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**Arboreal adventure: A cross curricular unit on trees**

Anne Elizabeth Boshoven

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ARBOREAL ADVENTURE: A CROSS CURRICULAR UNIT ON TREES

A Project

Presented to the

Faculty of

California State University, San Bernardino

In Partial Fulfillment

of the Requirements for the Degree

Master of Arts

in

Education: Environmental Option

by

Anne Elizabeth Boshoven

March 1997
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March 1997
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ABSTRACT

An Arboreal Adventure is a multi-disciplinary, thematic unit which offers to students hands-on learning related to a variety of trees, in order that they may gain a broader appreciation of the natural environment and perspective on the interdependence of all living things. The curriculum covers the subject areas of language arts, including reading, writing, and poetry; mathematics, including measurement, averages, ratios, proportions, and area of rectangles, triangles, and squares; science; and social studies. The unit can be taught for two to three weeks for students in grades six to eight. If the unit is taught as part of the middle school philosophy set forth in Caught in the Middle (California Department of Education, 1987), each curricular area can be taught in approximately one week by the respective subject area teachers.
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# TABLE OF CONTENTS

ABSTRACT ........................................................................................................ iii

ACKNOWLEDGMENTS .................................................................................... iv

INTRODUCTION ............................................................................................... 1

REVIEW OF THE LITERATURE

- Defining Environmental Education ................................................................. 4
- Teaching Strategies ......................................................................................... 6
- Importance of Environmental Knowledge, Responsible Attitudes, Skills, and Active Participation ......................................................... 10
- Developmental Patterns of Students in Relation to Environmental Education . 12

GOALS AND OBJECTIVES ............................................................................. 13

DESIGN OF THE PROJECT ............................................................................. 14

RESULTS .......................................................................................................... 15

APPENDIX: THE ARBOREAL ADVENTURE UNIT ............................................ 17

- Arboreal Adventure: A Multi-Disciplinary, Thematic Unit ......................... 18
- Introduction ................................................................................................... 19
- Subject Area: Language Arts ......................................................................... 21
- Subject Area: Mathematics ............................................................................ 28
- Subject Area: Science .................................................................................. 32
- Subject Area: Social Studies ......................................................................... 50

BIBLIOGRAPHY ............................................................................................... 54
INTRODUCTION

As a child, I would sit with paper and pencil in hand before a beautiful landscape—rolling hillsides, hundreds of trees pouring forth the brilliant colors of autumn, a sunset with the radiance of beauty as strong as a campfire blazing in the evening on an ocean beach front. I so desired the ability to replicate the beauty on my paper. Unfortunately, I was not an artist. Despite my attempts, I would “mess up” my picture, resulting in the crumpling and tossing away of my paper world. If I happened to create a piece worthy of display, I would hang it on the family refrigerator. Eventually, food spatter and dust would “mess up” my paper world, resulting in it being crumpled and tossed away.

While it is possible, and quite easy, to crumple and toss away paper worlds, it is not so with our real world, Planet Earth. Unfortunately, Planet Earth is being “messed up.” Yet, Planet Earth cannot be crumpled and tossed away in hopes of a new and fresh start.

Over fifty years ago, Aldo Leopold was calling for people to stop conquering the world and to start becoming citizens of it, so that we might preserve the environment (1966). Today, it is generally accepted that environmental education is critical for the preservation of our world. Steps have been taken to develop effective and responsible environmental education. In a 1968 California mandate, the Miller Bill required that environmental education be included in grade levels kindergarten through twelve, and all subjects where appropriate. In 1969 and 1970, The National Environmental Policy Act and National Environmental Education Act, respectively, were enacted as a tool for “improving the quality of the human environment” (Disinger, 1993, p. 24). The National
Environmental Education Act of 1990, under the direction of the United States Environmental Protection Agency, "reemphasized the need to increase public understanding of the natural environment and to advance and develop environmental education and training" (Klein & Merritt, 1994, p. 15). While it is generally accepted that environmental education is critical for the welfare of our world, environmental education is only beginning to take roots in every day school curriculum, and sporadically at best.

*An Arboreal Adventure* is designed to allow classroom teachers, grades six through eight, easy integration of environmental issues into their already existing curriculum. The project, as a whole, provides a multi-disciplinary, thematic unit which offers students hands-on learning related to a variety of trees, in order that students gain a broader appreciation of the natural environment and perspective on the interdependence of all living things.

The publication, *Caught in the Middle* (California Department of Education, 1987), stated that thematic units and active participation are major components of the middle school philosophy. *It's Elementary* (California Department of Education, 1992) suggested that teachers feel resistant to the addition of areas of study to already crowded curriculum. In *An Arboreal Adventure*, lessons integrate environmental education into already existing curriculum so that teachers do not feel the pressure of adding another study to their schedule. Such integration is not only supported by *The Science Framework for California Public Schools: Kindergarten Through Grade Twelve* (California Department of Education, 1990), but it also adds depth to student understanding of concepts through repeated exposure throughout the curriculum.
Furthermore, *The Science Framework for California Public Schools: Kindergarten Through Grade Twelve* (1990) also recommended active participation on the part of the student at all grade levels at least forty percent of the time. Each lesson of this unit includes such active participation.

While *An Arboreal Adventure* is designed to be used as a thematic unit, teachers may decide not to integrate the entire curriculum. Each lesson may also be taught as an entity unto itself.
REVIEW OF THE LITERATURE

The review of the literature first defines environmental education and explains the goals of environmental education. Then, teaching strategies for environmental education are discussed, including thematic teaching, active participation, multi-disciplinary, cross curriculum, group learning situations, issue investigation, action models, outdoor education, personal journals, and story telling. Next, the importance of environmental knowledge, responsible attitudes, skills, and active participation is examined. Finally, a look is taken at known developmental patterns of students in relation to environmental education.

Defining Environmental Education

Environmental education is an interdisciplinary process of developing citizens who are knowledgeable about the total environment, including both its natural and built aspects, and have the capacity and the commitment to engage in inquiry, problem solving, decision making, and action which will assure environmental equality (Disinger, 1993, p. 35). Thus, environmental education is an interdisciplinary process of developing an understanding about the total environment – including nature, culture, technology, people, ideas, and feelings about the environment – which also engages the learner in inquiry, problem solving, decision making, and constructive actions that assure environmental equality. Constructive actions involve active participation in the discovery of one's own interpretation of the world.

