cognitive strategies" or skills that are used for sorting out complex tasks and information.

One noted cognitive psychologist is Jean Piaget. Within Piaget's theory of learning, there are four stages that children go through during cognitive growth and development. The four stages are: sensory-motor stage (birth to two years), preoperational thought stage (two to seven years), concrete operational stage (seven to eleven years), and formal operational stage (eleven to fifteen years.) These four stages are based on operations, each having the following four characteristics: First, the operations are mental and require the use of symbols; second, they derive from actions and can be thought of as internalized actions; third, they exist in an organized system where all operations are integrated with all other operations; and fourth, finally they are logical and follow a system of rules (Bjorklund, 1989).

The sensory motor stage occurs from birth to two years of age. During this stage, the central task of cognitive development is the acquisition of a rudimentary capacity for internal thought (Brainerd, 1978). Piaget argued that newborns live in a world in which there is no clear distinction between their own bodies and things in their environment. Children start out by using the abilities they possess at birth. They are confined to overt action, and mental representation is absent. However, many processes do occur during this period of growth. Children begin thought processes by what Piaget calls "schema." These are mental structures used to organize a perceived environment. Schemas are used to identify, process, and store new information. "They can be thought of as the categories individuals use to classify specific information and experiences." (Heinich, Molenda, & Russell, 1993, p.14). These structures have the ability to adapt and change with mental development and learning.

Another characteristic of the sensory motor stage is the process of "assimilation" and "accommodation." "Assimilation" is the process in which the learner incorporates new information and experiences into an existing schema. (If, however, when new information and experiences do not fit in any current schema, a new one is created.) This process is called "accommodation."

Additionally, children develop what is called "object permanence." During the sensory-motor stage, object permanence is the concept that things continue to exist even when they cannot be seen or touched. This process begins at birth and continues between 18 to 24 months. An example of this is showing an infant a toy, and then hiding the toy. The infant will not make any effort to look for the toy prior to the development of object permanence. "Out of sight, out of mind" is a good description. However, after a child develops object permanence, there is evidence that the infant has the ability to retain the image of the toy even in its absence, and to look for the toy.

The beginnings of language development also take place in this stage, from the nondescript noises and sounds of a two-month-old to his/her first words by twelve months. "The sensory-motor stage is a step-by-step account of the infant's progress from cognitive contents that are reflexive, self-centered, and disorganized to cognitive contents that are instrumental, adapted to the demands of the environment, and well organized" (Brainerd, 1978, p.47).

The pre-operational thought stage occurs between two to seven years of age. During this period of growth and development,

> intelligence is symbolic, expressed via language, imagery, and other modes, permitting children to mentally represent and compare objects out of immediate perception. Thought is intuitive rather than logical and is egocentric, in that children have a difficult time taking the perspective of another (Bjorklund, 1989, p 23).

During this stage, mental representation is present but true operations have not yet appeared. Children tend to be more action-oriented, and according to Piaget, it is early in this stage that skills of “symbolic play” (pretending) and imitation appear. In addition, “Research indicates many children cannot recognize pictured objects in problem solving situations when they have not had hands on sensory experiences with the object whereas, they can solve the same problem when dealing with the actual object” (Haney, 1995, p. 18). Hence, it can be argued that hands on experiences through concrete and visual means are essential in order for children to learn.

> Children respond to direct, purposeful experiences, not only because they are young, but also because they are learning many new things for the first time. Real experiences have the greatest impact on them because they have fewer previous experiences to look back on and refer to than do older learners. Real experiences provide the foundation for learning, for example, if children are to look at a picture of flowers and know what they are, they must have first seen, smelled, and touched real flowers (Simonson, Smaldino, Albright, & Zvacek, 2000, p.72).

The most important achievement of the pre-operational thought stage is the development of language. As a child experiences things, using his or her senses, information is processed and transferred into a mental schema. Piaget found that language in the Pre-operational Thought stage has two distinct functions: egocentric language, used for the purpose of self-stimulation, and socialized language. He found that children utter more egocentric language than socialized language, and they speak either monologue, repetition or collective monologue (having a conversation with another person, but not taking that person's half of the conversation into account). During his observations with children, Piaget found that when language is first acquired at the onset of this stage, it is entirely egocentric, and that there is a gradual shift from egocentric language to social language after the child discovers that language may be used to communicate with others. As the child grows, the egocentric language disappears and the social language becomes dominant. This process occurs at different ages according to the development of the child.

Other scholars agree with Piaget, but only to a point.

> Although different investigators have reported different percentages of egocentric language these percentages vary as a function of demographic and situational factors, the observed proportion of egocentric utterances never reaches 50 % in even the very youngest subjects. Contrary to Piaget's original studies, egocentric language apparently never predominates in children's speech. This is an extremely important finding because it suggests that, from the beginning of the preoperational stage, the primary aim of children's language is to communicate with other people (Brainerd, 1978, p. 123).

This illustrates that children need to physically, mentally, and visually learn the basic concepts of language and speech through mental processes and growth.

Another process characteristic of the pre-operational thought stage is "Egocentrism". As the child develops and matures into the next stages of development, he/she loses his/her egocentrism.

"Now that a child has fragments of symbolic thought at his disposal, he must learn how to organize those thoughts into systematic programs" (Farnham-Diggory, 1972, p. 17). As they do this, they enter the period known as concrete operational thought. This stage occurs between seven to eleven years of age. According to Piaget, "operations" are logical relationships among concepts or schema. During this stage children become able to use logical relationships for the first time, although this new ability is largely limited to objects and events that are real, tangible, and concrete. "The mental operations of this stage work only when they are being applied to information that the child has directly perceived. They do not work when they are being applied to information that is abstract and purely hypothetical" (Brainerd, 1978, p. 137).

Seriation, occurring in this stage, is the ability to put items in a series or sequence. For example, if two children ages 8 and 4 were given sticks with varying lengths and were asked to put them in order from shortest to longest, the eight year old would be able to do this, however, the four year old would often place a few sticks out of sequence (Seifert & Hoffnung, 1987).

Although problem solving is the foundation of concrete-operational thought, the child is still limited to thinking about only concrete or real concepts rather than abstract ideas. Consider the following:

> An eight year old who enjoys collecting bugs and butterflies knows a great deal about their behavior. Ask him anything about how they look, their feeding patterns, or their scientific names, and he will probably be able to answer. But ask him about more abstract things, such as why different species have developed differences in size, shape and coloring, and he will probably not know what to say (Seifert & Hoffnung, 1987, p.67).

If however, he is able to answer these questions, he has probably begun to enter the next stage, formal-operational thought. The formal-operational thought stage occurs between eleven to sixteen years of age. During this stage of development, children are able to make and test hypotheses, and think more abstractly. Children are very idealistic during this time; scientific reasoning, overt action, and inner thinking characterize thinking. Formal operational thought differs from concrete operational thought in three important ways: emphasizing the probable versus real, use of scientific reasoning, and the ability to hold several ideas in mind at one time and combine them in logical ways.

In a study conducted by Socony-Mobil Oil Co., some interesting information was obtained about the way in which people learn: 1 % learns through taste, 1-1.5 % learns through touch, 3-3.5 % learns through smell, 11 % through hearing, and 83 % through sight. It was also discovered that the retention factor differed depending on the method used to learn. Socony-Mobil further found that children retain 10 % of what they read, 20 % of what they hear, 30 % of what they see, 50 % of what they see and hear simultaneously, 70 % of what they say, and 90 % of what they say and do at the same time. Children also recall more after a time span when they have used the multisensory approach (Lall & Lall, 1983, p. 5).

As children mature and grow, their ability to learn through the use of concrete examples and visual cues only continues to grow. The child does not stop learning the processes, concepts, and content, the material just becomes more challenging and abstract. By no means should the method of learning become altered due to age and/or maturity level.

*The Importance of Teaching Children About Environmental Science*

It is crucial to teach environmental science to children while they are young in order for them to understand that Earth will provide for us, but it must be taken care of. If children are not taught the inherent value of environmental sciences the place called home will not last for future generations. Encouraging children to learn about the Earth, and the many ways in which natural resources can be used for human benefit will only make them value it more and realize how precious it is.

First and foremost, the educator must be scientifically knowledgeable and able to teach current facts to the students. In addition, as a teacher, being educated and fair will be reflected in the students who are being taught. A cognitive psychologist would argue that there must be an order in which information is taught for a child to learn. Students should first be taught basic factual information (concrete operational thought) after which the theories are presented (formal operational thought), supported by research. "The 'process approach' of observing, classifying, measuring, and the like supposedly led to more advanced processes such as making hypotheses, controlling variables, and finally, experimenting. This emphasis on "the processes of science" was seen as the true essence of science" (Good, 1977, p. 159).

As evidenced by cognitive development theory, the learning process regarding environmental sciences can begin earlier. Children are able to understand the content and understand the efforts that are being made to protect the environment and the sciences that support it. It was shown in the previous section that by the time our children reach the age of seven, they are intellectually able to take the information they are presented and understand the concepts that support the environment. By the age of eleven, they want to use scientific reasoning to understand the environmental sciences and phenomenon that are currently under investigation.

Piaget believed that intelligence reaches its peak between the ages of 11-15 years. He has even suggested that human intelligence may be superior at that point to that of adulthood. According to Tanner & Inhelder (1960), Piaget proposed

> the reasoning capabilities of untrained adolescents may be superior to those of college-trained young adults. This surprising claim was based on a series of investigations conducted in Great Britain…these investigations indicated that young adults at the University of Bristol did worse on the abstract reasoning tests…than the adolescents (Brainerd, 1978, p. 203).

Children see things in a different light than adults-it may be described as a fresh perspective, or at least, an unbiased view. Children have the ability to understand and contribute their knowledge, if given the right direction and information. It is our obligation to teach our children the facts about environmental sciences and let them explore all possibilities. With the facts, they can use reasoning to make sound decisions. If we do not teach our children, they get caught up in the myths and opinions of others, which, in turn, leave them with canted ideas and distorted perceptions that can possibly persist throughout their life span. It is our responsibility to take the initiative and show them the importance of environmental sciences.

"It might be said, therefore, that environmental education is concerned with developing informed attitudes of concern for environmental quality. Environmental education is different in that it is concerned with involving people in environmental problem solving" (Swan, 1969, p. 28). We, as educators, have neglected the importance of making our environmental education relevant to the needs and interests of children; this is our biggest challenge. “Children can begin to gain some understanding of their environment in the elementary years, but more importantly they should be made aware of the intricacy and potential beauty of their environment” (Swan, 1969, p. 28).

A 1991 study conducted by Dunlop and Scarce concluded that there has been an increased concern for the environment within the U.S. since the 1960s. Surveys based on a “national probability sample” asked whether the “environmental protection laws and regulations have gone too far, not far enough, or have struck the right balance.” The public answered “not far enough”. These statistics climbed from 34 % in 1972, to 54 % in 1990 (Kempton, Boster, & Hartley, 1995, p.4-5). In a second long-term comparison, Cambridge Reports asked the respondents to choose between “We must sacrifice economic growth in order to preserve and protect the environment” and the converse. Respondents chose to “sacrifice economic growth, a response “up from 38 % in 1972 to 64 % in 1990 (Kempton et al., 1995, p 4-5). The Gallup Organization, also in 1990, asked respondents “Do you consider yourself to be an environmentalist or not?” 73 % said they do consider themselves environmentalists and 24 % said they do not. That same year a researcher named, Yan Kelovich found that 64 % of respondents would be “willing to pay as much as 10 % more a week for grocery items if I could be sure they would not harm the environment” (Kempton et al., 1995, p 4-5).

These studies lend support to postulate that in a society that is becoming more aware and concerned about the environment, it is important that the children learn the basics at an early age.

> When taught well, environmental education can be informative and absorbing. It can bring to life the scientific principles…too often, however, environmental education skips the basics, pushing students into complex and controversial topics such as endangered species and global warming without establishing a scientific basis of knowledge (Sanera & Shaw, 1999, p.1).

As illustrated, the American people, in general, are becoming more aware of the issues effecting the environment. The questions we need to ask, however, are: are our children learning the basics that are necessary for them to make well informed decisions that will affect them during their entire life, and are they being provided with the essential, factual concepts that effect environment? Research has shown evidence that our children are lacking the knowledge necessary and/or are associating negative attitudes towards environmental education.

In a study published in the *TAPPI* Journal in 1996 entitled "Public Perceptions of the Pulp and Paper Industry", 656 high school students were surveyed in the Pacific Northwest area of the country. The findings of the study concluded that seventy-nine percent knew that trees are a renewable resource, but twenty-one percent did not. "One respondent said, 'Because a tree takes a long time to grow, I think trees are not renewable.'" Fifty-six percent were unaware of the potential utilization of alternative raw materials for papermaking. Fifty-five percent of the respondents knew that the strength of paper with recycled fibers tends to be weaker than paper made with virgin fibers, and forty-five percent believe recycled paper is stronger. However, ninety-seven percent of these high school students plan to attend a university (Martin, Desai, & Paun, 1996, pp. 97-102).

In another national survey of high school students, the study concluded: “Most high school seniors possess an elementary comprehension of environmental problems and lack the necessary understanding to go beyond the common recognition of an issue and use their knowledge to grasp the consequences of environmental problems or offer solutions for those problems” (George C. Marshall Report [GCMR], 1997).

Indeed, essential concepts that we have assumed students learn by taking courses are actually never learned in a way that they can be used in the real world (Bruer, 1993).

*Why the Problem is Occurring: Resources and Materials*

Research has shown several areas of concern that contribute to the problem of why children’s knowledge is lacking in areas of environmental science.  In particular, there are two areas we will focus on: insufficient resources and materials, and lack of teacher knowledge.

In order to teach environmental science, schools should provide current, and factual textbooks that allow the children to expand their mind and develop ideas of their own.  Books that are used in school systems need to be accurate and reviewed on a regular basis since the research and technological world are advancing every day.  Ideas, theories, and information are proven and disproved all the time, and these need to be addressed by the people who decide what books and materials are to be used in the classrooms.

