Environmental science activities for use within the ninth grade houses of Lancaster High School

Robert Louis Whitney

ENVIRONMENTAL SCIENCE ACTIVITIES FOR USE WITHIN
THE NINTH GRADE HOUSES OF LANCASTER HIGH SCHOOL

A Project
Presented to the
Faculty of
California State University,
San Bernardino

In Partial Fulfillment
of the Requirements for the Degree
Masters of Arts
in
Education:
Environmental Education Option

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by
Robert Louis Whitney
June 1997

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by
Robert Louis Whitney
June 1997
Approved by:

[redacted]
Dr. Darleen Stoner,
First Reader

June 10, 1997
Date

[redacted]
Dr. Joseph Jesunathadas,
Second Reader

June 10, 1997
Date

ABSTRACT

Cross-curricular activities emphasizing environmental education are an effective vehicle in assisting the teachers of Lancaster High School in their mandate of core subject integration. The author developed an environmental education activity guide for distribution to the faculty of his high school. The guide consists of twelve activities. Each activity includes a connection between one of our school's ninth grade core subjects (science, English, mathematics, and health) and environmental education. The activities utilize our school's technology: direct classroom internet connections; CD, laser and video disc library; and multimedia video-television studio. The guide is expected to be utilized by September, 1997. It is my hope that this guide will enable teachers of all subject areas to infuse environmental education activities into their semester plans.

ACKNOWLEDGMENTS

I would like to express appreciation to Dr. Darleen Stoner, chairperson for my committee, for her advice, assistance, and patience during the preparation of this document. Special thanks to Dr. Joseph Jesunathadas, who agreed to be on my committee and brought focus to my science activities.

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INTRODUCTION

The lack of environment-related topics within the Antelope Valley Union High School District's curricula motivated the development of this project. Six years of research, writing, and evaluation resulted in a series of interactive, critical-thinking, multidisciplinary activities designed with an environmental emphasis. These will be implemented into the existing curriculum of Lancaster High School's four ninth-grade core classes: integrated physical science, mathematics, health, and English.

The National Science Education Standards were included in the development of the curriculum. The standards recommend a hands-on, minds-on approach to science education which has also been advocated by the Antelope Valley Union High School District (AVUHSD) Director of Curriculum Dr. Mary Loughridge (personal communication, September 1, 1995.) Numerous studies demonstrate that the hands-on minds-on approach is more effective than the didactic method of teaching (Shymansky, Kyle, & Alport, 1983.)

Attention during the development process was also given to the <u>California Science Framework: Kindergarten through Grade 12</u> (California Department of Education, 1990) and Goals 2000: Educate America Act (U.S. Department of Education, 1994.) Furthermore, consideration was given to the advocates for science literacy as outlined in these documents: Benchmarks for Science Literacy, (American Association for the Advancement of Science, 1993) and Science for All Americans (Ahlgren & Rutherford, 1990.) All documents prescribe the need for an evaluation of America's science curricula within the public schools and for the genesis of student-centered inquiry activities. This is compatible with the Piagetian idea of allowing the learner to "construct" knowledge through reflection of their experiences (Roopnaire & Johnson, 1993.)

Implementing a interdisciplinary curriculum development project such as this requires that the teachers involved with the future use of the curriculum have an understanding of the teaching changes necessary and a commitment to use those changes within their individual classrooms. Innovation will only become practice if teachers recognize the positive significance of interdisciplinary strategies on the learner outcomes.

Significance of the Project

In the Science Framework for California standards, the authors recommend including "socially sensitive" issues into the curricula (California Department of Education, 1990). Environmental education issues such as population dynamics and land management draw opinions both adamant and heartfelt from defenders and objectors alike. It is difficult to separate the local, social, ethical, and moral concerns that are relevant to students from science curricula. Within such lessons, careful distinction must be made by the teacher to differentiate between the scientific and nonscientific components. The sensitivity of the issues should not preclude a teacher from presenting such material.