The 1977 Tbilisi Intergovernmental Conference on Environmental Education defined the objectives for environmental education as developing: 1) an awareness to the
total environment including its problems and issues, 2) a sensitivity through experience in and understanding of the environment, 3) a feeling of concern and motivation for active participation in the environment, 4) skills for identifying and solving environmental problems, and 5) an opportunity to be actively involved in working toward the resolution of environmental problems (in Hungerford & Volk, 1990).

Disinger (1993) said, “The bottom-line purpose of environmental education is the promotion of responsible individual and social environmental behavior” (p. 35).

Hungerford and Volk (1990) also claimed that the primary purpose of environmental education is to promote changes in human behavior (p. 8). Stoner (1992) added that it is the goal of environmental education to “produce citizens who understand and appreciate their relationship to the environment, while also developing their critical thinking skills and commitment to constructive action” (p. 1). David Orr (1990) claimed that “the goal of education is not mastery of subject matter, but of one’s person. Subject matter is simply a tool” (p. 54). Orr also claimed that education should help students “make the leap from ‘I know’ to ‘I care’ to ‘I’ll do something’.” (in Miller, 1995, p. 35).

It is widely accepted that active participation on behalf of the learner is critical (Ramsey & Hungerford, 1989; Sia, Hungerford, & Tomera, 1985; UNESCO, 1978; Volk, 1989;). Iozzi claimed, “Whereas knowing how to promote environmental quality is important, possessing such knowledge certainly does not ensure that one will be motivated to take action” (1989a, p. 4). Disinger (1993) stated that while research supports that knowledge of environmental concepts is necessary, knowledge, in and of itself, is not sufficient to bring about responsible environmental behavior. Hungerford and Volk
(1990) agreed that knowledge of the issues does not lead to responsible behavior towards
the environment. Instruction must also develop in the learner a sense of ownership and
belief that individuals are capable of making a difference so that they are prompted to
become responsible, active citizens. In addition, Hines, Hungerford, and Tomera
(1986/87) stated that while knowledge of environmental issues and the capability of
choosing the course of action most effective in a given situation are necessary, it is just as
important to be able to convert this knowledge into responsible action. Yet, they also
believed that personal factors such as an internal locus of control, positive attitudes
toward the environment, and a sense of personal obligation toward the environment are
also necessary for an individual to take action in an appropriate manner.

Aldo Leopold provided a vivid analogy: “[People] are only cogs in an ecological
mechanism such that, if they will work with that mechanism, their mental wealth and
material can expand indefinitely (and) if they refuse to work with it, it will ultimately grind
them to dust.” Leopold also asked, “If education does not teach us these things, then
agree that the major aim of EE [environmental education] is to produce individuals who
will willingly and responsibly participate in environmental maintenance and remediation”
(Hungerford & Volk, 1990, p. 17).

Teaching Strategies

David Orr (1990) claimed that “all education is environmental education” (p. 54).
Depending upon what is taught, or not taught, students learn that they are “part of or
apart from the natural world” (Orr, 1990, p. 54). It is widely accepted that environmental
education should be multi-disciplinary and interdisciplinary (Cook, 1982; Goldbert, 1991; Ham & Sewing, 1987/88; Lisowski & Williams, 1993; Tanner, 1974; Terry, 1971).

Iozzi (1989b) believed that environmental education should be infused into existing curricula at all levels of education because environmental problems are for the most part social problems. Pennock and Bardwell (1994) stated that environmental issues “provide a context for interdisciplinary learning” (p. 5). Stoner (1992) made the point that “all education is environmental,” adding that students need to be taught “how to think” rather than “what to think” (p. 2). Simmons (1989) agreed that environmental issues cut across the traditional disciplinary lines and, therefore, they should be infused throughout the school curriculum at every grade level.

Pennock and Bardwell (1994) pointed out that because young people have concerns about the environment, the study of these problems not only motivates them to learn but can help them develop a sense of hope. The study of environmental issues can develop skills such as decision making, critical thinking, and problem solving. Also, such study connects students to their communities and their peers (Pennock & Bardwell, 1994).

The California Department of Education (1990) recommended that environmental education be taught “thematically in every classroom at all grade levels” (p. 4). Thematic units and active participation are major components of the middle school philosophy set forth in Caught in the Middle (California Department of Education, 1987). Klein and Merritt (1994) stated that environmental education requires active learning by students to improve investigation and critical thinking skills.
Engelson (1985), Evans (1988), and Simmons (1989) supported the study of environmental issues through multi-disciplinary viewpoints. Evans encouraged teachers to ignore the artificial boundaries between the disciplines and focus on the problems that cut across them. Stoner (1990) promoted the infusion of environmental education into the curriculum through cross-curricular, thematic units because the use of such themes can potentially act as a means of student dropout prevention by providing meaning, purpose, and motivation for students.

The authors of the Compendium for Integrated Waste Management (California Department of Education, California Integrated Waste Management Board, and California Department of Toxic Substances Control, 1993) also agreed that environmental education is an interdisciplinary subject. The authors of the Compendium for Water Resources (California Department of Education, California Department of Water Resources, and Sonoma State University, 1992) stated that "environmental education curriculum materials are, by their very nature, interdisciplinary" (p. 33).

In combination with the interdisciplinary and multi-disciplinary approaches, researchers have suggested additional teaching strategies for environmental education. Ballantyne and Packer (1996) suggested group-learning situations for environmental education in which students are presented with alternative conceptions or incompatible knowledge because students are required to "explain, elaborate, or defend their positions to others" (p. 30). Two specific examples provided for group-learning situations are structured controversy and role play. Lisowski and Williams (1993) claimed that the issue investigation and action model "directly targets the behavioral realm" (p. 74). Hungerford
and Volk (1990) supported the issue investigation and action model teaching strategy that provides first hand experience, learning by doing, and involvement in real-life issues because the student is provided with opportunity to plan, apply, and evaluate alternative actions as they relate to particular environmental issues. Iozzi (1989a) reported that many researchers support the simulation model as far as it entices and motivates students in learning. Carlson (1993) reported that issue investigation using simulation in her classroom “overwhelmingly” increased student awareness of the environmental science about which they heard and read in everyday life, particularly through media.

Furthermore, Iozzi (1989a, 1989b) claimed that outdoor education is effective at improving environmental attitudes and values. Students are provided the opportunity to observe and discuss their likes, dislikes, and what they would like to improve in their environment. Lisowski and Williams (1993) suggested that “certain environmental concepts and skills are best taught in the environment” (p. 77).