Since some environmental issues are so complicated and emotional, it is easier for parents and teachers to let emotions, rather than facts, guide discussions and teachings.  It is often easier to let outsiders who have biased opinions present information.  Many materials used in schools, including textbooks that are published by national publishers, are unreliable, due to printed misinformation, etc. It is difficult to sort through all this information and present the facts to children (Sanera & Shaw, 1999). For example, this description is from a storybook for small children called *Rainforest.*

> A man on a bulldozer destroys the rain forest and it's animal life. Justice is done when the rains come and wash the bulldozer over a cliff, killing the man. (A drawing shows the man falling to his death.) 'The Machine was washed away!' concludes the book. 'But the creatures of the rain forest were safe' (Cowcher, 1988).

We, as a society, want to present our children with the facts. We do not want to scare them away with astonishing stories that will charge them emotionally. In contrast to the many devastating stories about the environment, it has been found that certain aspects of the environment have actually improved substantially in North America. For example, the United States has more standing timber now than it did in 1920, and more timber grows each year than is cut (Harrington, 1991). When the facts are laid out on the table, and the theories are explained, children will have the opportunity to choose which theory they think fits the facts. Knowing that many of these theories are still under investigation, and knowing that scientists don't always agree on which theory is the correct one, may allow the children to be more open minded. Children will see that science, as a discipline, is often full of uncertainty and always open to discovery and further research. They have already begun to think critically, and this will lead them to think for themselves rather than accept every theory that has been presented to them.

To support this idea that children are often misinformed of the facts, a few more examples may be helpful. Some environmental activists believe that logging is bad, and often textbooks give our children a one sided view of this issue.

> 'Large areas of forest also have been wasted,' says the Merrill text *Biology: Living Systems*. 'At one time, forests covered most of the eastern and western United States. These forests were cleared for farmland and much of the timber was burned or used for other purposes. By the early 1900s, it was evident that too much of this natural resource had been removed' (Sanera & Shaw, 1999, p. 88).

"'What if the forests that are cut down for paper are not replanted?' asks the Merrill text *Biology: The Dynamics of Life.* 'Eventually wood would become a limited resource' (Just in case students miss the point, the text shows a picture of a clear-cut forest.)" (Sanera & Shaw, 1999, p. 88). In these examples, the text fails to explain what the wood is used for, primarily for the houses these people needed to live in. It also fails to explain why logging is necessary and that it does not mean that all forests are clear-cut. Textbooks need to explain both sides of the story for a complete understanding of what is happening, and why. They also need to explain what the current state of the forests is in the area the students are studying. Leaving them with this canted idea and one-sided view is not educating children. They will not grow up with informed knowledge, only opinion.

What do we as educators do? The key problem is that the textbooks tell only one side of the story. We need to step in to offset the myths that pass as facts in these textbooks. We, as parents and educators, need to learn the facts ourselves.

Environmental education needs to be grounded in science to help the children understand the complexity of the living world, based on natural laws and principles. Theories need to be taught to children, as well. Not only one theory, but all theories that are scientifically supported with research and experimentation. Memorization of facts has the potential to bore a child. However, when presented with the opportunity for discovery, a child's curiosity builds to excitement. Children should have the opportunity to view debates over the many environmental issues, as a part of the search for truth. These types of activities make science fun and interesting. Learning needs to be fun in order for a child to be interested. This type of learning can introduce children to the way knowledge is obtained, how its validity is established, and how conclusions are presented (Sanera & Shaw, 1999).

The Independent Commission on Environmental Education, (heretofore referred to as the Commission) a group of ten specialists working in the field, performed an evaluation on selected textbooks, supplementary textbooks, and other resources that are widely used or recommended for use in environmental education by authoritative sources. Of special concern to the Commission, is the fact that environmental education materials are often factually inaccurate, superficial, or designed to persuade rather than to inform. Studies of environmental education show that students do not lack concern for the environment, they lack knowledge (GCMR, 1997). In a recent study conducted by the North American Association for Environmental Education (NAAEE), it was found that the most frequently cited reason (51.1 %) for elementary school teachers to teach environmental sciences was to 'encourage students to be active in protecting the environment'. Only 22 % indicated 'to demonstrate that what students are learning in class is relevant to everyday life', 9.7 % indicated 'to help students understand current issues', and 3.8 % indicated 'it's a good way to teach problem solving or decision-making skills' (NAAEE, 2000).

Of the ten findings by the Commission, six are directly related to our focus:

*(1)Teachers are the key to successful environmental education, but the materials often fail to give them the support they need.*

Whether a student really learns about the environment is more dependant upon the teacher than the materials the teacher uses. Those teachers who are aware of and can identify misinformation can correct the information as they present his/her lesson. However, environmental issues can rapidly become complex and the teacher may not have the expertise to know when materials may include outdated or erroneous information. According to the NAAEE study "the most commonly used sources of environmental teaching materials are textbooks with 79 % response from teachers" (date).

(2) *Environmental education materials often fail to prepare students adequately to deal with controversial issues.*

Although the Commission found this to be true, they are not suggesting that teachers avoid bringing controversial topics into the classroom. Grade appropriate, environmental courses should challenge the students to think critically about controversial issues. Unfortunately, materials have been found to lack enough of the information required to arm students with the knowledge they need to understand and discuss environmental controversies thoughtfully.

(3) *Environmental education materials often fail to help students understand tradeoffs in addressing environmental problems.*

"Many environmental teaching materials fail to convey the tradeoff of one risk for another that pervade environmental management efforts. Instead, in descriptions of actions to reduce environmental damage, textbooks often suggest that the solution is obvious and that people are simply not taking action" (GCMR, 1997, p. 22). This leaves adults appearing as if they do not care about the environment, which is not the case. These are sensitive issues with no easy solutions. "Virtually every environmental issue presents an opportunity to engage students in analyzing tradeoffs. If the tradeoffs are not considered, students will be left with simplistic and misleading perceptions of issues" (GCMR, 1997, p. 22).

(4) *Factual errors are common in many environmental education materials and textbooks.*

"In its review of environmental education materials and textbooks, including resources by Federal agencies and those recommended by professional education and science groups, the Commission found a number of the materials with errors, failure to point out the uncertainties inherent in the interpretation of complex physical data, misleading presentations of data, or errors of omission. These errors tend to stem from insufficient review by professional scientists" (GCMR, 1997, p. 22). "Real environmental education would teach children critical thinking skills. It would inform them that science is an ongoing search for the truth" (Sanera & Shaw, 1999, p. 23).

Although authors of all these materials are not always scientists, and new data is constantly becoming available in the world of science and education, factual errors should be corrected and caught in the review process. "Teachers will perhaps take into account that advocacy or industry groups may be inclined to select evidence that is most persuasive for their point of view, and therefore, they should make sure that students have access to other information as well. Selective presentation of evidence for the purpose of persuasion is, however, intolerable in textbooks labeled as science textbooks" (GCMR, 1997**,** p. 23).

*(5) Many HS environmental science textbooks have serious flaws. Some provide superficial coverage of science. Others mix science with advocacy.*

According to the Commission, many textbooks are aimed at persuasion rather than fact, and others introduce issues, but then fail to provide understanding of the scientific underpinnings of the issues. One of the most troubling examples found by the Commission is the textbook <u>Environmental Science: Working with the Earth</u>, written by G. Tyler Miller and published by Wadsworth. It is used in schools in Texas and several other states. The textbook begins with a discussion of the 'crisis of unsustainability' faced by the earth and calls for an 'Earth-wisdom worldview'. To define 'Earth wisdom,' the text quotes David Foreman, founder of EarthFirst, "When a chain saw slices into the heartwood of a two-thousand year-old Coast Redwood, it's slicing into my guts…Madmen and madwomen are wrecking this beautiful, blue-green, living Earth" (Miller, 1995).

"Other texts frequently combine superficial discussion of environmental science with lists of suggested political and social responses" (GCMR, 1997, p. 24). One book even recommends that students send funds to environmental groups to become green consumers.

(6) *There is no relationship between the quality of the material and the authoritative recommendations that accompany the publications.*

Many people assume that since materials or resources come from a particular source that they have heard of, especially if it is an environmental group or federal agency, then the source is accurate; this is not always the case. "Educators should be aware that recommendations by even the most respected professional organizations are no guarantee of the accuracy or quality of the environmental education materials" (GCMR, 1997**,** p. 24)

*Why the Problem is Occurring: Teacher Knowledge*

In 1988, in an editorial in the *American Scientist*, Jon Miller (1988) estimated that this nation's population is only 5 % "scientifically literate". Furthermore, it has been found that elementary school teachers often lack sufficient science background to effectively teach their students. Elementary teachers frequently report they are comfortable teaching reading, but two-thirds feel unprepared to teach science (Fort, 1993). The Carnegie Commission on Science, Technology, and Government quotes the National Science Teachers Association's estimate that only 35,000 of the nation's one million primary-grade teachers are specifically trained in science (1991). This is a significantly small number in comparison to the rest of the teachers. There are simply not enough teachers who specialize in areas of science, forcing schools to turn to other, less qualified teachers to fill these positions. In 1998, 38 percent of public school teachers held subject-matter specific degrees, whereas 62 percent held degrees in various education-related fields (National Center for Education Statistics, 1998, http://nces.ed.gov/programs/coe/2000/section4/indicator47.html). According to data cited by the Federal Coordinating Council for Science, Engineering, and Technology, more than half of America's principals report trouble finding science teachers (1991).

Changing attitudes towards science is the first step in changing the percentage of the "scientifically literate" within our nation. Teachers and students could make a tremendous difference in their own lives by simply having the attitude that they *can* understand science. When we don't have the confidence to believe that we *can* understand, "how can we expect the students to cease running from anything that makes them feel intellectually insecure if we persist in running ourselves?" (Arons, 1983, p. 110). Exposure to science can overcome the fear and loathing of science and technology by the majority of 'science –shy' students. If we, the educators and students, don't understand something, the first step is not to assume we *can't* understand it. What is needed is general knowledge, not specialized information. Once this is recognized, help can be found within the society (Fort, 1993). Learning environments need to be provided where students can discover and then enjoy science.

Sheila Tobias noted that unfortunately many good students on the college level leave science forever due to the fact that the introductory college courses are so competitive and are that way to "weed out" all but the top students (1990). Those students who were not formally thought of as being 'science smart' are forced out of entering majors in this area. Often times, students are left feeling inadequate and discouraged by the very same institution that accepted them into the university. Prewitt states "Schools should teach science in a manner that opens up personal opportunities for all their students, not just for those whose career choice is science or engineering" (Fort, 1993, p. 681).

"Many scientists, teachers, parents, administrators, and organizations are eager to improve science education" (Fort, 1993, p. 676). Robert Hazen and James Trefil point out that if we want people to understand highly scientific issues that will affect them, we need to explain it to them in a way that it is understandable (1990). The goal is to achieve literacy in science, which can be done by understanding the basic scientific underpinnings and constructs as well as the awareness of the impact of science and technology on society (Miller, 1983). Not all citizens need to understand science as a scientist does, but they should understand enough science to make intelligent decisions that may affect them (Fort, 1993).

*Why the Problem is Occurring: Reform Efforts*

Collaborative reform efforts, and professional development activities for teachers directed towards improving student learning, are needed within elementary schools across the country. Reform may be constructed in many ways, but keeping the focus on the students is the essential key to its success.

The need for professional development "means that the success of these programs is judged not by how many teachers and administrators participate or how satisfied they are with the program, but by whether the program alters instruction in ways that benefit students" (Sparks, 1994). "Any effort to improve schools must be designed to meet the goal of creating an active, thinking curriculum in specific disciplines, and success should be judged by whether increasing numbers of students reach agreed-upon performance standards" (Honig, 1994, p. 791).

One persistent problem seen in efforts to improve education is that these efforts typically are not organized around improving teachers' knowledge of content or enhancing their ability to collaborate to improve instruction (Bainer, Barron, & Cantrell, 1994). "Teachers must learn the core concepts in a discipline, which should anchor instruction. They also need to know how students learn (or fail to learn) these concepts" (Honig, 1994, p. 792). A second aspect to this problem is that there have not been enough schools that have focused their "reform activities on establishing specific performance standards in the basic subjects and then on increasing the number of students reaching those standards" (Honig, 1994, p. 791). "One well-grounded guideline is that to be of optimum effectiveness an environmental education program should span the entire curriculum, K-12. Total involvement is essential, for different components of environmental attitudes have varying susceptibility to influence at different age levels" (Swan, 1969, p. 28). This effort needs to be collective, and not individual, in order to improve student performance. In addition, no solution to the problems dealing with the environment will be successful without broad public support.

A successful reform effort, which has made progress within its community, is Teaching Opportunities for Partners in Science- TOPS. Five counties in California are partnering up with retired scientists to provide science content knowledge to teachers and students. These recruited scientists are trained and supported by governmental agencies, private industry, and institutions of higher learning. "Retired scientists have much to offer teachers to improve their knowledge of science and, therefore, their teaching of the subject" (Wilson, 1997, p. 6).

The three main goals of TOPS is to work side by side with the science teachers to (1) plan and deliver hands-on science lessons, (2) make presentations to the teachers on a variety of topics in physical, earth, life, and environmental sciences, and (3) act as "content resources" at family science events for students, teachers, and parents. Now in its fourth year, TOPS is highly regarded by the elementary schools it serves.

For teachers, the expertise provided by the scientists offers help to overcome fears of science and gaps in scientific knowledge. In recent surveys administered by the TOPS program to participating teachers, over 90 % reported that the "TOPS program had provided content knowledge for the teacher, improved student attitudes towards science, and provided content expertise for science lessons" (Wilson, 1997, p. 6). Furthermore, "Teachers said they felt more "on track" in science with new-found science knowledge provided by their TOPS partners" (Wilson, 1997, p. 8).