Environmentally related concepts and activities are easily accommodated within the California Science Framework's thematic emphasis. Environmental education, defined as a comprehensive approach to exploring the 'people-nature' relationship, including components of ecology, global crises, human value formation, and action plans (D. Stoner, personal communication, May 10, 1990), traditionally has been presented in stand-alone units within science classes in the secondary grade levels. The Science Framework for California easily allows for infusion within the theme examples of the document. Themes assist in weaving various curricular areas together in a logic and natural fashion. For example, the "Water-Logged" activity developed in this project has geologic, mathematics, economic, geographic, and historical components. It is not possible to adequately present this topic from a one-dimensional perspective.

Researchers such as Piaget and Renner have shown educators that children of all ages construct their own knowledge in order to form meaningful connections between classroom activity and usefulness. The learner must be actively engaged in his or her own learning, and have the freedom to explore personal directions within the activity. Called constructivism, this theory of learning is now guiding how lessons are presented (Wheatly, 1991).

Work done by Piaget and others on how children best learn is evident in the National Science Education Standards (National Research Council, 1995). In addition, other changes at the state and local level reflect this movement too. The Antelope Valley Union High School District (AVUHSD) acknowledges the need to revisit traditional science laboratory methods for their efficacy. These reasons have moved the author to investigate, revise, and implement changes within his laboratory and classroom to accommodate more hands-on, minds-on science.

Statement of Need

The purpose of this project was to develop and compile a series of hands-on, minds-on environmentally-based activities for teachers within the AVUHSD, specifically the Lancaster High Freshman Houses. The Director of Curriculum for the AVUHSD continues to guide curriculum writers, faculty committees, and classroom teachers in assembling lessons which utilize constructivist ideals. The director has provided guidelines for the evaluation of activities and curricula to insure a constructivist direction. This movement is in concert with changes suggested by the State of California Department of Education, National Science Study groups, and the National Science Teachers Association. All interested agencies and groups are increasingly concerned about not only how students learn, but how they build concepts.

The ultimate aim of education is to shape responsible human behavior (Hungerford & Volk, 1994). Although environmental curricula alone without "natural experiences and activism" does not guarantee a change in learner behavior (Finger, 1993), it serves to satisfy the new direction of science education in California, and provides students with the opportunity to experience environmental issues at the level of participation and evaluation.

Previous to this project, there was not a comprehensive environmental science curriculum or a compilation of environmental activities written specifically for use in the high school district. Individually infused units or activities have been taught only at the most informal level, and only as a matter of coincidence with current world events or spontaneous student-generated questions. This activity guide would be utilized within our four ninth-grade core courses.

It is hoped that these activities will be utilized by other high schools within the district as they develop "house" concepts similar to those of Lancaster High School.

REVIEW OF RELATED LITERATURE

The review of literature presents findings from research pertaining to environment-related science education for secondary school students in the United States. This review includes discussion on the constructivist learning theory as it applies to high school-aged students, summaries of selected national reform publications which reflect the need for education about the environment, and justification for the infusion of environmental activities into the curriculum.

Pedagogical Approaches to Ninth Grade Learning

Jean Piaget, a Swiss born psychologist, studied the development and construction of cognitive processes in children and young adults. Application of his findings was marginal in the United States until scholars in the 1970s searched for solutions to poor student performance on standardized math and science tests (Educational Testing Service, 1988). Empowering students by actively involving them in the learning process was a solution supported by Piaget (Phillips 1969.) Gardner (1993) agreed, with the addition that active learning is not only physically handling objects, but also the processes within the student's brain that are a result of the hands-on learning.

Intellectual development was classified by Piaget in terms of knowledge gained during interactions with the world (Joyce & Weil, 1992). Several stages of interaction were identified: Sensorimotor stage (0 to 2 years); Preoperational stage (2 to 7 years); and Concrete and Formal Operational stages (7 to 16 years.) Most secondary students in the United States function in the Operational stages. This transitional stage marks the advent of rational activity in the child. Learners exhibit fewer concrete processes and increase their formal operations, such as reflection and theory formation (Sullivan, 1967).