Also, Ballantyne and Packer (1996) recommended the use of personal journals where students reflect and record their experiences. They explain that such journal writing enables students to become “aware of and explore their feelings toward the environment, reflect on their own and society’s interrelationship with the environment, and reevaluate their conceptions of why particular environmental issues are important” (p.30). Beringer (in Ballantyne & Packer, 1996) added that story telling about real-life environmental conflict and decision making on behalf of the student helps these individuals to evaluate situations, identify conflicts, and take responsibility for their stance on an issue.
As discussed above, there exists a variety of effective teaching strategies for environmental education. No one strategy is effective by itself; rather, combining the strategies to offer variety of style and experience is what is effective. Similarly, exposure to attitudes/values and to environmental knowledge is necessary. The education focused upon only attitudes/values or only knowledge does not offer effective opportunity for meeting the goals of environmental education (i.e., responsible environmental behaviors).

Importance of Environmental Knowledge, Responsible Attitudes, Skills, and Active Participation

Newhouse (1990) explained that because technology alone will not solve environmental problems, and because the root of environmental problems is human behavior, the design of the environmental education programs must include attitude and behavior research. "People often assume that knowledge will influence attitude, which will in turn affect behavior" (Newhouse, 1990, p. 27). Ramsey and Rickson (in Hungerford & Volk, 1990) proposed a linear model for changing behavior of students. They claimed that increased knowledge leads to increased awareness and positive attitudes which in turn lead to increased responsible action.

In contrast, Hines et al. (1986/87) have published literature supporting a nonlinear model of increased responsible behavior. They suggested that an intention to act will more likely result in action. This intention to act is dependent upon knowledge of issues and action strategies available, ability to act appropriately for the given situation, as well as various personality factors such as attitudes, locus of control, and a sense of personal responsibility. Together, these elements form a web which may lead to responsible
environmental behavior (Hines et al., 1986/87). Newhouse (1990) also supported this nonlinear model for the development of responsible behavior.

Research by Borden and Schettino (1979) has shown that virtually no correlation exists between knowledge of an issue and willingness to participate in responsible activities related to those issues. Newhouse (1990) concluded after an extensive review of the literature that “evidence that attitudes lead to appropriate behaviors or actions is not strong” (p. 27). Hungerford and Volk (1990) explained that the objectives of environmental education include “not only knowledge, attitudes, and skills, but also active participation in society” (p. 9). Thus, active participation on the part of the learner is vital; knowledge alone does not inspire responsible behavior.

Ballantyne and Packer (1996) stressed the importance of a holistic approach to environmental education. They claimed that to address environmental knowledge without consideration to attitudes and values limits the extent to which students can translate their knowledge into action. Still, on the other hand, Ballantyne and Packer (1996) explained that to “address environmental attitudes and values without providing an accurate and relevant knowledge base will limit the power and effectiveness with which attitudes/values are applied” (p. 27). Without knowledge, environmental behavior can be driven by misconceptions. Gigliotti (1990) argued that many “concerned citizens” lack comprehensive environmental knowledge, basing their values and behaviors on mere ecological myths.
Developmental Patterns of Students in Relation to Environmental Education

Stoner (1992) and Kellert (1985) suggested that environmental education programs should correspond to the known growth patterns of students. Stoner (1992) claimed that the major emphases for the following grade levels should be awareness and attitudes for grades pre-K through 3; knowledge and attitudes for grades 3-6; knowledge, skills, and attitudes for grades 6-9; and skills, knowledge, action, and attitudes for grades 9-12. Many have agreed that environmental attitudes and values should be developed at the lower elementary grades and then reinforced and further developed throughout the students’ middle and high school education (Bryant & Hungerford, 1977; Iozzi, 1989a; Miller, 1995; Rajeski, 1982).

Iozzi (1989a, 1989b) recommended that the greatest emphasis be placed on positive environmental attitudes and values during the elementary and middle school years. Then, during the senior high school years, greatest emphasis should be placed on developing the cognitive aspects of environmental attitudes and values presented in the lower grades (Iozzi 1989b). It is important to understand, however, that at no time is environmental knowledge totally ignored. The difference between the grade levels is the amount of emphasis placed on the different aspects (Iozzi, 1989b).
GOALS AND OBJECTIVES

The goal of this project was to develop a cross curricular, multi-disciplinary, middle school focused unit of approximately two to three weeks. The purpose of the unit was to offer to students the experience of hands-on learning related to a variety of trees, in order that they gain a broader appreciation of the natural environment and perspective on the interdependence of all living things. The unit was designed to help students not only appreciate the interdependence of all living things, but also to develop responsible attitudes, specific knowledge, and responsible actions towards the environment.

The goal was achieved in the following manner:

1. Developed a two to three week cross curricular, multi-disciplinary unit which allows a wide variety of hands-on experiences and interaction with trees. The unit included lessons and activities covering the following curricular areas: language arts, including reading, writing, and poetry; mathematics, including measurement, averages, ratios, proportions, and area of rectangles, triangles, and squares; science; and social studies.

2. Reviewed by the writer’s colleagues.

3. Field tested these activities in the writer’s classroom. Modifications were made to lesson plans throughout the unit.

4. Provided workshops about the unit to teachers at the 1995 Inland Empire Environmental EXPO and a Middle School Symposium of 13 middle schools and distributed copies.
DESIGN OF THE PROJECT

An Arboreal Adventure was originally designed to be used as an interdisciplinary unit by a team of teachers who teach according to the philosophy set forth in Caught in the Middle (California Department of Education, 1987). Subject area concepts were based upon the curriculum set forth in the Rialto Unified School District's Curriculum Outlines (1993). To develop lessons, various curricular guides containing lessons relating to environmental education were reviewed. Some lessons were adapted from their original sources based upon appropriate subject matter and grade level. Other lessons are original and were designed by the writer.

The unit consists of lesson plans to be taught over a two to three week period. Each lesson plan includes objectives, a time frame, materials needed, background information, procedural steps, extension activities, and a listing of California Framework correlation (science, language arts, mathematics, social science). Also included are masters of needed worksheets and samples of completed work.

In addition, the appendix includes the detailed lesson plans described above, as well as a list of curricular resources the writer found valuable during the preparation and teaching of this unit.
RESULTS

The writer field tested the unit in her seventh grade classroom and in one of her eighth grade classrooms. In addition, the writer’s team teaching partners tested various lessons within the unit in their eighth grade classrooms. The field test data was used to modify the final lessons.