Teachers commented on how the students looked forward to science when the TOPS partner was present. Students are reported to have even skipped recess and to stay after school with the partner. One teacher said that the program has made the children more aware of how science applies to the real world (Wilson, 1997).

Another program to which reform is presently being implemented is the Wood Magic Distance Education Program. This program is designed to bring current, factual information to children across a large geographic area, and enables teachers to cover environmental areas, such as wood science.

*Course Design and Implementation*

When focusing on the design of a course or program, many pieces of information are considered. The first step is to locate and compare other instructional designs that already exist for use by instructional designers. Gustafson and Branch (1997) provide a reference for many different models based on the use of the course or program. They provide an overall idea of what a design model should include, such as: (1) determining appropriate outcomes, (2) collecting data, (3) analyzing data, (4) generating learning strategies, (5) selecting/constructing media, (6) authentic assessment, (7) revision, and (8) implementation. In addition, the authors consider three models: (1) classroom orientation, (2) product orientation, and (3) system orientation.

Authors Danielson, Lockee, and Burton (2000) contribute to the discussion on design by focusing on design implementation, and highlighting other areas of importance. One area, labeled 'Interface', relates to the system that the course or program will be utilizing. Important aspects of the design, such as a needs, task, learner, and functional analysis are described in their research in a way that is different from the manner in which another author will use the term. Research focuses on the following questions: What will the user be able to do with the finished system? What tasks will the learners need to perform with the computer that are not created for the course by the designer? What are the learners' current abilities with a particular computer or system? The authors also delve into the two types of evaluation for a program, summative and formative.

Within the many stages of a design, key issues that continue to resurface are ones which deal with interaction and psychological distance. These two key issues play a major role in the development of each stage of the design, as they are in constant battle to increase one and decrease the other. Wagner (1997) offers her perspective on the difference between interactivity and interaction. She defines interaction, which is the focus, as a behavior where individuals and groups directly influence one another. She discusses 12 types of interactions and why they are advantageous to any course or program development. The twelve types are: (1) Interaction to increase participation, (2) …to develop communication, (3) ...to receive feedback, (4) …to enhance elaboration and retention, (5) …to support learner control/self-regulation, (6) …to increase motivation, (7) …for negotiation of understanding, (8) … for team building, (9) …for discovery, (10) …for exploration, (11) …for clarification of understanding, and (12) …for closure.

Wolcott (1996) discusses "the shift from how to work around the distance in its physical sense, to how to keep from further distancing learners in a psychological and social sense (p.23)." She defines the term "psychological distance" as the psychological effects of physical separation or mental dimension of separatedness or dissimilarity between people. Wolcott describes strategies and practices for minimizing it within a distance education environment. She describes common attitudes and policy issues regarding distance education as well (Wolcott, p. 23-27.)

According to Weston and Cranton (1986) the "instructional design" is the selection or development of teaching methods and materials. Within one's design, one of the methods described below based on the preference of the designer, as well as, the content of the presented materials. They identify four teaching methods that serve as a vehicle for instructor-student communication: (1) instructor-centered, (2) interactive, (3) individualized, and (4) experiential. Materials that are used to communicate the instructional message contain three components: (1) the delivery system, (2) the message, and (3) the condition of abstractedness. Weston and Cranton describe the delivery system as the physical form of the materials and the hardware, or instrument used to present material. The condition of abstractedness refers to a continuum, which ranges from concrete to abstract forms. They describe how all the components fit together for a meaningful instructional design.

Hardy (1999) focuses on other fundamental actions to be taken by the instructional designer. She pinpoints fundamental questions that instructional designers should consider and ask him/herself when faced with the challenge of developing a distanced delivered course or program. She discusses several issues that are important in the developmental stages of the design. Key topics include questions, student assessment, course delivery, development of course content, methods of evaluation, and opportunities for communication.

Another area of importance is the technological aspect of the design. Simonson, et al. (2000), begin their discussion with the importance of real experiences and how adults are able to rely on past experiences, and children are not, this is where learning takes place. The authors describe this phenomenon in Edgar Dale's 'Cone of Experience,' and stating that as a designer, one should only be as realistic as needed in order for learning to effectively occur. Simonson, et al., guide this discussion into describing the different ways in which one can conduct a distance delivered program, and how these choices serve as realistic or abstract mechanisms for learning.

# Solving the Problem: Instructional Design Model

*Chapter Three*

Often, new books and materials are difficult to obtain in many elementary schools, especially those with low budgets.

> In science, many natural phenomenons are not open to elementary investigation because the necessary equipment may be too sophisticated. Due to reasons like these, motion pictures, filmstrips, television, and trade books must be readily available to both the teachers and the children (Kuslan & Stone, 1972, p. 287).

Children should not be made to suffer the consequences for inadequate materials. Learning should be a fun experience. If it is not, children tend to lose interest and often do not pay attention.

> School science can be a deadly bore to both children and teacher if it functions only to communicate information. It is difficult to see how the motive of competence or the need for self-fulfillment through achievement will maintain interest in recitation science. It may seem naïve to insist that science can be fun, but it can, and it should be. Science should be enjoyable not only because so much of it is directly apprehensible to children but also because children like to manipulate and to experiment. There may even be a manipulative drive that experience in science can satisfy. In a sense, science is a toy-play (Kuslan, & Stone, 1972, p. 119).

There should be opportunities for all children to have exciting learning environments. Every child should have the opportunity to develop and expand his or her mind and become a curious, mature adult. What are the alternatives to education or materials when they are not provided at the current location? What types of fun activities are available in schools with low budgets?

Distance education is one avenue that can be explored within the K-12 school system. This technology can provide an alternative solution to those schools that do not possess the appropriate resources needed to reach the children on an intellectual level.

*Distance Education as a Solution*

Distance education takes place when a teacher and student(s) are separated by physical distance; and technology (i.e., voice, video, data, and print), often in combination with face-to-face communication, is used to bridge the instructional gap (Lockee, 2001, personal communication). It is widely used among higher learning institutions and often used to enhance the quality of traditional primary and secondary schools. Distance education can be found in many forms, such as: interactive radio instruction, correspondence courses; computer-based courses; video-based courses; and audio-based courses.

In many countries children living in remote rural areas do not have access to the same educational resources as do children in more populated areas.

> One-way radio has been widely used to improve educational quality since the early 1970s, particularly in Africa, Asia, and Latin America. Because of the generally low cost and wide availability of radios, even in remote areas, this technology is second to print in both economy and extent of use in distance education. Interactive Radio Instruction (IRI) uses one way radio to deliver activity-based learning and involves having the "radio teacher" communicate the

lesson, integrating the lecture with activities that have students answer questions, sing songs, and do practical tasks. These activities occur during carefully timed pauses, with the classroom teacher serving as facilitator. IRI programs are generally used to supplement instruction provided by classroom teachers who have inadequate training and limited learning resources (Potashnik, M., Capper, J, 1998).

Another proven distance education technology is video-based instruction, and in particular, two-way video/audio conferencing. When using video systems, real-time interaction between the teacher and the students is typically provided. This means that the teacher and students can interact and communicate with each other, while both hearing and seeing each other at the same time. This type of system has the benefit of reaching many students at the same time, in different geographic locations (Olcott, 1999). It also gives the students a more realistic instruction in comparison to a textbook, which is what is necessary when young children are the learners (Simonson, et al., 2000).

With the ability to reach many students at one time, distance education could provide concrete learning experiences for environmental sciences. The number of students who are receiving the instruction about important topics in environmental science, if presented in an appropriate manner, would drastically increase.

By providing information through two-way video/audio conferencing, the material is displayed visually. Visuals provide a concrete reference point for students, and can help them by simplifying the information. "A visual that breaks down a complex idea into its components can show relationships that might be otherwise confusing to students" (Simonson et al., 2000, p. 121). When using distance education as an alternative to lectures and textbooks, not only would the learning needs of the students be met, but they would also have a better understanding of the processes they are studying.

*Instructional Design Model*

When deciding to develop a program using distance education technologies, models are often used to guide the development of the program. These models, based on literature, are grouped according to the intent of the program, such as, classroom use, training for the workplace, etc.

An instructional design model is used to provide the tools necessary to visualize, direct, and manage the processes for generating and revising guided learning. Further, it allows us to view linear and concurrent aspects of instructional design, and to select and develop appropriate operational tools to complete the design of a course or program. An instructional design model should contain enough detail to establish guidelines for managing the people, place, and things that will interact together, and to estimate the resources required to complete the program planning (Gustafson & Branch, pp. 18-23).

Many variables come into play when designing a distance education course or program. As with people, courses are different from one another and require different types of teaching styles. One design may not be any better than another, and the style or design that an instructor chooses is a matter of preference. The following design was created with children in mind, although it is a simple guideline for many types of courses and programs that require different delivery modes.

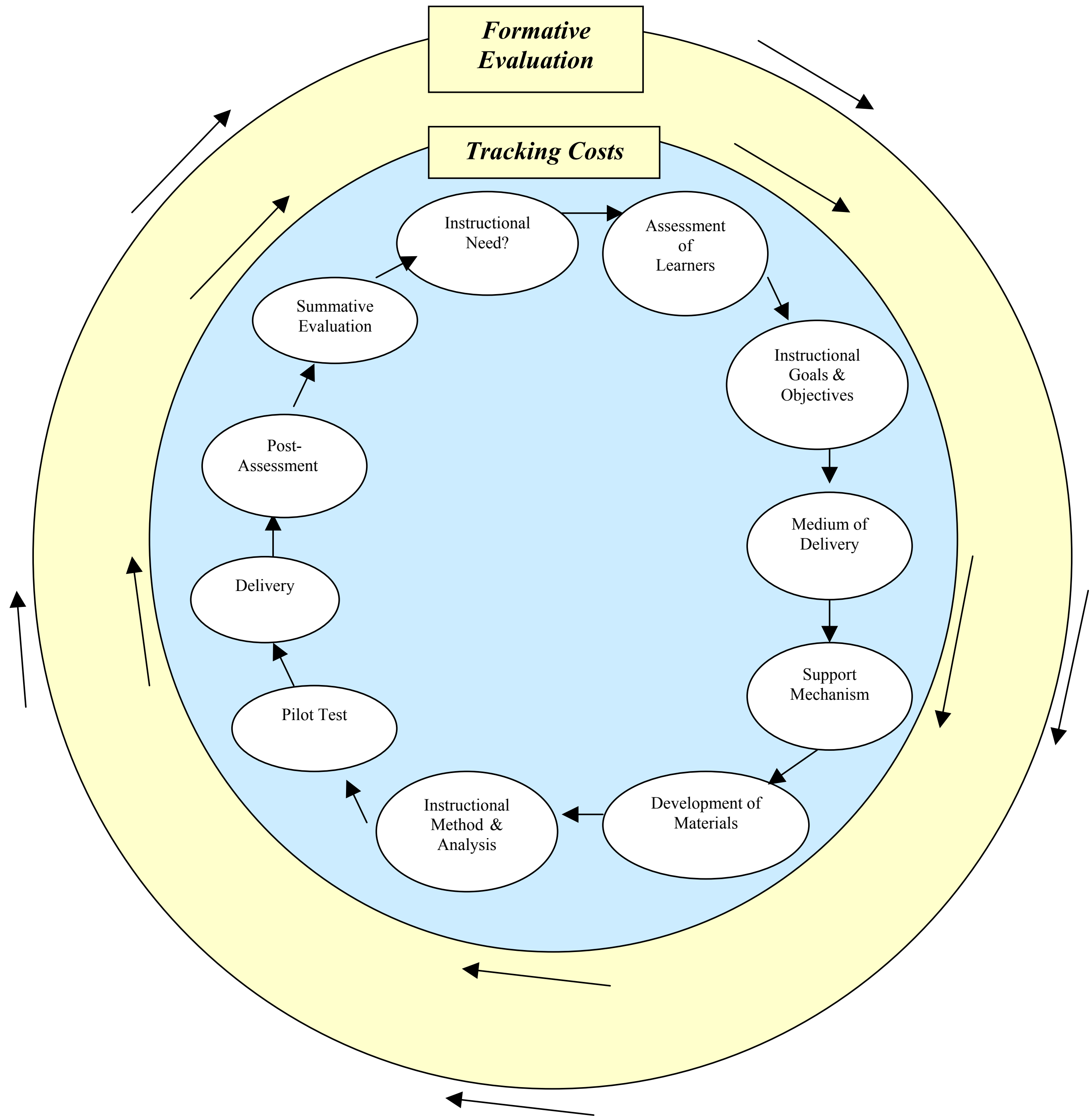


Figure 1: Instructional Design Model Graphic

*Steps to the Development of a Program*

Two components involved in this design model, formative evaluation and tracking costs, occur continuously throughout the entire development of the program. Formative evaluation is an ongoing process that is apparent in all stages of development. The intent is to evaluate and improve instruction within the course or program. Formative evaluation is thought of as a process to be completed during the developmental stages of the model. Tracking the costs, or keeping a running tab of all expenses, is essential when designing any program. Once the course or program has been fully developed, the designer will then have a detailed list of all expenses paid during the program. By doing so, this gives the designer an idea of where the program stands financially, and how much it will cost to fund the program in the future.

The ***first step*** to this instructional design model is to conduct an analysis to determine what the instructional need is for this program and what the intended outcome for this particular program may be. This can be done in a number of ways. Designers should organize a discussion group with fellow teachers or conduct an informal interview session with them. Some of the questions one would like to address are: Would this program benefit students? Are the children missing this information in their current curriculum? Is it necessary for them to learn this information? Would they be interested in participating in this program?