A random assemblage of ninth grade students is expected to include equal numbers of concrete and formal operational learners. As suggested in Content Standard C in the National Science Education Standards "...as many as half of the students in this age group will need many concrete examples and considerable help in following the multi-step logic necessary to concept development within secondary school curricula" (National Academy of Sciences, 1995).

Therefore, care must be given in the curriculum development process to insure that the concrete operational learner is allowed sufficient instructional attention and resources to begin bridging into more formal cognitive processes. This may require participation within smaller cooperative groups or greater attention from the classroom teacher. However, researchers have indicated that not all concrete operational learners will be intellectually receptive to this bridging during the term, as discussed by Renner and Stafford (1972).

Piagetian theory includes the idea of individuals constructing their own knowledge from their experiences. Brooks (1990) characterized constructivists as those who believe that knowledge is the result of individual constructions of reality. Learning is inherently an active process by which the learner builds new ideas from past and current knowledge.

Since learners bring their own banks of experience to the classroom, this suggests that teachers should encourage students to discover principles individually as opposed to traditional "dogmatic" concept transmission from the instructor. Teachers must develop instructional strategies so that students may more efficiently build upon what has already been learned (Bruner, 1990).

Traditional classroom instruction in science involves demonstrations, the recitation and discussion of preapproved facts, and author led "cookbook" laboratory experiences. In order to involved learners more actively, Merritt and Klein (1994) suggested the constructivist alternative to traditional methods:

> Four main components of a successful constructivist lesson: (a) introduction of a real-life problem by the students or teacher for the students to resolve, (b) student-centered instruction facilitated by the teacher, (c) productive group interaction during the learning process, and (d) authentic assessment and demonstration of student progress. (p. 16)

Students actively engaged in constructivist lessons select reasonable solution strategies according to their past experiences with similar phenomenon. Therefore, relevance is key to student motivation, interest, and success; as is the style in which the student learns.

Howard Gardner (Harvard 1991) studied the cognitive development of students and identified several particular learning styles. He labeled these as multiple intelligence. Multiple Intelligence theory (MI) assumes the intellect as being composed of seven faculties: musical, bodily-kinesthetic, logical-mathematical, linguist, spatial, interpersonal, and intrapersonal. He concluded that students learn in ways that are identifiably distinctive, as outlined within these faculties. Utilizing Gardner's MI as a tool within the classroom stands in contrast to a national educational system that believes all students learn the same material in the same way. The broad spectrum of students would be better served if information and assessment could be presented in different ways. Gardner's multiple intelligences could also be efficiently utilized during activities by dividing or assigning group members in a way to bring together members of different learning modalities. That is, each group member would be responsible for an assigned task within the activity that corresponds to their learning style.

The measurement of learning should ideally examine application of knowledge rather than simple recitation of fact or replication of procedure (Rutherford & Ahlgren, 1992). Assessment within a constructivist environment results from a student-teacher partnership that investigates the new-found knowledge on a variety of levels appropriate to the student and their strengths as compatible with Gardner's multiple-intelligences.

Science Framework for California Public Schools

Nationally and locally, educators and scholars are searching for solutions which will assist in promoting a scientifically literate public. At the public school level, students have performed at distressingly low levels with regard to basic scientific understanding (Educational Testing Service, 1988). The implications of an illiterate public are borne from the crises within public science education itself, according to the California Science Framework: Kindergarten through Grade 12 (California Department of Education, 1990).

In response, the California Science Framework (1990) authors and advisors published their ten expectations for scientific literacy. Attention was given to constructivist theories of the learning process and allowance for students to develop their curiosity through individual inquiry and investigation. Also, a thematic curricular approach was promoted.

The content standards proposed within the California Science Framework (1990) embraced environmental education as a vehicle to foster greater understanding of humans and their relationships with the natural world. References to such science and society topics are found within the three content chapters: physical science, earth science, and life science.