Students enjoyed the unit, especially those lessons which took them outdoors. Many students gained new insight as to the importance of trees in their lives, as well as gaining knowledge about the role of trees in the ecosystem. Some students developed an attachment to their trees of study, and as a result named their trees, like “Mr. Crumbly.” One student commented, “I liked studying trees a lot. It was fun. I never before knew there was so much life in a tree and that trees are so important to people.” Another student, responding to a question about what motivated her to work so hard during this particular unit, confessed, “We did our work because we didn’t realize we were learning anything but we were.”

Students were impressed with the hands-on application of vegetation to paper during the “Artwork a la Veggy” and cinquain writing lesson. Many comments like “wow” and “cool” ensued. Students illustrated their understanding of the importance of trees in their lives through their cinquain writing. One student wrote:

Needle Rick

The really cool tree
Anchor sturdy, provides food, oxygen, homes
A very beautiful and important provider of life
My tree
Another student illustrated his appreciation for trees by writing:

Summer’s Love

Big, magnificent, beautiful tree.
Branches flowing freely in summer’s breeze
Plays a lovely part in every humans life
Peaceful life

In addition, students demonstrated positive work ethic and increased responsible action within their environment. Some groups of students went well beyond the assigned material and created portfolios about their trees. They took photographs of themselves sitting in and hugging their trees. They wrote material relating what they learned in the classroom to what steps they could take to positively affect the quality of life for trees on campus. One student related how he convinced his father not to cut down a tree in his backyard by agreeing to clean up the area around and care for the tree.

The writer presented the unit at the 1995 Inland Empire Environmental EXPO and participated in a Middle School Symposium of 13 schools. Copies of lessons were distributed. Attendees responded favorably to the materials presented. One attendee, in particular, stated that he was extremely impressed by the extent of the hands-on activities and the degree of integration of the various curricular areas. Many other attendees commented on the completeness of the lesson plans provided and the ease of implementation into their own classrooms.
APPENDIX: THE ARBOREAL ADVENTURE UNIT
ARBOREAL ADVENTURE
A Multi-Disciplinary, Thematic Unit
INTRODUCTION

The following curricular unit, Arboreal Adventure, is a multi-disciplinary, thematic unit which easily infuses environmental education into already existing curriculum. This unit offers students hands-on learning related to a variety of trees, in order that they may gain a broader appreciation of the natural environment and perspective on the interdependence of all living things.

If there is to be an Earth, as we know it, for future generations, people must develop a sense of environmental awareness and the initiative to act responsibly in relation to this environment. Infusing environmental education into already existing curriculum is a valuable avenue for such development. The Arboreal Adventure unit makes such an infusion. Both The Science Framework for California Public Schools: Kindergarten Through Grade Twelve (California Department of Education, 1990) and Caught in the Middle (California Department of Education, 1987) recommend that lessons be taught around a theme. The Arboreal Adventure unit does just that with a thematic focus on trees.

Overall Objectives of the Unit

As a result of participation in the Arboreal Adventure, students will be able to:

1. apply mathematical concepts, tools, and techniques to realistic situations in nature,
2. read and/or write for information, interpretation, and/or application,
3. determine how natural events relate to individual experiences; i.e., develop an understanding of their role in societal events;
4. apply scientific concepts in specific, realistic, and hands-on experiences,
5. develop their creative abilities through artistic expression, and
6. work together as a group for a common goal.

Evaluation of Expected Outcomes

One can find out what a person knows by having the person do something. Authentic assessment is a method of assessment that attempts to find out what students know and can do by using performance tasks. Emerging national standards for education emphasizes teaching through problem solving, integrated process skills and critical thinking skills, and looking for connections, both conceptually within a particular subject area and to the real world. These standards will produce goals of instruction that cannot be fully measured using traditional paper-and-pencil tests.

In comparison to these traditional paper-and-pencil tests, authentic assessment is
not as threatening to the student because there are many correct answers. It also makes
school learning more relevant to students' lives and to the real world. In addition,
authentic assessment helps teachers focus more on the primary outcomes of education;
that is, observation, research, and application, instead of bits of information. The lessons
in the Arboreal Adventure are especially well suited for authentic assessment. Students
can be evaluated on their ability to gather and apply information.

Determination of whether or not the objectives of each lesson are met can be made
through:

1. the quality of student work submitted for each lesson,
2. the accuracy of manipulation of concepts, tools, and techniques with
each lesson, and
3. performance on simulated situations created within the classroom.
The standard for quality of student work can be:
1. predetermined by the teacher, or
2. comparatively determined by the teacher upon receiving completed
   student work.

Lesson Organization

Each subject area plan includes objectives, time frame, materials needed,
background information, procedural steps, extension activities, and California framework
correlation. The procedural steps are identified as they correspond to the objectives.
Following each subject area lesson plan are master worksheets useful for the lesson,
answer keys for these worksheets, and lesson plans for specific activities within a subject
area; each paper is identified in the procedural steps.
Subject Area: Language Arts

Objectives: Students will be able to
A. Create an illustration using only vegetation as the source of expression, rather than traditional writing utensils
B. Create a cinquain based on number of words, focused on a tree and surroundings of choice.

Time Frame: 45 minutes

Materials:
1. "Artwork a la Veggy" worksheet
2. pen or pencil
3. vegetation for illustration

Background:
A cinquain is a piece of poetry five lines long. Each of the five lines contains a specific number of either syllables or words. My example will focus on the number of words.
The first line is a 2 word title.
The second line is a 4 word description of the title.
The third line is a 6 word description of action.
The fourth line is an 8 word description of feeling.
The fifth line is a 2 word different way to put the title.

Here is an example:

_Towering Oak_

_Tree of strength, beauty_
_Growing great, growing strong, growing steady_
_Transquil home to abundant life; providing food, shelter_
_Growing slowly_
Activities / Procedures

A1. Gather different kinds of vegetation -- grass, leaves, flowers, bark, fruit, etc.
A2. Have the students sit quietly outdoors, viewing a tree of choice. Students should listen, look, smell, and feel the tree and its surroundings.
A3. Hand out the worksheet for the "Artwork a la Veggy." (Master LA.A.1)

B1. Rather than using traditional writing utensils, smear the vegetation on the paper to create an illustration of the tree and its surroundings. This is called "Artwork a la Veggy."
B2. Over top of the "Artwork a la Veggy," have students write a cinquain about the illustrated tree and its surroundings.