The ***second step*** is to perform an assessment of the learners in order to gauge their level of understanding in the areas we are teaching. For an instructional design to be effective, the instructor should consider three components: (1) demographic characteristics-who are the students? What are the student's ages? What gender are the students? Where do the students come from (country, city)? Are the students married? Do the students have full time jobs? (2) Socio-psychological characteristics-are the students going to be on-campus? Will the students connect from within the state or country? (3) Systemic influences-what types of "life roles" do the students possess? It will be important to find out what learning experiences they have had, and what types of families they come from. All of these things will help the instructor gain an understanding of the students and their background in order to select a classroom approach that will no only reach them intellectually, but challenge them intellectually as well.

The age and grade level of the intended students, and what their experience within a particular subject or topic is also important, particularly in the initial stages of the instructional design model. These attributes allow the course or program to be tailored around the students. This information can be addressed by performing a pre-assessment of student learning, a simple way to determine whether the students are knowledgeable in a particular area of study. It could be as simple as asking a few basic questions before a program and ask for a show of hands, giving the designer a basis for determining whether learning will occur during the program

The ***third step*** in this model is to clearly state the instructional goals and objectives prior to the selection of program content. These objectives need to be defined in detail for the students as well as for the instructor. This is where the program begins to take shape. The designer decides *what* the students will learn in the class, what concepts are important, and how to integrate these ideas into their lives. It cannot be expressed enough how important it is for these objectives to be clear, concise, and attainable for the scope of this program.

The ***fourth step*** in the model is to determine what medium will be used to deliver the program. Unfortunately, this choice is often not one for the designer to make.

First, one needs to determine what attributes each media type possesses. For example, pictorial media is often used for presenting concrete information, while print does a good job of communicating abstract ideas (Dickie & Levie, 1973 ). The psychological aspects of using distance education technologies need to be addressed at this time. "A medium which has the attribute of providing pictorial stimuli may elicit psychological responses which are not possible with a medium that does not have this attribute" (Dickie & Levie, 1973, p. 860). Children need the visual stimuli as well as the auditory one while learning new ideas and concepts at this age; print based material alone is not sufficient for children.

Instructors must consider other variables if choosing the distance education environment, such as the feeling of psychological distance among the students. A physical "place" can elicit many feelings within a person. In other words, if a student is in an asynchronous environment or an Interactive Video Conferencing (IVC) environment (a place where the student does not see the instructor), the "psychological distance phenomenon" may exist between the student and the instructor/institution. This means that a sense of isolation or lack of community may affect the student resulting in the student feeling he or she did not receive full benefit of the course. One student who was involved in this type of asynchronous environment described it as a "cold medium…you get no instant feedback" (Wegerif, 1998, p. 5). Psychological distance can also be felt if interaction is absent between not only other classmates, but the institution as well. How can the instructors design the program or course to minimize this distance? What tools can they implement into their instructional methods to address this phenomenon? Simple tasks, such as using a student's name when addressing him or her, can make a big difference in the psychological distance that is occurring in these environments. Another idea may be placing the students' pictures on the course web site, showing enthusiasm, and encouraging participation, can be a way to break down the distance barrier (Moore & Thompson, 1990).

The ***fifth step*** in the model is to develop support mechanisms within the program. These mechanisms are in place to provide vital information to teachers and students during the progress of a course or program. They provide resources, links, and help for all aspects of the course or program. For example, the development of a web site which teachers can use for on-line registration of the program, as well as for communication with the site designers. The teachers would be able to use the web site to update materials and for the organization of the program. It can also provide library resources, contact information, feedback forms, and other interactive links.

The ***sixth step*** is to develop the materials for the program. In doing so, one must make sure that the materials themselves, as well as the manner in which the materials are communicated to the students, is appropriate for the chosen audience. First it is necessary to decide what the most cost effective way (for students and instructor) to produce these materials is, as well as what delivery system will be used to present them (Weston & Cranton, 1986). Designers should ask: How will I go about preparing these materials after I have decided on a delivery system? What is the best way to present the material (electronic design of visuals)?

Another consideration regarding material selection is class size. This is very important in some learning environments. Class size must be determined well in advance. Some questions that need to be addressed at this stage in the model are: How many copies of materials are needed? How much would it cost for the students to receive the materials? How can interaction be incorporated among X number of students in the class? How many students can be enrolled in the class and still have an effective learning environment?

One must also consider the physical facilities that will be used for the course or program. Where is it physically located? Can the students get there? What type of room is it? How can this room facilitate interaction between the instructor and students? Finally, the availability of resources should be determined. Who supports the teacher? Are there classroom aides? Is there technical support for the teachers? Do the students have technical support? All of these factors are important when a desired learning outcome is expected.

The ***seventh and eighth steps*** can be completed simultaneously. These are: instructional method selection and instructional analysis.

In instructional method selection, one decides *how* to teach and conduct the class. There are several choices ranging from the predominant lecture method which is instructor-centered, to the self-paced method which is student-centered, and many in between. This choice depends on the instructor's style of teaching and his or her chosen course. This takes a lot of time and preparation on the instructors' behalf. During this stage of development, the instructor needs to be aware of the previous variables we have already discussed, such as psychological distance and interaction. How can the instructor minimize the psychological distance within the course by the method of design? How can he or she integrate interaction to reduce distance between students? In what ways can the instructor integrate interaction between the students him or herself using the method chosen? Is interaction important in this course? How can the instructor assist students who are in need of tutoring? The instructor needs to devise a method of answering questions promptly, and being available for questions from students (Trentin, 2000).

In instructional analysis, the instructor must decide in *what ways to facilitate* students' learning based on the previously chosen method. He or she must first decide what skills the students will be utilizing during the learning process, and what tasks the students will perform. Will they use cognitive thought or affective learning? Is it a subject that requires psychomotor skills? After deciding the manner in which the students will learn, he or she must then decide how to teach while using these domains. What activities promote the usage of these domains? Will the students be responsible for assembling or building something? Will they need to form groups with other students to discuss a topic? Will they need to label a diagram on a test? These are some considerations the instructor should think about when designing a course focused on what they want the students to learn and how they want them to learn it

Future assessment of the students' learning is decided at this point in the model. The instructor must decide how they want to evaluate the students on the subject matter of the course. After deciding what and how to teach the material he or she must decide how to test the students. It is the responsibility of the instructor to design the instruments needed to conduct an assessment, whether it is creating tests, projects, essays, etc.

The ***ninth step*** of the model is to conduct a pilot test of the new program with students or colleagues to allow for feedback. Feedback is very important and the design of the program or course will benefit from it. The pilot test also lets the instructor take notes and correct mistakes that have been established within the design of the program or course. Often little details are left out simply due to oversight.

Instructional delivery is the ***tenth step*** in the model, where the instructor performs the duties designed for the program or course. Prior to delivery, technical support must be arranged and available for the instructor, as well as for "distant" sites that will be participating in during the program. By this time volunteers (at distant sites) must have training with the equipment in the room and the students should have received materials pertaining to the class.

The ***eleventh step*** is to conduct a post-assessment of the students. As mentioned earlier, a pre-assessment has already been conducted to determine knowledge before delivery. A post-assessment will now be conducted to determine whether the students have retained the goals and objectives of the program and each activity, as well as to determine knowledge after delivery of the program.

The ***twelfth step*** is to conduct a summative evaluation of the course or program after each delivery. A summative evaluation can be conducted by a professional Summative Evaluation Facilitator and/or participating students/teachers to see if the original needs' have been met by the program. This evaluation creates a way for the instructor to receive feedback from the students on a regular basis during the program or course. This is necessary to determine if the instructor's presentations were clear and effective, and present an opportunity for students to interact with the instructor regarding problematic or helpful issues they have confronted throughout the course or program (Wagner, 1997). This may be through email, face to face discussions, telephone calls, reports, evaluation sheets, etc. The (AEIOU) Approach is one way in which a facilitator can evaluate the course or program. AEIOU stands for the five components in the approach: Accountability, Effectiveness, Impact, Organizational Context, and Unanticipated Consequences. (This approach "provides a framework for identifying key questions necessary for effective evaluation of a project" (Simonson, et al., 1999, p. 229).) Each component prompts the facilitator with questions to make sure all areas of the evaluation are met. Some of this information will be available to the facilitator through records, interviews with participants, and evaluation sheets completed by participants.

A subset of the summative evaluation is the cost analysis. This is an investigation into the costs of the course or program to determine if finances are available for improvements or changes within the current setup of the program.

A second subset of the summative evaluation is the stakeholder feedback. This is a report designed to summarize the following: analysis of feedback from participants, cost analysis, and suggested changes/improvements. This report is made available to all who have invested time and money to the course or program with the intentions of improvement.

*Examples of Success*

Now that a thorough description of an instructional design model has been presented, the following two examples are success stories in the realm of distance education. Within the United States and around the world, there are hundreds of distance education initiatives integrating the use of technology in the classroom. Two projects will be discussed that are directly related to children in elementary school.

The first project is called The Ohio SchoolNet Telecommunity Project. This project utilizes Interactive Videoconferencing (IVC) to teach students in their classrooms within the state of Ohio. It includes 11 state telecommunities, some of which offer entire programs and others that offer the use of supplemental teleconferences that target particular curriculum units, similar to the WMDEP. For example:

> a unit targeted at fourth graders integrated the study of electricity, math, and reading by using four 45 minute teleconferences that allowed the students to interact with a variety of electricity-related resources while engaging in hands-on math, science, and reading activities (Kirby & Roblyer,p.49).

An evaluation of the project was conducted by the North Central Regional Educational Laboratory, and focused on the effects on students, teacher, program development, and technology use. Evaluations were conducted via case studies, surveys, site visits, and interviews. The following was found:

For the programs that were used as a supplement to a curriculum, this project gave students access to interactive resources that were not otherwise available, and allowed for learner-centered models of instruction to be used. Full-time technical support is recommended in these types of learning environments (Kirby & Roblyer, 1999).

There was an overall positive influence on the students who participated in the projects. Teachers identified four points:

(1) Students showed more interest in learning activities that were introduced in teleconferences.

(2) Students demonstrated better evaluation of information and a deeper understanding of the concepts.

(3) Students produced a higher quality of work.

(4) Students were more interested in world events" (Kirby & Roblyer, p. 49).

Also noted was better classroom behavior, a decrease in stereotypes of nearby communities due to interaction with them, and increased access to information.

Teachers were found to have: "moderate increases in their abilities to integrate their teaching with the state curriculum frameworks; support student-centered learning; participate in interdisciplinary teaching; and work collaboratively with colleagues" (Kirby & Roblyer, 1999, p.50). Teachers also reported feeling they were in the "passive" role of teaching, and that they were not directed (teacher development) in the correct way to integrate new teaching strategies.

It was found that not all students were able to participate in this project; and that it was often offered only to students of high intelligence. "In addition, poorer districts sometimes failed to participate because they felt they couldn't afford the project costs, and some wealthier districts withdrew from the project because they felt they contributed more than they received" (Kirby & Roblyer, p. 50).

Overall, the ability for many students to benefit from a program of this nature and learn in an environment that utilizes new technologies, leads to the belief that the advantages of this kind of program outweigh the disadvantages.

The Star Schools Project is another example of a successful distance education program. This is a federally funded program designed “to encourage improved instruction in mathematics, science, foreign languages, literacy skills, and vocational education for underserved populations through the use of telecommunications networks” (Simonson, et al., 1995, p.3-4). The Star Schools Project has funded different types of programs that are provided to a large number of students via satellite delivery. They have sponsored an effective program in Iowa called the ICN (Iowa Communications Network), where the entire state is connected through a fiber-optic network that includes more than 500 educational sites (with a proposed 350 more sites to be added.) This educational system is built around the development of partnerships between high schools that share courses and activities. The schools form partnerships with each other and share and receive courses and instruction (Simonson, et al., 2000). This program allows the schools that lack required courses, due to money, resources, or qualified personnel, to join together with another school to share resources. By doing so, the schools are able to hire qualified teachers, possibly save money, and access resources that they would not have gained otherwise. This program illustrates the advantages to this type of educational offering.

There is hope that the Wood Magic Distance Education Program will be a success after implementation, as these previous examples have shown. The WMDEP utilizes the instructional design model described in Chapter Three.  This program is the focus of the next chapter.

# Wood Magic Distance Education Program

## Chapter Four

*Instructional Need*

The need for children to have a basic understanding in the areas of environmental science, particularly wood science, is growing. The Wood Magic Distance Education Program is an interactive program whose purpose is to teach children about environmental science through hands-on activities. The types of things children learn about in this program are: how paper is made, the strength of wood and wood products, how plywood is made, everyday uses of wood and wood products, and some of the unusual things in which wood and wood products can be found.

The Wood Magic Program Distance Education Program and all its related activities are centered around environmental science. Wood is not only a material that is used for many applications, but the way in which wood is used is a function of the environment. For example, papermaking uses two natural resources; wood and water, to produce quality paper and paperboard products. Using wood for papermaking is also beneficial for the environment because it can be recycled several times and, thus, reduce the amount of trash in landfills. Consumers and businesses reuse paperboard products, such as cardboard boxes, every day, since the wood fibers in these products do not breakdown and are so durable.

Plywood is a heavily used resource in the construction industry. It is primarily used for the construction of light-frame structures, single-family homes, apartments, and commercial buildings (Haygreen & Bowyer, 1996). Plywood is also environmentally friendly, as its production consumes far less energy than the production of other materials, such as aluminum siding. Not only does energy conservation benefit the environment, but plywood also allows trees smaller in diameter to be put to use when they cannot be used for lumber. "Optimizing lathe chargers and high-speed lathes capable of peeling to 3 1/2 inches or smaller cores make it currently possible to utilize much more of this forest resource" (Haygreen & Bowyer, p. 344).

Overall, "true forest sustainability requires integrating environmental concerns throughout the chain from forest management to the production and distribution of all forest products including wood and non-wood products. The most important contribution of wood science and technology to forest sustainability lies in its application along this 'environmental supply chain' through to the market place" (Cohen, 2002, p. 9).