The California Superintendent for Public Instruction Delaine Eastin (1995, p.1) commented, "California's frameworks (content standards) represent an important step towards defining what students should know, so that we may now develop how they learn (performance standards)."

National Science Education Standards

The National Science Education Standards (National Academy of Sciences, 1995) were developed to serve as a guide to develop a scientifically literate American public.

The standards were based on previous publications such as A Nation at Risk (National Commission on Excellence in Education, 1983) and Science for all Americans (American Association for the Advancement of Science, 1995). The standards rest on the premise that science is an active process, and that a "hands-on" approach should incorporate a "minds-on" component; actively engaging the learner physically and mentally.

The national standards' goals aim to produce educated students who are able to appreciate and understand the natural world; make informed decisions based upon sound scientific principles; apply a deepened knowledge of scientific processes to public policy and technologic concerns; and raise their economic potential through application of their scientific understanding.

Environmental knowledge is specifically acknowledged as important within the standards. For example, content standard F in the national standards suggests that a result of activities in grades 9-12 is that students should develop understanding of personal and community health, population growth, natural resources, environmental quality, natural and human-induced hazards, science and technology in local, national, and global challenges.

The standards share the common goal of a scientifically literate American public with Project 2061

(AAAS, 1995) the California Science Framework: Kindergarten through Grade Twelve (1990), and Goals 2000 (AAAS, 1995.) Each program suggests local interpretation of necessary means and the utilization of local resources for successful implementation.

Goals 2000, Project 2061, and Science Literacy

In September 1989 President George Bush and the nation's governors agreed to six national goals in education to be reached by the year 2000. Strategies to reach these goals were developed over the following two years with the support of President Bill Clinton, and a definition of what young people must know and be able to do to secure a position in the workforce was stated (AAAS, 1995.)

Goals of scientific literacy are expressed within the recommendations of Project 2061: Education for a Changing Future (Ahlgren, 1990). Important within this project is Ahlgren and Rutherford's (1990) text Science for all Americans. As found in similar studies, there is not a clear legal mandate for specific educational changes, but a body of literature and scholarly documents offering professional educators the fuel and mechanisms for systemic rearrangement.

Infusion of Environmental Education

A cornerstone of environmental education its infusion throughout the school curriculum (Engleson, 1985). Although many infusion-based activity products exist in district curriculum, evidence suggests that few are adequately implemented in non-science curricular areas (Simmons, 1989).

The developer of environmental education infusion activities should draw from research to insure outcomes compatible with the body of current research. Disinger and Howe (1988) pointed out that good knowledge of environmental concepts is not sufficient:

> Knowledge of environmental issues, issue skill analysis, and attitudes and values related to taking action are also necessary for the individual to take action and to act responsibly.

Research from Switzerland suggests a link between people's environmental behavior and their initial experience with nature. Finger (1993) contended that, in the absence of fear related to catastrophic environmental problems (e.g., ozone depletion, global warming), information and knowledge can have an effect on student's future environmental behavior. Finger also recommended that curriculum developers consider the following four practices: provide a nature experience to the learners;

include a collective experience in environmental activism; avoid centering an activity around environmental catastrophes; and address student concerns, fears, and anxiety regarding global environmental issues initially instead of later. Finger's research was targeted for application in adult education, but consideration may be due for educators within public schools as well. Indeed, more research is necessary to determine its relevance for children and young adults.

Resolving society's environmental problems was addressed by Stapp and Wals (1994) through the linkage of theories of change with practical action. This "Action Research" had its origins with John Dewey's (1963) philosophy of reflective thinking. According to Stapp and Wals, Dewey criticized schools for separating thought from action and thinking from doing. An improved community is the result of a school curriculum which emphasizes student involvement with real world problems.