Extensions:

1. Read Dr. Seuss' The Lorax. Have students write their own ending following the word "Unless ...." A lesson plan is included with the masters for this subject area section. (Master LA.Ex.1) The 30 minute video could also be shown.

2. Have students choose an animal that might live in the tree. Instruct them to write a story about "A Day in the Life" of this animal from its perspective as it lives in and around the tree.

Reading Framework for California Public Schools Correlations:

- Decoding / Language Processing
- Comprehension Development
- Vocabulary and Concept Development
- Writing Development
- "On the lines" Reading for Information
- "Between the lines" Reading for Interpretation
- "Beyond the lines" for Evaluating and Integrating Information
- The Art of Questioning
- Creative Responses to Literary Works
ARTWORK A LA VEGGY

On the back side of this paper you will create a piece of Artwork a la Veggy. Rather than using traditional writing utensils, use vegetation to "smear" yourself a picture.

Then, once your piece of artwork is complete, you will write a cinquain. A cinquain has five lines:
- The first line is a 2 word title.
- The second line is a 4 word description of the title.
- The third line is a 6 word description of action.
- The fourth line is an 8 word description of feeling.
- The fifth line is a 2 word different way to put the title.

Here is an example:

_Towering Oak_

_Tree of strength, beauty_
_Growing great, growing strong, growing steady_
_Transquil home to abundant life; providing food, shelter_
_Growing slowly_

Of course, your cinquain will be about your tree.

You can prepare your cinquain on this side of the paper, and then transfer it neatly to the other side with your picture.
LESSON OF THE LORAX

Objectives:

Students will:
1. hypothesize and draw conclusions about the environmental impact of human behavior, and
2. create an original ending to a story.

Background:

In *The Lorax*, Dr. Seuss introduces the "Once-ler" who cuts down the beautiful Truffula trees so that he can use their wonderful silk tufts to knot "thneeds." Thneed sales are so successful that the Once-ler builds a factory and invents the Super Axe Hacker which cuts down four trees at one time. The Lorax speaks up in defense of the trees, animals, air and water that the Once-ler is destroying in pursuit of bigger and bigger profits. Finally, when the last Truffula tree is cut down, production of thneeds ends. Closed factories, polluted air, polluted water and an uninhabitable wasteland are all that remain on the once beautiful site. The Lorax can no longer live here, but he leaves behind a small pile of rocks on which the word "UNLESS" is inscribed.

*The Lorax* illustrates an ecosystem, a unit in which living and non-living parts interact. All of the parts are linked together and function as a unit. When one of the parts is damaged or removed, the entire system may fail.

Procedure:

1. Encourage the students to sit in a comfortable position.
2. Read the story, showing the students the illustrations as each page is read.
3. Focus the follow-up discussion on the concept of an ecosystem and note how each step of the Once-ler's developing business removed a piece of the ecosystem until the entire system ceased to function. Encourage students to speculate on:
   a. why the Super Axe Hacker was invented
   b. why the Once-ler ignored the Lorax's warnings
   c. what happened to the Lorax
   d. why the Once-ler is called "Once-ler."
4. Ask students
   a. to name some "thneeds" -- things that we "think" we need
   b. how the "thneeds" (things we think we need) are sometimes only
      "thwants" (things we want), but we get them confused
   c. how our "thneeds" conflict with protecting the environment
   d. to list ways we can control our "thwants" and live in harmony with the
      environment
   e. to explain what happened to the Once-ler when there were no more
      Truffula trees, and what he could have done to minimize his factory's
      affect on the ecosystem.

Evaluation:
1. Distribute the "Unless . . ." worksheet (LA.Ex.2) to students and have them
   write a new conclusion for The Lorax following where the word "Unless . . ."
   leaves off.
2. Have students write a paragraph about each of the following issues:
   a. why the Once-ler cut down the Truffula trees
   b. why the Brown Bar-ba-loots have to leave
   c. what the Lorax's message "Unless" means.
3. Have students list 3 ways the Thneeds' Factory caused problems for the
   Truffula Tree forest and its residents.

Going Further:
1. Have students create a collage of thneeds, either as a class project or
   individually, by cutting pictures from magazines.
2. Discuss the ways we use natural resources, emphasizing their value in our
   lives. Have students create ads for natural resources, modeled after the
   Once-ler's Ad for the Thneed:
   "A Thneed's a Fine-Something-That-All-People-Need.
   It's a shirt. It's a sock. It's a glove. It's a hat.
   But it has other uses. Yes, far beyond that.
   You can use it for carpets. For pillows! For sheets!
   Or curtains! Or covers for bicycle seats."
3. Instruct students to draw diagrams or flow charts of the steps involved in the
   production cycle of thneeds.
4. Have students illustrate their needs and wants as contrasting pictures.
   "Thneeds" and "Thwants."
Unless...
UNLESS . . . (con't)

by: ____________________________
Subject Area: Mathematics

Objectives: Students will be able to
A. Use circumference measurements and averages to estimate the age of a tree
B. Use ratios and proportions to estimate the height of a tree
C. Use area calculations of rectangles, triangles, and squares to estimate the crown area of a tree.

Time Frame: three to four 50 minute periods

Materials: (per student)
1. string (about a meter in length)
2. a meter stick
3. data worksheet (Master M.AB.1)
4. an area outside with trees that is easily accessible by students

Background:
1. Students should be familiar with the idea that circumference is the distance around a closed figure.
2. When measuring circular distances, students can either:
   a. use a tape measure, if available, or
   b. use string to determine the distance around, and then measure that length of string using a ruler.
3. A ratio is a numerical comparison of two things. A proportion is an equality between ratios; that is, two ratios set equal to each other.
4. A proportion can be solved using cross multiplication.
5. The area of a rectangle equals length multiplied by width.
6. The area of a square equals side multiplied by side.
7. The area of a triangle equals the base multiplied by the height, the product of which is divided by two.
Activities / Procedures

A1. Make 3 measurements of the circumference of a tree using a piece of string. Take these measurements at varying locations on the trunk of the tree.
A2. Record these 3 measurements and then calculate the average circumference of the tree. (Master M.AB.1)
A3. Estimate the age of the tree using the scale 1 inch = 1 year, or 2.54 cm = 1 year.