The Wood Magic Program, originally founded by Mississippi State University, has grown. Virginia Tech and a few other universities have adopted Wood Magic to reflect the unique needs and interests of their communities. Very popular with elementary schools, these programs present active, hands-on, and engaging science-based education, allowing students the opportunity to obtain both a theoretical and practical knowledge in these areas of study.

The program offers an opportunity to educate tomorrow's citizens by extending the reach of traditional Wood Magic Programs that currently exist to a program offered via distance education. The proposed course of instruction will broaden access to Wood Magic nationwide by providing Wood Magic Distance Education programs with web-based learning sites and stand alone kits that can be delivered via interactive video technologies.

*Assessment of Learners*

The target audience is third, fourth, and fifth grade students in the range of seven to eleven years of age. The focus of this program will expand to the East Coast, but currently it serves students who live in Southwest Virginia, primarily those surrounding the campus of Virginia Tech. These areas are generally rural with families coming from a range of low to middle socio-economic status. This non-credit program will be approximately an hour and a half long. The Wood Magic Distance Education Program is a supplement to information that students study in their regular science class, particularly in the environmental science area. Participants in the Wood Magic Distance Education Program will discover the ways wood impacts their daily lives. They will formulate relationships between wood, science, and technology. The learners will experience real world applications to theoretical knowledge attained from science courses. According to the theoretical model discussed in Chapter One, this type of learning program is ideal for this age group. Piaget postulated children between the ages of seven to eleven, were in the concrete operation thought stage, which is characteristic of formulating logical relationships between objects that are real, tangible, and concrete.

The participants in the WMDEP will decide how to use, reuse, and recycle wood products in a variety of ways.

The content of this program will include the following activities that illustrate the need to understand and learn about wood science:

- Wet Elbows
- Rock Stars

- Wood Sandwich

Each of these activities will utilize a combination of efforts by the learners. Wet Elbows is a group activity consisting of groups of 4 students; Rock Stars, is a class effort; and Wood Sandwich, is an individual, or group effort.

A pre-assessment of student learning is also conducted at this time. Teachers in the classroom will distribute a worksheet, which asks the students questions in relation to wood science, in particular to the activities they will perform the following day, but that also correlate to the Virginia Standards of Learning. The same worksheet will be distributed to the children after the program, to perform a post-assessment. The pre/post assessment can be seen in Appendix D.

*Instructional Goals and Objectives*

In order for the program to be a success, goals and objectives that are realistic and beneficial to the learners must be produced. A series of three activities have been chosen that will educate the learner about the importance of environmental sciences and allow the student to indulge in these activities while having fun. As educators, we borrowed Piaget's idea that within the concrete operational thought stage, true knowledge originates from active manipulation of materials. A "commitment to active learning in turn leads teachers and curriculum planners to put more tangible activities into educational programs whenever possible" (Seifert, & Hoffnung, 1987, p. 484). Within the three activities, the following are the goals and objectives for each:

*Wet Elbows*

- Goal – Given a procedure sheet from the instructor(s), learners will implement the process of how paper and paper products are produced.
- Objective 1 (cognitive) – Learners will be able to verbally list the chronological steps in the process of papermaking.
- Objective 2 (psychomotor) – Learners will be able to produce an actual sheet of paper given raw materials.
- Objective 3 (affective) – Learners can apply the process of recycling their own paperwork at home into a new sheet of paper.

*Rock Stars*

- Goal – Learners will be able to observe the strength of wood under tension.
- Objective 1 (cognitive) – Learners will point out the grain on a piece of wood.
- Objective 2 (cognitive) – Given pieces of wood with different thickness, learners will choose the strongest piece of wood.
- Objective 3 (cognitive) – Given a sample of a cut tree, learners will identify growth rings.
- Objective 4 (cognitive) – According to the number of growth rings, learners will determine the age of the tree.

*Wood Sandwich*

- Goal – Learners will implement the processes necessary to make plywood.
- Objective 1 (cognitive) –Given pieces of veneer, learners will be able to define and identify the grain.

- Objective 2 (cognitive) – Given a piece of veneer, learners will formulate a relationship between grain direction and strength.
- Objective 3 (psychomotor) – Given several pieces of veneer, learners will arrange the pieces of veneer to produce a sheet of plywood according to the instructor's specifications.

*Technologies-Medium of Delivery*

This program will be delivered via Interactive Video Conferencing (IVC). It will be delivered from the home site, the Forest Service-Wood Education Resource Center located in Princeton, West Virginia, out to other remote sites. This method of delivery is 2-way video and audio conferencing, with a supplemental web site for the teachers to prepare for the program, ask questions, and download information. IVC allows for children's attention to be held for a longer period of time due to the face-to-face interactivity, as well as, the excitement of using a new technology. The goal is to make learning fun for the student in a new and exciting way, which will captivate their attention, and allow them to engage in concrete and real learning experiences.

As the first program to be implemented will be a pilot study, three elementary classes will participate in this program at one time. Each class will be transported by bus to each of the three facilities. One class, with teacher and volunteers, will be participating from the Forest Service Wood Education Resource Center, located in Princeton, WV. This is the main site where the distance instructor will be delivering the program. The two other sites have not yet been determined. At each site, the elementary school teacher for each participating class will serve as facilitator, along with the help of a couple of volunteers. The recommended number of students participating in each class should not exceed 20. There will also be a technical support person available at all three sites.

Interactive Video Conferencing will be used to communicate with the teachers and learners at all sites during the program. All learners are encouraged to interact with the distance instructor, as well as their teacher and other learners in the class. Email addresses will be available from the web site for the participating students to communicate with each other. The learners will be grouped according to location. Following the program, the distance instructor will post a question on a discussion board located on the main web site. Each learner will be required to address the question, and respond to a peers' answer to that question. However, they are not allowed to respond to a comment from any learner that is in their home class. The learners are also encouraged to utilize chat software, such as Instant Messenger, to discuss information from the lab experiments. Requirements for the teachers would include obtaining all necessary materials two weeks prior to the scheduled program date, which would be sent to the teachers of each attending class. Teachers are responsible for confirming that they have received the materials via email or phone.

The host site (Princeton, WV) has access to ISDN lines, which are typically phone lines that consist of pairs of 64 KB of information bundled together to make 384 KB. Using the 384 KB allows for access to other sites with equal or more amounts of data transfer capacity. The use of a "bridging service" has been incorporated to allow calls to be made to more than one site simultaneously. This service acts as a mediator to first tie all the lines together and then transmit out to the individual remote sites.

The justification for using an ISDN line for this program rather than a more sophisticated method is cost. Using 384 KB is a sufficient amount of data transfer for this program. The use of an ATM-T1 line was discarded because of its limitations', if an ATM network were used, communication would be limited to only sites that have access to this ATM network and have a T1 line. It also greatly increases the price of IVC. Using the ISDN will allow the roots of the program to be established within a reasonable budget. Upgrading is always an alternative for future interest.

The host communities are expected to hire technology student support staff in an effort to provide support, as well as for setting up the equipment and testing it prior to the start of the program. They are also responsible for shutting all equipment down after the program is completed.

The first formal formative evaluation meeting will be held at this time to determine if the development of the program is realistic. It will be reviewed as to whether the goals and objectives can be met using the medium of delivery that has been chosen, as well as the use of this medium in the targeted areas of delivery. Tracking costs will be evaluated at this time to assess whether the program falls within the allotted budget. It should be emphasized that, although this is the first formal meeting for purposes of formal evaluation, evaluations are performed at each stage in the model.

*Support Mechanisms*

While designing this program, the desire is to keep the steps to a minimum and promote an easy, well-designed method for the success. Each teacher will sign his or her students up for the Wood Magic program by using an on-line registration form. This method of choice allows for easy access and fast updates to those preparing the materials and organizing the program. Wood Magic brochures will be sent out to science teachers explaining the program and will include the web site address and the on-line registration form. An email will also be sent out to remind teachers to sign-up for the program within the available time frame.

The web site will include the registration form, library resources, email addresses for contact information, instructions on lab materials and a separate feedback form, to be completed after the program. This site will also include links to other interactive sites that are student-centered and to environmental science links for the benefit of the teacher and his or her students.

The teachers enrolled in the program will be asked to go the web site and review the materials before the program in order to be prepared to assist the learner. The feedback and assessment form will be an on-line survey and the teacher will be encouraged to fill the form out to provide constructive criticism on the program. The completion of these forms is important so that the program can be improved in future years according to teacher feedback.

Initially, the program will be available twice a year. This will allow for modification of the content and instruction according to the students level of understanding and to address the Virginia's Standards of Learning (SOL's) for third, fourth, and fifth grade science.

*Development of Materials / Instructional Strategies*

The WMDEP uses print, electronic materials, and concrete objects, as the main teaching materials during the program. The printed materials are in the form of discussion sheets, and notes that state the main points of the information that will be presented. A Power Point presentation is also used as supporting material, which presents the main steps of the activities for the students to view. The experiential method is used for this program, which allows the students to work together with concrete materials (focus of the program), involving them in hands-on experiences. The activities would allow the students to create real samples of different items that utilize wood, resulting in their learning from realistic cues that would not otherwise occur. Imagine what the children will learn and remember when they have the chance to make real paper during our program, in comparison to following a textbook and looking at pictures of people making paper (Weston & Cranton, 1986).

The activities previously mentioned are teacher-directed and will be completed using several instructional strategies. These strategies are:

- Verbal Information- to communicate with the instructor and other students;
- Hands-on Activities- to perform activities using psychomotor skills;
- Demonstration/Assembly- to learn by observation and in turn complete the tasks at hand;
- Intellectual Skills- to understand the processes being shown;

For each activity, the students will have the materials sent to their school prior to the start of the program. The distance instructor at the remote site will first provide verbal information addressing the importance of environmental education and how it pertains to the students' everyday lives. The materials will be passed out to the students, and the distance instructor will provide a demonstration. The students will be conducting the experiments at the same the instructor is demonstrating it. The on-site teacher and volunteers are there to assist the students with the experiments. Additionally, by utilizing IVC, the distance instructor will be able to monitor the students' progress as they are conducting the experiments.

The teachers at each site will cue the distance instructor when they need to slow down during the progress of the activities. The students will also have the opportunity to ask questions of the distance instructor as they develop ideas and curiosities. The distance instructor will continuously tie the activities back to the instructional goal and reiterate the objectives to the students. The feedback to learners will be instantaneous during these activities.

*Pilot Test/ Delivery*

Conducting a pilot test for the program using fellow students or colleagues allows for feedback. Feedback is integral to the learning process and the program design is dependant upon it to improve. Feedback will help the instructor determine what was and was not being understood so that subsequent programs can address any misunderstandings.

*Evaluation*

A formative evaluation will be conducted throughout the development of the program. As an example, a brief small group evaluation will be conducted immediately after the pilot test has been delivered to the group of third, fourth, and fifth grade teachers who participated in the pilot test. The evaluation of program will be based on the following:

1. Are the goals and objectives being met?
2. Do the materials and activities support the goals and objectives?
3. Does the content correspond with the elementary school's Standards of Learning in science (in VA only)?
4. Are the current technologies sufficient? Are upgrades to the system needed?
5. What are the participants' attitudes towards the content of the instruction?
6. What are the participants' attitudes concerning the strategies used to deliver the instruction?
7. Is the website accessible to the public? Are all links active?

For the first year, a summative evaluation will be conducted after each program has been delivered. This evaluation will be performed by a professional Summative Evaluation Facilitator to see if the program fulfills its original intentions. He/she will use the AEIOU approach that was discussed previously in Chapter Three (step 12 of the design model). The teachers and students who participated in the program will also perform a summative evaluation. The teachers will fill out a simple evaluation form in the week following the program, which will be relayed to the on-line survey from the web site. As a post-assessment of the students' learning, the students will complete a follow-up activity the following day in the classroom. This assessment will be in the form of an activity worksheet and will communicate to the teacher if the students retained the goals and objectives covered in the program. This is the same worksheet the students completed in the pre-assessment, with the exception of an additional section for the students to comment. The teacher will review these activities, and make comments accordingly on his/her on-line survey. The teacher's evaluation will be based on the following questions:

1. Are the students receiving hands on experience and having fun while learning?
2. Are the students learning the targeted information?
3. Does the content correspond with the elementary school's Standards of Learning in science (in VA only)?
4. Are the sites easily accessible to the elementary school?
5. Are accommodations available for students with special needs?
6. Are the IVC rooms accommodating to students with assistive needs?

The stakeholder feedback analysis is a report containing the following compiled information: analysis of feedback from teachers, cost analysis, and suggested changes. This report will be provided to the Forest Service and other members who have invested time and money into the program, and should be used for future improvements.

A cost analysis will be completed after each program to determine if funds are available for improvement. The current budget will be reviewed with the Forest Service, and other persons involved, evaluating the effectiveness of the program to ensure the funds are used in an appropriate manner. A report containing: feedback, evaluations and assessments, and cost analysis will be compiled for all stakeholders of the program.