Student involvement in environmental issue instruction is paramount to researchers Hungerford and Volk (1994). They found that issue awareness alone does not translate to appropriate environmental behavior, in spite of many educators who feel otherwise. Ownership and empowerment during the instructional process were believed by Hungerford and Volk to result in improved citizenship behavior, the ultimate goal of education according to the authors.

Simmons believed that a relevant, rigorous, engaging, and usable environmental activity guide will address the current cross-curricular deficit shown by research (Simmons, 1989). Activities contained will allow for student-initiated participatory actions designed to nurture project ownership.

Summary

Science and environmental education has been shown to significantly contribute to a literate and involved public when students are directing their learning and participating actively in issue-based programs. This may be accomplished successfully within constructivist lessons when environmental concepts are introduced as real world problems for students to solve (Merritt & Klein, 1994).

Orr (1990) believed that achieving environmental literacy is possible only when education is viewed in the context of these six principles:

> First, all education is environmental education. To teach economics, for example, without reference to the laws of thermodynamics or those of ecology is to teach a fundamentally important ecological lesson: that physics and ecology have nothing to do with the economy.
> Secondly, the goal of education is not mastery of subject matter, but of one's person. Subject matter

is simply the tool.
Thirdly, that knowledge carries with it the responsibility to see that it is well used in the world.
Fourth, we cannot say that we know something until we understand the effects of this knowledge on real people and their communities.
Fifth is the need for faculty and administrators who provide models of integrity, care, thoughtfulness, and institutions that embody ideals completely throughout their operations.
Finally, that the way learning occurs is as important as the content of the particular course (p. 12).

Orr's principles served as a basis for the author's environmental activity construction. In tandem with Gardner's multiple intelligence research (1993), a usable and worthy approach to environmental activities can be implemented.

DESIGN OF THE PROJECT

This chapter presents a description of the school population; the "freshman house" concept; and methodology for field testing, and feedback mechanisms.

This project was designed with two goals: first, to provide an opportunity for the students to construct connections between their core classes and environment-related topics; and a second, to enable students to model the characteristics of a proactive citizen involved in community issues.

Population

This project encompassed 150 freshman students taught by the author within the Apollo House of Lancaster High School. All Apollo House students were ninth-graders, between 13 years, 10 months old and 15 years, 2 months old. There were approximately an equal number of boys and girls. The socio-economic, intellectual, and motivational level of these students was quite varied.

Freshman Houses

The concept of "house" or "family" instructional grouping for freshman students was developed during the school's organizational seminars prior to the opening of Lancaster High School in 1995. It was unanimously agreed upon by the staff that a higher level of campus ownership would result from the grouping the freshman students into five "houses."

Each house consisted of four core teachers in the subject areas of mathematics, health, science, and English. All students in a house had the same four core teachers. The house concept allowed teachers to implement interdisciplinary activities, including environmental education, within the core subject areas.

Methodology of Field Testing

A preliminary, informal, field-test of activities took place between October 1994 and June 1995, at Antelope Valley High School in Lancaster, California. One hundred and forty-eight ninth grade earth science students took part in the field test. A second field test was performed within the same district at Lancaster High School between September and November of 1995. One hundred and five earth science students participated in the second field testing. The preliminary Antelope Valley High School study group was similar in ability and age to the students at Lancaster High School. A total of 16 science activities were tested, each having an environmental education component.

Feedback

Student that participated in each activity were asked to respond to the following prompts.

1. Discuss how the activity related to any other subject areas in which you were concurrently enrolled in.

2. Describe the environmental knowledge you gained during this activity.

3. After completing this activity, do you feel a greater need to take action or become involved in an environmental cause? Explain your answer.

Further evaluation was conducted by the teacher through classroom observations, interviews with students, and telephone interviews with parents. Areas of evaluation included time on-task, student behavior, group dynamics and interactions, and content of activity write-ups. The researcher specifically looked for changes in behavior and cognitive processes in comparison with that of standard non-environmental science activities within his class.

The writer utilized three guiding research questions during the evaluation of student responses to each activity.