B1. Hold a meter stick perpendicular to the ground. Using another meter stick, measure the length of the standing meter stick's shadow.
B2. Record the measurement on the worksheet.
B3. Using the meter sticks, measure the length of the tree's shadow.
B4. Record the measurement on the worksheet.
B5. Using ratios and proportions, calculate the approximate height of the tree:

\[
\frac{\text{meter stick (1 m)}}{\text{meter stick's shadow length}} = \frac{\text{tree height}}{\text{tree's shadow length}}
\]

C1. Walk from the trunk of the tree out to the edge of the crown in eight different directions. Measure each of these distances, making recordings on the worksheet.
C2. Decide upon a ratio to compare the actual measurements to a sketch that is made on paper. For example, 1 meter equals 1 cm, or 1 pace equals 1 cm.
C3. Draw the eight lines of measurement to scale (Fig 1). Then, connect them so the shape of the crown can be seen (Fig 2).
C4. Over top the sketch, fit rectangular, square, and triangular shapes. Using the chosen scale, calculate the areas of the shapes, adding and subtracting these calculations as necessary to determine the area of the crown.
Mathematics Framework for California Public Schools Correlations:

- Mathematical Ideas
- Mathematical Thinking
- Tools and Techniques
- Communications

Standard 1: Mathematics as Problem Solving
Standard 2: Mathematics as Communications
Standard 3: Mathematics as Reasoning
Standard 4: Mathematical Connections
Standard 5: Numbers and Number Relationships
Standard 6: Number Systems and Number Theory
Standard 7: Computation and Estimation
Standard 12: Geometry
Standard 13: Measurement
AGE OF TREE

Circumference Measurements

Average Circumference

Estimated Age of Tree
Remember: 1 inch = 1 year
2.54 cm = 1 year

HEIGHT OF TREE

Shadow Measurements:

<table>
<thead>
<tr>
<th>meter stick's shadow length</th>
<th>tree shadow length</th>
</tr>
</thead>
</table>

Calculation: \[
\frac{\text{meter stick (1 m)}}{\text{meter stick's shadow length}} = \frac{\text{tree height}}{\text{tree's shadow length}}
\]

Height of Tree: ______________
Subject Area: Science

Objectives: Students will be able to

A1. Explain the importance of vascular tissue in a plant
A2. Describe 2 types of root structures
A3. Diagram cross sections of a root and a stem
A4. Diagram and label a cross section of a leaf
A5. Find and observe stomata
A6. Explain the importance of photosynthesis and respiration
B1. Distinguish between gymnosperms and angiosperms
B2. Distinguish between pollination and fertilization
B3. Dissect and label the parts of a flower
B4. Explain a variety of methods of seed dispersal
B5. Dissect and label parts of a seed

Time Frame: Objectives A -- three to four 50 minute periods
Objectives B -- three to four 50 minute periods

Materials:
1. carnations or celery sticks
2. leaves
3. microscopes, cover slips
4. construction paper of various colors, glue or tape, scissors
5. gladiolus flowers
6. kidney beans
7. simple dissecting equipment; i.e. tweezers, probe
8. stereoscope, optional
Background:

Vascular tissue provides a means of internal transportation for food and water in land dwelling plants. The two types of vascular tissue are xylem and phloem. Xylem is responsible for transporting water upwards within a plant. Phloem is responsible for transporting food upwards and downwards through the plant. Vascular tissue also provides support for the plant.

The two basic plans for roots are called taproots and fibrous roots. Taproot systems consist of a long, thick main root (the taproot) and thin, branching roots that extend out of the taproot. Carrots, cacti, and dandelions are examples of plants with taproots. Fibrous roots consist of several main roots that branch repeatedly to form a tangled mass of thin roots. Grass, corn, and most trees have fibrous root systems.

Research reference books for general diagrams of root, stem, and leaf cross sections.

Stomata are microscopic openings on the bottom of most leaves which allow for the exchange of water, oxygen, and carbon dioxide between the leaf and the atmosphere. These gases, in combination with sunlight, allow photosynthesis to occur within the plant's leaves. One of the products of photosynthesis is oxygen. Humans need oxygen to respire. One of the products of respiration is carbon dioxide. Plants need carbon dioxide in order to carry out photosynthesis.

Angiosperms and gymnosperms are two types of seeding plants. Angiosperms are seed plants whose seeds are contained in a vessel called an ovary (like an apple tree). Gymnosperms are seed plants whose seeds are naked, or not covered by an ovary (like a pine tree).

Pollination is when the pollen is carried from a plant's male reproduction structures to a plant's female reproductive structures. If the pollen grain delivers the sperm cell to the egg cell in the ovule, fertilization has taken place.

Refer to reference books to clarify parts of a flower, parts of a seed, and methods of seed dispersal, depending upon what materials are used.
Activities / Procedures

Following is an explanation of individual activities for objectives A and B. The student products from these individual activities can then be combined into a larger product, as explained and illustrated after the individual activity explanations. (see Master S.3)

A1. Putting carnations or celery pieces into colored water for a day or two will allow students to see the movement of water through the vascular tissue. (Master S.A.1)
A2. Choose a method of presenting the two basic plans for roots from the various teaching methods known. (Master S.A.2)
A3. Have students draw and label basic cross sections for roots and stems. (Master S.A.3)
A4. Have students obtain a leaf from a tree, using their tree of focus if possible. Peal the bottom epidermis from the leaf and observe the stomata under a compound microscope. Have students diagram what they see. (Master S.A.4)
A5. Have students diagram and label the cross section of a leaf as a representation of their trees of focus. (Master S.A.5)
A6. Have students illustrate the relationship between photosynthesis and respiration using construction paper. (Master S.A.6)
B1. Have students determine which trees on campus are angiosperms and gymnosperms.
B2. Choose a method of presenting pollination and fertilization from the various teaching methods known. (Master S.B.1)
B3. Obtain gladiolus flowers for simple dissection. Have students diagram and label what they observe.
B4. Choose a method for presenting seed dispersal from known teaching methods.
B5. Have students dissect seeds, and then diagram and label them. Kidney beans work well for this. (Master S.B.2)
Extensions:

1. Create leaf rubbings of the trees' leaves.
2. Press the trees' leaves and then laminate them with construction paper.
3. Create bark rubbings. Then draw in pictures of the various animals seen living in the trees.
4. Place pieces of paper over parts of leaves still living on the tree and then observe what happens to those leaves over a period of a few days.
5. Tie baggies over some leaves on the tree and observe what happens over a period of a few days.

Science Framework for California Public Schools Correlations:

Life Sciences
CAPILLARY ACTION ACTIVITY IN CELERY STICKS

This activity demonstrates how fluid moves in trees (and other plants).