*Proposed Budget*

The proposed budget for the Wood Magic Distance Education Program includes start-up costs as well as annual systems maintenance costs if a school were to integrate this system in their individual school. This information is provided in the following table:

Table 1. Costs to Implement IVC Technologies

| CATEGORY | ONE-TIME COSTS | ANNUAL COSTS |
|---|---|---|
| Zydacron System (operating system) | $5,000.00 | 0 |
| Scan converter | $1,300.00 | 0 |
| Instructor camera | $1,200.00 | 0 |
| Student camera | $1,200.00 | 0 |
| Push to Talk microphones (20) | $5,000.00 | 0 |
| Camera mount (2) | $570.00 | 0 |
| Furniture (cart) | $500.00 | 0 |
| VCR | $150.00 | 0 |
| Room lighting | $600.00 | 0 |
| Cable conduit | $400.00 | 0 |
| Command touch panel | $5,000.00 | 0 |
| Computer | $2,500.00 | 0 |
| UPS power backup | $200.00 | 0 |
| Projector | $4,000.00 | 0 |
| Screen | $450.00 | 0 |
| Tech support (2 hrs, 2 semesters) | $200.00 | $200.00 |
| Bridging service | $540.00 | $540.00 |
| Summative evaluation facilitator | $4,000.00 | $4,000.00 |
| | | |
| **TOTAL** | **$32,810.00** | **$4,740.00** |

Usage costs for the IVC technologies are not standardized and vary greatly within states, as well as facilities. If a class were to visit one of these facilities, the cost of materials, plus the following estimate of the costs would incur:

Table 2. Usage Costs

| | |
|---|---|
| ISDN Lines (long-distance calls) | $115.00 / 1.5 hours |
| Room Fee | $150.00 |
| Bridging Costs | $85.00 / 1.5 hours |
| **Total** | **$350.00 / for each site** |

The "Big Picture" of this program is for the learners to be exposed to science material that would compliment their current studies in a way that provides hands-on experiences. Wood is one of the most accessible, versatile, and renewable resources. It is cost efficient and very strong. Wood is the primary material used in the construction of houses. It is used to manufacture things such as desks, tables, and chairs. It is also used to produce things such as napkins, paper, and books. Because of its efficiency in cost and strength, wood is one of the primary resources, and most utilized resources, impacting day-to-day living. This program is designed to teach the variety of ways in which wood is used in everyday life. It is often overlooked and not recognized for its many contributions within society today.

The instructional goal of the WMDEP is the following: Participants in the Wood Magic program will discover the ways wood impacts their daily lives. They will formulate relationships between wood, science, and technology. The learners will experience real world applications to theoretical knowledge attained from science courses. The participants will decide to use, reuse, and recycle wood products in a variety of functions.

*Sample Unit of Instruction-Wood Sandwich*

Students participating in this activity will be making a piece of plywood, or what the Wood Magic Distance Education Program calls a "Wood Sandwich". Within Piaget's concrete operational thought stage, this activity involves the process called seriation described in chapter 1, which refers to the ability to put items in a series or sequence. The children are utilizing this learning process when asked to place the wood veneers in a particular order. The instructional objectives for the Wood Sandwich activity have been listed in the previous section, but are reiterated below to provide a complete picture of the activity.

- Objective 1 (cognitive) – Given pieces of veneer, learners will be able to define and identify the grain.
- Objective 2 (cognitive) – Given a piece of veneer, learners will be able to formulate a relationship between grain direction and strength.
- Objective 3 (psychomotor) – Given several pieces of veneer, learners will be able to arrange the pieces of veneer to produce a sheet of plywood according to the instructor's specifications.

The program begins with the facilitators passing out pieces of veneer and asking the students to bend it with and against the grain. This allows them to see and "feel" the stiffness of the wood in the different directions. It is explained to them how the plywood is made stiffer when the grain is alternated. The learners then have the opportunity to try using their own materials. A comparison is then made between making a cheese sandwich and making a piece of plywood. This allows the learner to gain an understanding of the process of making Plywood.

<u>Needed Materials:</u>

Extremely thin pieces of veneer about 6” square

Glue paper sheets

Very hot iron

Binder clips or clamps

<u>Instructions:</u>

1. Each learner will receive three pieces of veneer and two pieces of glue sheet
2. Demonstrate the assembly process to the learner and allow them to follow along with you.
3. Place the two veneer sheets together; making sure the grain is in the same direction.
4. Have the learner slightly bend the veneer, noticing its stiffness. Caution them not to bend it too far, causing it to snap.
5. Then ask them to change the direction of one piece of the veneer, so that the grains are in opposition to one another. Have the learner again slightly bend the veneer, observing the stiffness. This test should demonstrate to the learner how much stiffer it is when placed in opposing directions.
6. Next, have the learner place one piece of glue sheet between each piece of veneer, so that it resembles a double-decker sandwich. The glue sheets will become sticky upon heating.

7. Place a piece of aluminum foil on either side of the stack
8. Place the “sandwich” under a high quality iron (high heat, no steam) and apply pressure in a sliding motion for 3 minutes on each side of the 3-ply stack.
9. Clamp each side of the “plywood” with two binder clips, size 5.
10. Allow the glue to dry.
11. Each student now has a mini sample of Plywood.

After the activity is completed, the instructor will review the information with the learners. He or she will verbally go over the goal and objectives with them, and ask simple questions to “test” their understanding. This is an easy method of assessing student learning to see if they retained any information by going through the process of this activity.

*Wood Magic Distance Education Kits*

This teacher-directed IVC program is designed to be a supplement to third, fourth, and fifth grade science instruction in the elementary school. It is offered to provide access to those learners who would not have the opportunity to participate in these types of hands-on experiences in the area of wood sciences. This program allows the students to participate in a unique class experience that would not otherwise be offered within their normal curriculum.

The WMDEP kits are designed for educators to use at any location (distance education sites.) These kits consist of the following: Instruction booklet, which is the instructions and material list including the cost and place of purchase, for each event (Appendix A).

# Results and Discussion

*Chapter Five*

A thorough description of the instructional design model, and the Wood Magic Distance Education Program has been provided. What is not known, however, is whether teachers would be interested in incorporating this program into their current curriculum. One must consider: Are there barriers preventing them from implementing the program? What is the significance of any relationship that may exist between barriers? The aim of this study is to determine the barriers to implementing this program in U.S. schools, and how these barriers influence the adoption of distance education programs in current school curricula.

### *Methodology*

In order to address the questions posed above, a survey (Appendix C) was conducted of third, fourth, and fifth grade science teachers in Virginia. To define the population, the survey was limited to the state of Virginia. Additionally, in order to obtain a more similar sample population, and to control for differences in budgetary resources, private schools were excluded.

### *The Sample*

The purpose of choosing a sample from the population and performing a survey is to be able to make generalizations about that population. It is not feasible to seek information from every person in a particular population. " A sample, therefore, is intended to become a microcosm of a larger universe (Rea & Parker, 1992, p.107)" The methodology used to select the sample for this study is based on the mailed questionnaire sent to the teachers. It was first determined that the most important question on the survey is:

Please rate the following barriers if you were to adopt a Wood Magic program.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Time: | large barrier | 1 | 2 | 3 | 4 | 5 | small barrier |
| Travel Resources: | | 1 | 2 | 3 | 4 | 5 | |
| Cost of Materials: | | 1 | 2 | 3 | 4 | 5 | |
| Effectiveness of student learning: | | 1 | 2 | 3 | 4 | 5 | |
| Curriculum approval: | | 1 | 2 | 3 | 4 | 5 | |
| Lack of support personnel: | | 1 | 2 | 3 | 4 | 5 | |
| Lack of distance education experience: | | 1 | 2 | 3 | 4 | 5 | |
| Lack of technological knowledge: | | 1 | 2 | 3 | 4 | 5 | |
| Lack of knowledge of distance education technologies: | | 1 | 2 | 3 | 4 | 5 | |

Other (please fill in here): ______________________________________
______________________________________
______________________________________

1 2 3 4 5

The respondent was asked to rate each of the nine barriers based on whether they thought the barrier was large or small. This type of question is described as an ordinal measurement scale, which "orders people, objects, or events along some continuum" (Howell, 1992, p. 6), and it is used to estimate a mean outcome for each barrier.

The equation used for determining sample size for the above question is the following:

$$n = \frac{(Z_{\alpha/2})^2 (\hat{\sigma})^2}{h^2} \qquad (1)$$

where $\boldsymbol{n}$ is the required sample size, $\boldsymbol{Z_{\alpha/2}}$ is the reliability coefficient calculated assuming a 95% confidence interval to be 1.96, $\hat{\sigma}$ is an estimate of the standard deviation of the population (0.666), (maximum value-minimum value / 6) (Parasuraman 1986) and $\boldsymbol{h}$ is the tolerance level or precision level (error) in this case 0.05. Introducing these values into equation (1) we obtain a sample size of 683 teachers.

Because the names of the individual teachers within the schools were not readily available, six surveys were sent to each of the randomly selected schools. A total of 2700 surveys were sent to teachers, with the expectation of a 30 percent return. This percentage of return would result in 810 completed surveys, which is an overestimate of the calculated sample size. However, this overestimate allows for fluctuation in the number of teachers available to complete the survey at each school.

Using the Virginia Department of Education web site (www.pen.k12.va.us), 1237 public elementary schools were identified within Virginia. We randomly selected 450 schools out of the 1237 using a random number generator found at **www.random.org**. (The random number generator works by tuning a radio to a certain frequency where no one is broadcasting, the atmospheric noise is picked up by the receiver and fed to a computer by the microphone port. The random noise is sampled by a program as an 8 bit signal, the upper seven digits are discarded and the remaining bits are gathered and turned into a stream of bits with high entropy). A packet was sent to the principal of each school with instructions requesting him/her to distribute to the third, fourth, and fifth grade science teachers.

Each packet consisted of an introductory letter to the teacher, a page describing the Wood Magic Distance Education Program with the options to choose between offered programs, and a survey. Six self-addressed envelopes were included with each packet.

We calculated the three measures of central tendency, which are: mean, median, and mode, these can be found compiled in Table 3. A chi-square test was performed between the independent variables to determine any existing relationship. The chi-square test is a non-parametric test that allows us to reject or accept a hypothesis with a certain degree of confidence. In this case the hypothesis is that the independent variables: grade and years taught, have the same probability of response to the variables: barriers, option chosen and interest in pilot test. The test was performed to a confidence level of 95%.

*Results*

According to the survey, it was also found that the majority of respondents expressed an interest in attending a teacher workshop at a videoconferencing facility, in which teachers return from the workshop with the material to use in their own classrooms. It was also found that more respondents taught grade three, and the average number of years taught by all respondents was 12.9.

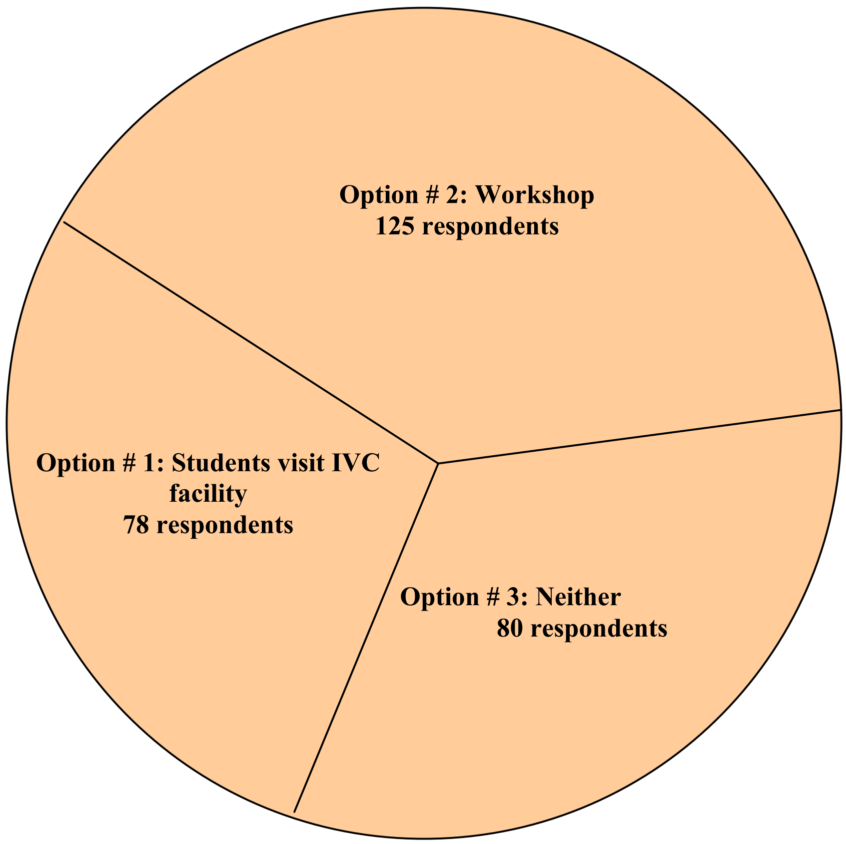


Figure 2. Options Chosen by Respondents
Total number of respondents: 283

Of the 299 teachers who responded to the question regarding participation in a pilot study this spring/summer; approximately seventy-five percent said ‘no’. The majority of those teachers, who responded ‘no’ to participation in the pilot study, were grade four teachers, and averaged 12.3 years of teaching experience. The majority of those who responded ‘yes’ to participation in the pilot study were also grade four teachers and averaged 14.2 years of teaching experience.

Table 3. Mean, Median, and Mode Analysis of Survey

| **Question** | **Mean** | **Median** | **Mode** |
|---|---|---|---|
| "What grade do you teach" | 4.0 | 4 | **3** |
| "How many years have you been teaching?" | **12.9** | 10 | 4 |
| "Which activity would you participate in?" | 2.0 | 2 | **2** |
| **Barriers:** Time | **2.1** | 2 | 1 |
| Travel Resources | **2.2** | 2 | 1 |
| Cost of Materials | **1.8** | 1 | 1 |
| Effectiveness of Student Learning | **3.4** | 3 | 3 |
| Curriculum Approval | **3.4** | 4 | 5 |
| Lack of Support Personnel | **3.3** | 3 | 3 |
| Lack of Distance Education Experience | **2.7** | 3 | 1 |
| Lack of Technological Knowledge | **3.4** | 3 | 3 |
| Lack of Knowledge in Distance Education Technologies | **2.7** | 3 | 3 |
| "Interested in participating in a Pilot Study?" | 1.7 | 2 | **2** |
| The grades that said 'yes' to the Pilot Study | **4.0** | 4 | 3 |
| The grades that said 'no' to the Pilot Study | **4.0** | 4 | 3 |
| Number of Years that said 'yes' to the Pilot Study | **14.2** | 11 | 4 |
| Number of years that said 'no' to the Pilot Study | **12.3** | 10 | 2 |

Utilizing the data collected, a bar graph was created to depict the order of the barriers to adopting the WMDEP into their current curriculums. The largest barriers to adopting the WMDEP were: cost of materials, time, and travel resources.