1. Were there noticeable changes in the behavior and interest of the students while participating in the activities?

2. Did the integration of interdisciplinary components into the activity benefit the students? If so, in what ways did they benefit?

3. Did the activities reflect the goals of the national and local educational reform measures described in this document? If so, were there noticeable results from their implementation?

Feedback provided by students and teachers during and after field-testing produced a meaningful body of information. Information regarding the amount of time students remained focused and "on task" was accepted as important by the author. Other physical behaviors such as wandering, vocal outbursts, or disruptive actions to gain peer attention were also accepted as important feedback.

RESULTS

Time-on-task was observed by the teacher to be higher during 11 of the 16 activities tested, as compared to time-on-task during other non-environmental activities. That is, students who were identified as having short attention spans by their parent or guidance counselor participated for more consecutive minutes than usual. It was inconclusive from the written responses whether the content or structure of the activities were responsible for the greater attention.

Slightly over fifty percent of the students field-tested addressed the importance of applying science to other subject areas. These respondents wrote of the need to have relevance in all coursework, and to be taught how to apply knowledge to real-life experiences. Several of these students, who were not observed modeling focused behavior during the activities, produced thoughtful conclusions and observations within their write-ups.

Overall class performance was decidedly improved during these 16 activities as compared to previous years. The author believes that the following two student statements may contribute to the understanding of this observation: "Last year we were taught about greenhouse gases and global warming, which was scary. Learning about solutions tells us what we can do about it." "I guess you can't get away from math and English!"

Student answers to their activity questions continually reflected the importance they attached to relevance and problem solving skills. Positive feedback was frequently stated in terms of activities that students found related to their life experiences.

The writer concluded that these environmental education activities allowed students to better understand the relationships between content in their classes. The activities included practical mathematics, health applications, and language arts, thereby increasing student interest in those classes.

Most students providing feedback concluded that the activity they participated in had connections to at least one other class they were currently taking. Two responses identified other content areas, specifically geography, that they were not enrolled in.

There were a wide variety of responses relating to the environmental knowledge that students gained during the activities. All responses approximated the environmental concepts that are stated in each activity in the appendix.

Exactly one-half of the responders felt a greater need to take action or become involved in environmental causes following the activity. All of these responses mentioned a concern for water conservation or household garbage production.

IMPLICATIONS FOR EDUCATION

The following summary of educational implications addresses the anticipated limitations of the activities and the future use of the project content at Lancaster High School.

Limitations

Activities were selected for inclusion if they contained components reflecting curricular concepts within the four core subject areas of English, health, mathematics, and science. The chosen activities also demonstrated the flexibility to allow students to construct their own meanings and to easily build the concepts.

Although future participating teachers will be given sufficient time to become familiar with these activities, it is expected that the normal constraints on the teaching environment will impact the effectiveness of the activities. Therefore, teacher enthusiasm, motivation, and preparation will be important factors in student outcomes.

Future Use

Developing, initiating, and concluding the inaugural year of a school was an exciting and rewarding experience. Many innovative ideas that were implemented subsequently underwent scrutiny and revision with the intention of an improved product for use the following year.

The environmental activities which were field tested have undergone several modifications, including time, procedure, and student assessment methodology. Quarterly in-servicing will continue to provide participating teachers with a mechanism to share the successes and failures of implementation.

The Antelope Valley Union High School District will distribute this guidebook district-wide after teacher feedback is received at Lancaster High School. This will be accomplished during the 1997-1998 academic year following activity implementation.

Discussion

The Stapp definition of environmental education (Stapp, et al), implies that its ultimate purpose is to prepare students to actively pursue a heightened environmental quality. Hungerford and Volk refined this concept of responsible environmental behavior and generated a functional model capable of being tested by researchers. The question remains whether either of these definitions is capable of producing measurable results. If educators are working towards a scientifically literate and environmentally active public, how soon must curricular design and pedagogy change to accommodate the methods necessary for observable behaviors? In order to employ a truly constructivist methodology, systemic changes must eventually manifest themselves productively at the classroom level instead of becoming nothing more than administrative rhetoric and paperstreams.