Materials:
1. Celery stalks with leaves attached
2. Food coloring
3. Water and drinking glass or vase
4. Magnifying glass, optional

Background:
 Fluids and nutrients move through a tree by capillary action, rather than because of a heart or other pump. Because water has such a high surface tension, it is difficult to pull water molecules away from each other. As a result, the water molecules tend to stick together and, therefore, will move up tubes. A water drop will stick to the end of a tube, like vascular tissue. When another drop comes in contact with the first drop, they stick together. This forces the first drop to move up into the tube. This process will continue all of the way up the vascular tissue of a tree.

Procedure:
1. Cut the ends off of the celery stalks at a slight angle.
2. Add a few drops of food coloring to a glass of cold water.
3. Keep at least one glass of food coloring free water and celery stalk set aside to act as a control.
4. Let these setups sit for at least 24 hours.
5. Remove the stalks from the water. Cut the stalks both across the veins and with the veins.
6. Using a magnifying glass, observe the coloration in the veins.
7. Compare the observations of the colored veins to the veins of the control stalk.
Evaluation:

Have students prepare a laboratory write-up for the experiment. Include:

1. Problem -- How does water move up tree trunks?
2. Hypothesis -- Student answers will vary.
3. Observations -- Record observations before putting stalk in the water. Record observations before removing the stalk from the water, after it was left for 24 hours; did the leaves wilt, is there color present that was not present before, etc.
   Record observations of the control stalk as it compares to the experimental stalk.
4. Conclusion -- Students should draw a conclusion based upon their observations.
LET'S GET TO THE ROOT OF THE PROBLEM
A Worksheet on Roots

Directions: Answer the following questions using complete sentences.
1. What are the two functions of roots?

2. What are the two basic plans for roots?

3. What is the outermost layer of a root called?

4. What is the function of the root hairs?

5. What is the function of the cortex cells?

6. What is the function of the root cap?

7. Name at least four roots that people eat.
LET'S GET TO THE ROOT OF THE PROBLEM
A Worksheet on Roots

Directions: Answer the following questions using complete sentences.

1. What are the two functions of roots?

   Roots anchor a plant in the ground, absorb water and minerals from the soil, and store food for plants.

2. What are the two basic plans for roots?

   Two basic plans for roots are a. fibrous roots and b. taproots.

3. What is the outermost layer of a root called?

   The outermost layer of a root is called the epidermis.

4. What is the function of the root hairs?

   The root hairs greatly increase the surface area through which a tree takes in water and minerals from the soil.

5. What is the function of the cortex cells?

   The cells of the cortex store food, carry water and dissolved minerals into the center of the root.

6. What is the function of the root cap?

   The root cap protects the tip of the root as it grows through the soil.

7. Name at least four roots that people eat.
   Answers will vary.
   Roots that people eat include carrots, beets, yams, turnips, horseradish, and sassafras.
ILLUSTRATION OF A TYPICAL ROOT

Make a colored diagram of a typical root. Label the following structures: cortex, epidermis, growth tissue, phloem, root cap, root hair, vascular cylinder, and xylem. Include any notes of explanation to enhance your illustration.
INVESTIGATION OF STOMATA

This activity is an investigation of the stomata of a leaf.

Materials:
1. Green leaf
2. Microscope slide and coverslip
3. Medicine dropper and water
4. Microscope
5. Tweezers

Background:
The leaf of a tree is where photosynthesis takes place. From the leaves, the phloem carries food down to the rest of the tree. The outer layer of the leaf is called the epidermis. The epidermis is covered by a waxy cuticle which protects the leaf and reduces water loss. Located on the under side of a leaf's epidermis are stomata. A stoma consists of two guard cells that surround a small opening. The stomata allow carbon dioxide to enter the leaf, and water and oxygen to leave the leaf. The guard cells control the opening and closing of the stomata.

Procedure:
1. Carefully break the leaf in half in order to peel away a piece of the thin, transparent epidermis from the bottom of the leaf.
2. Prepare a wet-mount slide of this small piece of epidermis.
3. Observe the prepared slide using a compound microscope. Locate the stomata in the epidermis. Observe the stomata from varying objective lenses.
4. Make a labeled diagram of what is seen.

Evaluation:
Have students prepare a laboratory write-up for the experiment. Include:
1. Problem -- What do stomata look like.
2. Hypothesis -- Student answers will vary.
3. Observations -- Prepare a labeled diagram of observations.
4. Conclusion -- Use the analysis and conclusion worksheet for the "Investigation of Stomata." (see Master S.A.4b)
INVESTIGATION OF STOMATA
Analysis and Conclusion Worksheet

1. What is the function of the leaf of a tree?

2. What is the advantage to the leaf of having a transparent epidermis (that is, you can see through it)?

3. What is the chemical equation for photosynthesis?

4. Why does a leaf have stomata on the lower part of the leaf rather than the upper part of the leaf?

5. Describe the appearance of the guard cells when the stomata are open in contrast to when they are closed.

6. What are the two functions of stomata?


8. Why do you think the stomata of a leaf are open during the day and closed at night?

9. Where are the stomata of a water leaf located and why?
INVESTIGATION OF STOMATA

Analysis and Conclusion Worksheet

1. What is the function of the leaf of a tree?
   The leaf captures the sun's energy and uses it to produce food.

2. What is the advantage to the leaf of having a transparent epidermis (that is, you can see through it)?
   A transparent epidermis allows sunlight to enter the leaf so photosynthesis can take place.

3. What is the chemical equation for photosynthesis?
   \(6 \text{CO}_2 + 6 \text{H}_2\text{O} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6 \text{O}_2\) (in the presence of sunlight and chlorophyll)

4. Why does a leaf have stomata on the lower part of the leaf rather than the upper part of the leaf?
   The upper part of the leaf is used for sunlight gathering, and therefore, filling it full of holes would decrease the amount of sunlight allowed in by the leaf.

5. Describe the appearance of the guard cells when the stomata are open in contrast to when they are closed.
   When the stomata are open the guard cells look somewhat like two sausages.
   When the stomata are closed the guard cells appear swollen.

6. What are the two functions of stomata?
   The two functions of stomata are a. to allow carbon dioxide to enter a leaf, and oxygen and water to exit; and b. to protect the leaf (by closing up) from excess water loss and becoming dehydrated.

   Excessive pollution on the leaves of trees can prevent carbon dioxide and sunlight from entering. As a result, photosynthesis cannot occur and the tree becomes sick, even dies.