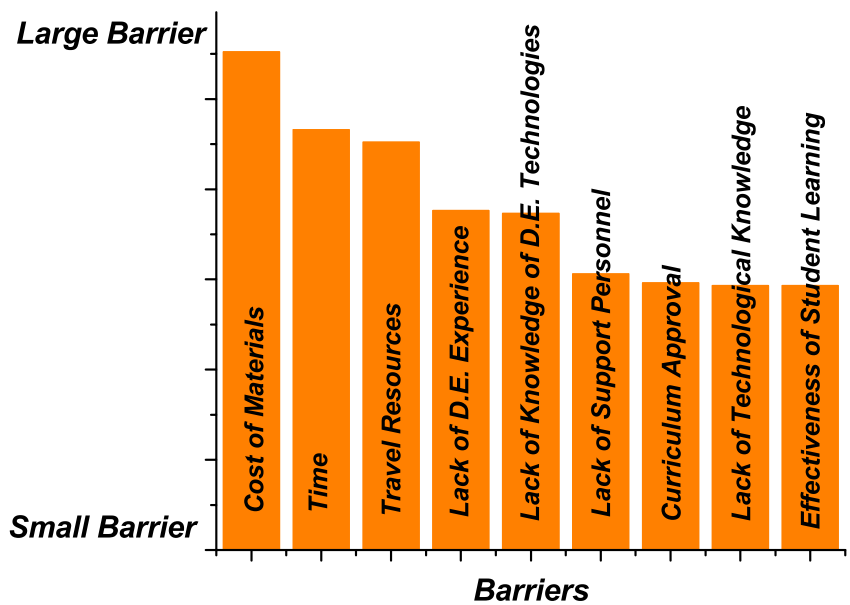


Figure 3. Barriers to Implementation of the WMDEP

The chi-square test found no significant relationship between the independent variables of grade and years taught to the nine barriers. However, it did find a significant relationship between the variables of grade and years taught to option chosen and interest in pilot test, the probabilities of such test can be found in Table C. (1-2) in Appendix C.

For the contingency table of grade taught to option chosen we found that more fifth grade teachers chose to attend a teacher workshop than expected. For the contingency table of number of years taught to option chosen it was found that more respondents in group 21-30 years teaching preferred to attend the teacher workshop than was expected.

For the contingency table of grade taught and interest in a pilot test, it was found that more fifth grade teachers did not want to attend a pilot test than expected, we also found the same relationship with the 21-30 years teaching group to the pilot test. However, there is no significant relationship between years teaching and grade taught.

*Limitations*

Several limitations or concerns bear mentioning in regards to the survey. The format of the survey created a few problems that became clear when they were returned. It was brought to the researcher's attention that the first two questions ("What grade do you teach?" and "The number of years you have been teaching?") should have been numbered questions #1 and #2. Since they were not numbered several respondents skipped these two questions**.** Further, the heading 'small/large barriers' should have been placed above all nine barriers listed. Because it was not placed above all barriers many respondents skipped the first barrier, 'time'.

Of the total 301 surveys returned, four respondents were not science teachers; three surveys were discarded due to two options being chosen and the researcher could not count one over another; and one survey was incomplete, and therefore thrown out.

Two additional barriers prompted by the respondents were recorded: (1) Distance learning is impersonal (3 respondents), and (2) Difficulties in finding grade appropriate materials that cross all three academic levels (grade 3-5).

In addressing the last question, ‘Would you be interested in participating in a pilot study for the instructional program this spring?’, many respondents replied that they would participate in the program *if* the following conditions applied: (1) at no cost, (2) no travel involved, (3) distance education facility were nearby their school (due to school system restrictions requiring bus travel to be within a certain distance).

Comments made by respondents reflected the following: (1) Five respondents commented on not having technology available to them, (2) Two respondents stated they would like to have the videoconferencing available to them in their own school, (3) and one respondent was not able to attend a facility due to the costs and being at is an ‘at-risk’ school.

# Conclusions

*Chapter Six*

In spite of the cost of materials, time, and travel resources, which were found to be the three largest barriers into adopting the Wood Magic Distance Education Program, the distance education environment is useful and currently being implemented nationally and internationally. The benefits of incorporating interactive videoconferencing technologies began with use in the higher institutions of education and are now exponentially growing into the K-12 curriculum. By implementing the WMDEP into current curricula, not only are students and teachers receiving factual information and hands-on experiences from the activities involved in the program, they are being exposed to current technologies, which foster growth in today's information society.

It was the researcher's expectation that the majority of the respondents would chose to bring their students to a facility equipped with distance education technologies. Instead, the majority (three quarters) chose to attend the teacher workshop in order to bring the skills and information back into the classroom. This option benefits the students while eliminating the three largest barriers: cost of materials, time, and travel resources. Finally, it is important to note that the option for the teacher to attend the workshop agrees with the outcome of the three largest barriers.

*Contributions of this Study*

The WMDEP has made several contributions in the academic areas of wood science and education. It has provided a detailed instructional design model for distance delivered instruction. This design model is grounded in theory and utilizes several characteristics of established instructional design models. This instructional design model can be used as a reference for instructors in all fields, even though our program has been tailored for instruction to children.

This study has found a need and interest in accessing and implementing the WMDEP. Although, as stated before, that it was expected more respondents would bring their students to a facility, receiving a twenty-eight percent response to implementing the WMDEP into the curriculum is a significant finding.

Furthermore, this study has identified nine barriers to implementing the WMDEP and has determined where, on a Likert scale of one to five (one being the largest, five being the smallest), these barriers were placed. Real life elementary school science teachers, who would be utilizing these technologies to implement the program, determined the placement of each barrier.

*Successful Characteristics*

The WMDEP contains many characteristics that have been shown to be a success in other implemented programs. The overall goal is to improve student learning in areas of environmental sciences such as wood science. In order to accomplish this goal, overall teacher knowledge in these areas needs to be improved, which takes a collaborative effort by many people to achieve. The reform effort called TOPS, which is previously described, discusses its three goals. The first goal is to plan and deliver hands-on experiences. The WMDEP is able to do this through the use of IVC. The second goal of this successful program is to make presentations to teachers to improve their knowledge of content. The WMDEP can do this by utilizing the teacher workshops, which was the most requested option on the survey of elementary school teachers. By providing a workshop, which utilizes IVC, teachers can obtain this knowledge and overcome the fears of teaching science, which have been reported as being so prevalent today. The workshop can fill the gaps in knowledge and allow for clarification in areas that are controversial. The use of the reform effort TOPS, found that ninety percent of teachers reported an increase in content knowledge. Teachers utilizing the WMDEP teacher workshop can also attain this type of result. The third goal of TOPS; providing a resource for students and families allows for students to become more involved in science activities. It was found that student's attitudes towards science improved by using TOPS, as well as an increasing their enjoyment of science. This ties directly to the two problems previously stated regarding the widespread misperceptions regarding the use and sustainability of American forests today, and the lack of hands-on activities as a means of learning for children ages seven to eleven.

*Further Research*

Exploring the implementation of the Wood Magic Distance Education Program, utilizing the instructional design model presented, would prove to be useful in the education profession. Addressing the issue of assessing the learners' knowledge as a result of the Wood Magic Distance Education Program by using the pre/post assessment worksheet would contribute to the improvement of the program as well.

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**APPENDIX A:** Wood Magic Distance Education Instruction Booklet

# WOOD MAGIC

## *INSTRUCTION MANUAL*

*Christina Pugh*
*Virginia Tech*
*2002*

# ROCK STARS


## Discussion

1. Discuss the strength of wood with the children by explaining that pound for pound, it is stronger than steel.

2. Express to the students that wood is a lot stronger than they might think. With this demonstration, the children will see how strong wood really is. It is quite a surprise!

# ROCK STARS

This activity corresponds with the following SOL's: Scientific Investigation, Reasoning, and Logic 3.1, 4.1, 5.1

*INSTRUCTIONS*

1. Place four school books on the table, allowing approx. a third of each book to hang over the edge of the table. Place them about a foot apart. Do this for both sets of books.

2. Slide the chain onto the stick and slide it to the middle, so the chain hangs from the middle of the stick.

3. Lay the two sticks over the books, as in making a bridge from one book to the other.

4. Place the S hook on the last loop of the hanging chain.

5. Attach the bucket handle on the S hook, and allow the bucket to hang (you may have to adjust the length of the chain if it is too long.)

6. Allow the students in each group to guess how many pebble or ponds of sand each stick would hold, write these down on paper.

7. Choose two volunteers to come up to the front to perform the experiment.

8. Put safety goggles on the volunteers

9. Allow the volunteers to slowly begin to fill up the buckets with the pebbles or sand using shovels, until enough weight is there to break the sticks.

10. Place the filled buckets on the scale to determine the weight it took to break the sticks.

11. Prize go to the student who was closest in their guess.

** Directions apply to both experiment set-ups

## Materials

| | | |
|---|---|---|
| 2 wooden sticks | 4 school books | 2 S hooks |
| 2 sand shovels | scale | 2 buckets |
| 2 chains | 2 volunteers | table (to work on) |
| 2 pairs of safety goggles | small pebbles or sand | |

# WET ELBOWS

## Discussion

1. Discuss how paper is made up of small pieces of wood, called *fibers*. We use paper every day, so much, that we don't realize how important it is for all of us. Some example of paper products are the following:

books, grocery bags, toilet paper, notebooks, and wrapping paper

2. Ask the children what happens to their old homework, see what types of responses you receive from them.

3. Explain that the advantage of paper is that it has the ability to be recycled and reused again and again. Let's see how you can make your very own paper!

# WET ELBOWS

This activity corresponds with the following SOL's: 3.3, 3.9, 4.8, 5.5, 4.1

## Materials

Wood fibers or small ripped pieces of old paper

Water

Large tub

Screen

An iron

Rolling pin

Blotter paper

Table

*INSTRUCTIONS*

1. Place bucket on left end of table, this serves as the beginning of an assemble line.

2. Place the screen and absorbent paper next to the bucket. Leave some space next to these materials for working room.

3. Further down the table, place the rolling pin, iron and more absorbent paper ( again, leaving working room).

4. Once the table is set up, fill the bucket half way with water and turn the iron on.

5. Place the wood fibers or scrapes of paper in the water.

6. Allow the children to come up to the table to begin the experiment.

7. Have the first child dip the screen in the water and bring up some wood fibers or *pulp* onto the screen.

8. Allow the excess water to drip out of the screen.

9. Place a piece of absorbent paper on top of the fibers that are on the screen.

10. Flip the screen over, while holding the absorbent paper in hand (teacher's assistance needed).

11. Remove the screen, still holding the absorbent paper and the wood fibers in hand.

12. Place the paper on the table, absorbent paper down.

13. Place another piece of absorbent paper on top of the pile.

14. Use the rolling pin to squeeze out the excess water.

15. Repeat # 13 and # 14

16. Use the iron to dry out the paper pile ironing both sides.

17. Remove the absorbent paper from the pile.

18. Place new piece of paper aside to dry.

# WOOD SANDWICH

## Discussion

1. Explain what Plywood is. It is thin sheets of wood, called veneer, that is glued together in opposite directions. The sheets or "veneer" comes from a tree that has been peeled (like an apple.) The strength of wood, depends on which direction the grain is going. "Grain" is formed by the way in which the tree grows. Wood is much stronger in the direction of the grain and less in the other direction.

2. Ask the children if they know what Plywood is used for. It is used in the construction of our homes and other buildings. It is in the floors, walls, and the ceiling too! Plywood is very strong, but it is also light, which is good in construction.

# WOOD SANDWICH

This activity corresponds with the following SOL's: Resources 3.1, 4.1, 4.4, 5.4, 5.5

## Materials

Cheese sandwich as the example

Extremely thin pieces of veneer about 6" square (Furniture grade veneer can be bought at a home improvement store)

Glue paper sheets

Hot press or iron

Tin Foil

#5 Binder clips

*INSTRUCTIONS*

1. Each student will receive three pieces of veneer and two pieces of glue sheet

2. Demonstrate to the children and allow them to follow you (make sure they are careful with the veneer, not to snap in by bending too far.)

3. Place the two veneer sheets together, making sure the grain is in the same direction.

4. Have the children slightly bend the veneer, noticing it's strength

5. Then, change the direction of one piece of veneer, so that the grain of the veneer is in opposition to one another, have the children do the same test of slightly bending the veneer, observing the strength. This test should demonstrate to the children how much stronger it is when placed in this direction.

6. Have the children place the two pieces of glue sheets between the veneer.

7. Place a piece of aluminum foil on either side of the stack

8. Continuously iron each side of the 3-ply stack for 1 minute while applying pressure (teacher assistance needed.)

9. Clamp each side of the "plywood" with two binder clips, size 5.

10. Allow the 3-ply stack to thoroughly cool.

11. Each student now has a mini sample of Plywood.

Table A.1. Materials List of KITS

| ACTIVITY | ITEM | PRICE | LOCATION |
|---|---|---|---|
| **ROCK STARS** | 2 Wooden Dowels (3/16” X 24”) | $0.33 | Wal-mart |
| | 2 Buckets w/shovels | $1.97 each (1 bucket w/ 1 shovel) | Wal-mart |
| | 2 Chains (1 ft each)- no. 12 Single Steel Jack | $0.43 / foot | Home Depot |
| * | 2 Volunteers | | |
| * | Small pebbles or sand | | |
| * | Scale | | |
| * | Table | | |
| * | 4-6 School books | | |
| * | 2 pr Safety goggles | | |
| | 2 S hooks | $0.94 | Wal-mart |
| **WET ELBOWS** * | Wood fibers or small pieces of old paper | | |
| * | Water | | |
| | Large tub | $3.88 | Wal-mart |
| | Screen | $ 4-6.00 | Home Depot |
| * | Iron (good quality) | | |
| | Rolling pin | $4.76 | Wal-mart |
| | Blotter paper | | Art Supply Store |
| * | Table | | |
| | 2 Photo frames 8X10 (to make screen) | $2.00 each | Wal-mart |
| **WOOD SANDWICH** | Extremely thin veneer, 6” square | | Donated by Westvaco |
| | 20 #5 Binder clips | | |
| | Tin foil | $1.46 | Wal-mart |
| * | Hot press or good quality iron | | |
| | Glue paper sheets | | Dynea Overlays, Inc (715) 634-5057 |

* Items the school will provide

**APPENDIX B:** Questionnaire Packet

Virginia Tech
VIRGINIA POLYTECHNIC INSTITUTE
AND STATE UNIVERSITY

Department of Wood Science and Forest Products

**College of Natural Resources**
**210 Cheatham Hall, Blacksburg, VA 24061-0323**
**(540)231-8853 Fax: (540)231-8176**

November 1, 2001

Hello, my name is Christina Pugh and I am a graduate student in the Department of Wood Science and Forest Products at Virginia Tech. I am gathering data for a thesis research project, which may be of interest to you and your profession. I am asking for 10 minutes of your time to read the following information and complete the attached survey to help me in this endeavor.