8. Why do you think the stomata of a leaf are open during the day and closed at night?
   During the day, the sun is providing necessary light for photosynthesis to take place; at night, there is no sunlight, and therefore no photosynthesis taking place, so the stomata close.

9. Where are the stomata of a water leaf located and why?
   The stomata of a water leaf, which floats on the surface of the water, would be located on top of the leaf. If they were located on the bottom, it would be difficult for the carbon dioxide - oxygen exchange.
ILLUSTRATION OF THE CROSS SECTION OF A LEAF

Make a colored diagram of the cross section of a leaf. Label the following structures: epidermis, cuticle (waterproof coating), palisade mesophyll, spongy mesophyll, vein containing both the xylem and phloem, and guard cells with stomata.
PHOTOSYNTHESIS

\[
\text{CARBON DIOXIDE} + \text{WATER} = \text{OXYGEN} + \text{GLUCOSE}
\]

CARBON-OXYGEN CYCLE

RESPIRATION

\[
\text{OXYGEN} + \text{GLUCOSE} = \text{CARBON DIOXIDE} + \text{WATER}
\]
Photosynthesis: 

\[ \text{CARBON DIOXIDE} + \text{WATER} \rightarrow \text{OXYGEN} + \text{GLUCOSE} \]

Respiration: 

\[ \text{OXYGEN} + \text{GLUCOSE} \rightarrow \text{CARBON DIOXIDE} + \text{WATER} \]
# POLLINATION AND FERTILIZATION

1. **Release of Pollen:**
   - Pollen is released by the male structures of the tree.
   - The sperm cell is carried within the grain of pollen.
   - The pollen grain is carried by wind, insect, birds, etc.

2. **POLLINATION**
   - The pollen is carried to the female structures of the flower.

3. **FERTILIZATION**
   - When the sperm cell from the pollen joins with the egg cell, fertilizing it.

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<td><strong>5.</strong></td>
<td><strong>6.</strong></td>
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<td>SEED FORMATION</td>
<td>SEED DISPERAL</td>
<td>GERMINATION</td>
</tr>
<tr>
<td>-- the result of fertilization</td>
<td>The scattering of seeds from where they were formed.</td>
<td>-- the early growth of an embryo -- sprouting</td>
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THE SEED
Dissection and Observation

Introduction, including pollination and fertilization:
1. Young seed plants are surrounded by a structure that provides food and protection.
2. An ANGIOSPERM is a plant whose seeds are contained in a vessel (the ovary).
   Examples of angiosperms include apple trees, orange trees, peach trees, maple trees, and lemon trees.
3. A GYMNOSPERM is a plant whose seeds are naked; that is, not covered by an ovary. Examples of gymnosperms include conifers (pine trees).
4. The reproductive structures of seed plants are known as CONES and FLOWERS.
   a. Pollen can be thought of as containing sperm cells, which are produced by male cones and flowers.
   b. The ovules, which are located within the ovaries in the female cones and flowers, contain the egg cells which develop into seeds when properly fertilized.
5. Pollination is the process by which pollen is carried from the male reproductive structures to the female structures of a plant.
6. Fertilization is when the contents of the pollen grain (the sperm cell) joins with the egg cell, fertilizing it.

SEED DISSECTION

The Experiment:
1. Obtain a bean seed from the teacher.
2. With a hand lens, or a stereoscope if available, examine the bean seed.
3. Loosen the seed coat and carefully remove it. The embryo takes up all of the space inside of the seed coat. Notice the cotyledons. A cotyledon is the embryo's structure that stores food.
4. Pull the seed into two parts.
5. Diagram your observation; that is, the inside of the seed. Label the following parts: seed coat, cotyledons, first leaves, embryo stem, and embryo root.
Project suggestion for the combination of the individual activities.

Labeled diagram of a cross section of a leaf here.

Leaf rubbing here.

Labeled diagram of a stoma here.

Labeled diagram of seed structure here.

Labeled diagram of root structure drawn here.

Creative depiction of the process of photosynthesis:

- SUNLIGHT
- CARBON DIOXIDE
- GLUCOSE
- OXYGEN
- WATER

Drawing of vascular tissue with explanation comparing and contrasting xylem and phloem tissue within the tree's trunk.
Subject Area: Social Studies

Objectives: Students will be able to
A. Sketch a cross section of a tree, including the tree rings
B. Prepare a historical timeline based upon their sketch, including both personal events and local, state, and national events
C. Illustrate their sketches and timelines to include personal goals for themselves

Time Frame: varies according to the depth the lesson is taken

Materials: (per student)
1. construction paper
2. writing utensils
3. reference materials, preferably including technology resources

Background:

Students need to understand that a tree adds rings of growth on the outside of the tree (right inside the bark), so that the oldest rings are those found in the center and the and the youngest rings are found on the outer part of the cross section.

Rings of a tree's cross section which are farther apart indicate a good growing year, rings which are closer together and darker indicate a poor growing season. Students, when drawing the tree's cross section, can draw ring distances according to historical and/or personal experiences. For example, if something positive in history is noted, the rings on the tree's cross section for the year in which that even occurred can be drawn farther apart.
Activities / Procedures

A1. On a sheet of construction paper, draw a cross section of a tree, including as many tree rings of growth as years of the tree's age. The sketch should be done lightly so that writing could be seen over the sketch.

B1. In boxes along the top of the construction paper, students will illustrate and explain personal events of their choice which occurred during the life of the tree.

B2. In boxes along the bottom of the construction paper, students will illustrate and explain state or national events of their choice which occurred during the life of the tree. These events could focus on any number of themes, including environmental laws and/or events, or discovery and/or extinction of living things.

C1. In 2 or 3 boxes at the end of the personal boxes (along the top of the paper), students will decide upon 2 or 3 goals which they have established for themselves. They can also use dotted lines to draw in additional growth rings on the tree to illustrate where their goal attainment corresponds to tree age.

Extensions:

1. Students can write letters of opinion to local newspapers as they relate to local events.

2. Students can write letters of opinion, or address questions to, governmental representatives at the local, state, and national levels as they relate to topics of study.

History - Social Science Framework for California Public Schools Correlations:

Goal of Knowledge and Cultural Understanding
(particularly historical literacy)

Goal of Skills Attainment and Social Participation
13 YEAR OLD TREE CROSS SECTION
PERSONAL EXPERIENCES

Positive Experiences

Negative Experiences

PERSONAL GOALS

AGE OF TREE

HISTORICAL EVENTS

Positive Events

Negative Events
Bibliography