At Virginia Tech we host an educational program for third, fourth, and fifth graders called Wood Magic. Wood Magic is an innovative and interactive science program designed to teach children the importance of wood and its products. We have created several activities that allow hands-on involvement and interaction while learning about important environmental science issues. Wood Magic addresses the following Virginia Standards of Learning (SOLs):

*Third Grade*: 3.2-Force, Motion, and Energy, 3.3-Matter, 3.4-Life Processes, 3.10, 3.11-Resources
*Fourth Grade*: 4.2-Force, Motion, and Energy, 4.4-Life Processes, 4.5-Living Systems, 4.8-Resources
*Fifth Grade*: 5.1-Scientific Investigation, Reasoning, and Logic, 5.5-Living Systems

Each program can be implemented in approximately one hour and thirty minutes. Feel free to check out our web site at www.woodmagic.vt.edu

My research is to take the established classroom program and develop it into a Distance Learning program using two-way interactive videoconferencing. I am looking to you for some advice on ways to make this program most accessible to you.

Your opinions and answers will be used only within the context of this research and your anonymity is assured. We ask that you please fill out and return the following survey no later than December 4, 2001. Your input will greatly increase the validity and reliability of this research and provide vital information, which will be of future use for the implementation of this program. Please feel free to contact me or my advisor, Dr. Audrey Zink-Sharp, with any questions you may have. I can be reached by email at cmister@vt.edu or by phone at (540) 231-8179. Dr. Zink-Sharp can be reached by email at agzink@vt.edu or by phone at (540) 231-8176. Thank you for your time in assisting with this project!

Sincerely,

Christina Pugh-Graduate Research Assistant
Dr. Zink-Sharp-Advisor

Virginia Tech
VIRGINIA POLYTECHNIC INSTITUTE
AND STATE UNIVERSITY

Department of Wood Science and Forest Products

**College of Natural Resources**
**210 Cheatham Hall, Blacksburg, VA 24061-0323**
**(540)231-8853 Fax: (540)231-8176**

Overview of Instructional Options for Wood Magic

To make the Wood Magic program more accessible to Virginia's science educators, we propose two options. First, we can deliver the program directly to your students via interactive videoconferencing systems. Videoconferencing provides real-time interaction between groups located in different places. This means that a wood science expert in Blacksburg and students in your location (i.e., school, community college, graduate center, etc.) can talk and listen to each other as if they were in the same classroom together. If you chose to bring your students to a facility for a field trip your school would be responsible for paying approximately $ 200 that covers hourly wage, room fee, bridging connection, and the cost of materials (divided among 20 students = $10 /child.)

A second option we can offer is the delivery of a Wood Magic workshop for teachers, so that you can implement the activities in your own classroom. The workshop would be delivered via interactive videoconferencing to a facility in your area. If you choose to participate in such a workshop, you would be responsible for a one-time fee of approximately $ 200. This price covers hourly wage, room fee, bridging connection, and cost of materials. You would then be able to take the information back into your classroom for unlimited use.

With this information in mind, please complete the enclosed survey and return it to:

Christina Pugh

210 Cheatham Hall
Blacksburg, VA 24061

Thanks again for your time, it is greatly appreciated.

Virginia Tech
VIRGINIA POLYTECHNIC INSTITUTE
AND STATE UNIVERSITY

Department of Wood Science and Forest Products

**College of Natural Resources**
**210 Cheatham Hall, Blacksburg, VA 24061-0323**
**(540)231-8853 Fax: (540)231-8176**

Wood Magic Distance Learning Program

Please complete the following information:

Grade(s) you teach:
Number of years teaching:

1. If given the option, in which activity would you most likely participate?
   (a) Take your class to the nearest videoconferencing facility to participate in a distance-delivered Wood Magic program.
   (b) Attend a teacher workshop at a videoconferencing facility near you so that you can teach the Wood Magic program to your students.
   (c) Neither

2. The following is a list of barriers that commonly prevent participation in distance learning events. Please rate the following barriers as you believe they could impact your participation in either of the distance delivered programs in Item 1.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Time: | large barrier | 1 | 2 | 3 | 4 | 5 | small barrier |
| Travel Resources: | | 1 | 2 | 3 | 4 | 5 | |
| Cost of Materials: | | 1 | 2 | 3 | 4 | 5 | |
| Effectiveness of student learning: | | 1 | 2 | 3 | 4 | 5 | |
| Curriculum approval: | | 1 | 2 | 3 | 4 | 5 | |
| Lack of support personnel: | | 1 | 2 | 3 | 4 | 5 | |
| Lack of distance education experience: | | 1 | 2 | 3 | 4 | 5 | |
| Lack of technological knowledge: | | 1 | 2 | 3 | 4 | 5 | |
| Lack of knowledge of distance education technologies: | | 1 | 2 | 3 | 4 | 5 | |

Other (please fill in here): ______________________________________________
______________________________________________
______________________________________________

3. Would you be interested in participating in a pilot study for the instructional program this spring?
   Yes / No

**Pilot Study Information**

If you are interested in participating in a pilot study of the distance-delivered Wood Magic program, please provide the following contact information:

Name:

School:

Grade(s) you teach:

Address:

Phone:

Email:

Dear Principal,

I am a graduate student in the Department of Wood Science and Forest Products at Virginia Tech and currently collecting data for my research. Please review and distribute to your third, fourth, and fifth grade science teachers. Your cooperation is greatly appreciated.

Thank you,

Christina Pugh

Dear Principal,

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Thank you,

Christina Pugh

**APPENDIX C:** Chi-Square Analysis

Table C.1. Chi-Square p-values: Grade/Year to Barriers

| | Grade You Teach (p-value) | Number of Years Teaching |
|---|---|---|
| Option Chosen | **0.034** | **0.048** |
| Barriers: Time | 0.415 | 0.451 |
| Travel Resources | 0.703 | 0.756 |
| Cost of Materials | 0.564 | 0.787 |
| Effectiveness of Student Learning | 0.519 | 0.636 |
| Curriculum Approval | 0.129 | 0.444 |
| Lack of Support Personnel | 0.453 | 0.420 |
| Lack of Distance Education Experience | 0.656 | 0.483 |
| Lack of Technological Knowledge | 0.946 | 0.138 |
| Lack of Distance Education Technologies | 0.972 | 0.716 |
| Interest in Pilot Test | **1.3E-06** | **4.3E-04** |

Table C.2. Chi-Square p-value: Grade to Year

| | Number of Years Teaching (p-value) |
|---|---|
| Grade Taught | 0.635 |

**APPENDIX D:** Pre/Post Assessment Worksheet

**Wood Magic Distance Education Program**
**Pre/Post Assessment of Learners**

Directions: Please answer the following questions. These questions are to help us gauge your knowledge; many of these questions are advanced, grade five questions. You are not expected to know all the answers-have fun!

**Wet Elbows: (The following SOL's are covered in this activity: 3.3, 3.9, 4.8, 5.5, 4.1)**

1. If one were to make paper out of cells that are long, will the paper be stronger or weaker, than if it were made of cells that were short?

   Stronger / Weaker

2. Paper is made of:
   a. Plastic
   b. Wood
   c. Cells
   d. Bark
   e. b and c

3. Which of the following are natural resources that are needed to make paper?
   a. Trees
   b. Electricity
   c. Water
   d. None of the above
   e. Both a and c

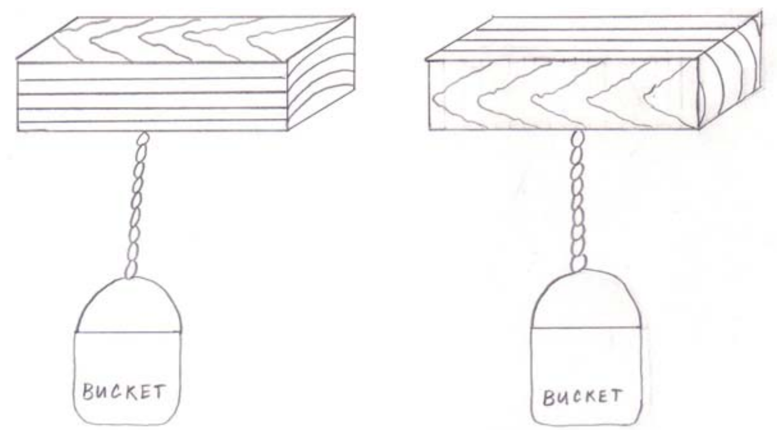
4. Cells come in many shapes and sizes.

   True / False

5. What part of a tree does paper come from?
   a. Leaves
   b. Stems
   c. Roots
   d. Flowers

**Rock Stars: (The following SOL's are covered in this activity: 3.1, 4.1, 5.1)**

6. During Wood Magic we will be testing the strength of wood. According the figure below, tell me which piece of wood will hold the most weight? The piece of wood is 3/16 inch by 36 inches, (note the growth rings on the wood).
   a. Wood # 1
   b. Wood # 2




Wood # 1 Wood # 2

7. Below is data from a test on the strength of wood. Rocks were added until the wood broke. The star (*) indicates the piece of wood that is unbroken. The X indicates the wood is broken.

| BREAKING POINT | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Sample | 4 rocks | 6 rocks | 8 rocks | 10 rocks | 12 rocks | 14 rocks | 16 rocks | 18 rocks | 20 rocks |
| Wood #1 | * | * | * | * | * | X | X | X | X |
| Wood # 2 | * | * | * | * | * | * | * | * | X |

Based on this data chart, which piece of wood do you think is stronger? Circle one
   a. Wood # 1
   b. Wood # 2

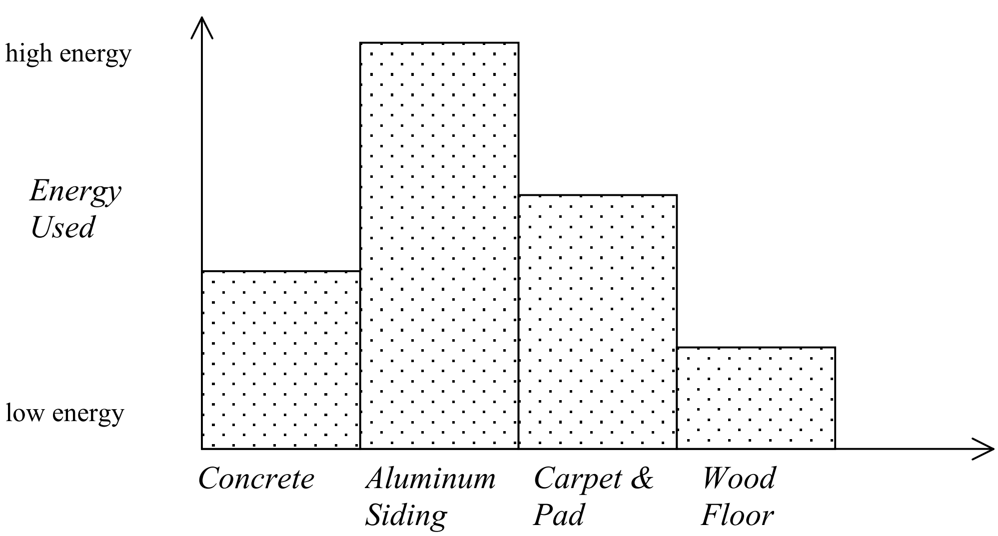
8. According to the chart above, indicate the breaking point of Wood # 1. ____________

9. According to the chart above, indicate the breaking point of Wood # 2. _____________

**Wood Sandwich: (The following SOL's are covered in this activity: 3.1, 4.1, 4.4, 5.4, 5.5)**

10. The cells in the trunk of a tree serve the purpose of:
    a. Transport food
    b. Transport water
    c. Provide strength
    d. Acts as storage space
    e. All of the above

11. Lignin is:
    a. A natural glue
    b. Type of tree
    c. Type of woodpecker
    d. None of the above




12. According to the bar graph, which material uses the most energy during manufacturing?
    a. Concrete
    b. Aluminum siding

c. Carpet and pad
d. Wood Floor

13. According to the bar graph, which material uses the least energy during manufacturing?

a. Concrete
b. Aluminum siding
c. Carpet and pad
d. Wood Floor

## Vita

Christina E. Pugh

02/21/1977

Christina was born on February 21, 1977 in Portsmouth, VA. She grew up and graduated from Tallwood High School in Virginia Beach in 1995. She later earned a BA in Communications from Virginia Polytechnic Institute and State University in 1999, and finally her MS in Wood Science and Forest Products in 2002.

She has held positions at Virginia Tech as an undergraduate recruiter for admissions as well as a departmental recruiter for the Department of Wood Science and Forest Products.

She currently lives with her husband, Dylan V. Pugh, in Christiansburg, VA.