Infused environmental activities can be an important part of such systemic changes in science and environmental education. The need for environmental activities to address non-science curricular areas appears great and immediate. Activities should ideally be designed to minimize potential reluctance of the non-science educator to apply "science" within their units.

At Lancaster High School, the success of environmental activities may be measured not only by the graduation of responsible earth-stewards but by the eventual role of the activities as integral components within the theme-based interdisciplinary curricula currently being developed.

APPENDIX A: ENVIRONMENTAL ACTIVITIES

THE GARBAGE GAZETTE — Household Waste

SUBJECTS:
Integrated Physics and Chemistry,
Health , Mathematics

APPROXIMATE DURATION :
4 hours per week for 4 weeks

SKILLS:
analyzing, calculating, classifying,
evaluating, record keeping

ENVIRONMENTAL CONCEPTS:
- Each person is responsible for their own environment.
- Wherever people live, they consume natural resources.
- People can make personal choices which affect the conserving, recycling, and destroying of natural resources.
- Disposal of waste products is affecting the environment.

OVERVIEW:
Notice that traditional lesson objectives have been replaced by environmental concepts. Student team members will classify their personal solid wastes by type, volume, and weight; research and implement strategies to reduce their waste; and then design and publish articles for a 2-page newspaper displaying their data and outcomes.

MATERIALS:
1. Macintosh or IBM PC with Pagemaker or Microsoft Publisher software
2. Calculator
3. Bathroom scale
4. Cost information data (researched from internet sources)
5. Literature reference: A Distant Mirror by Barbara Tuchman

PROCEDURE:
- Contact the local waste management company, county land fill, and internet sites for general information pertaining to waste types, disposal methods, and recycling.
- Begin a class discussion of household waste types, quantities, sources, long-term storage, etc. Possible questions to include:
    1. What are the types of household wastes?
    2. Are any types toxic? Describe them. Why are they toxic?
    3. Should toxic wastes be disposed of the same way as non-toxic waste? Why or why not?
    4. What are the airborne by-products of plastic production?
    5. What are better types of packaging for consumer products?
    6. Why do companies use packaging?
    7. Where does waste go once it is picked up at a house or business?
    8. Is it picked up for free?
    9. What happens to waste at its disposal destination?
    10. How is human health impacted by landfills?
    11. Will future generations experience the same procedure of disposal?
    12. What types of wastes can be, or are now being, recycled?
    13. How does the process of recycling impact human health?

- Divide students into teams of four.
- Assign team member responsibilities by informal multiple intelligence indicators:
  mathematician: performs calculations and cost analysis
  linguist: writes and publishes newspaper articles
  visual-spatial: creates the newspaper format
  intrapersonal: researches and brainstorms methods of household waste reduction
  (Poems, stories, lyrics, songs, and artwork are also welcome.)
- Initiate activity time by having student team members list all possible types of household wastes they produce individually. Have them estimate the weight of their daily wastes.
- Student teams should now convert their daily waste weights to monthly, yearly, and lifetime. They will then compare their estimation to the figures provided by the waste management or landfill regarding what an average American discards annually and in a lifetime.
- Student teams will research waste disposal and domestic sanitation practices in fourteenth century Europe. Oral reading from Barbara Tuchman's A Distant Mirror may be appropriate with teacher discretion. Students should include a group essay on their confidence in today's waste disposal practices as compared to fourteenth century European practices.
- Student teams will be given class time each day to work on their individual assignments within their group. (Breakdown of specific minutes-per-block class to be determined during inservicing)

NOTES:
The newspapers will be photocopied on used printer paper accumulated in the classroom or computer lab. (Newspapers may also be viewed electronically on classroom or campus computers, if available. This would be the environmentally-preferred option!)

CONTENT INTEGRATION:

Chemistry:	Discuss the molecular structures of various toxic and non-toxic substances.
Health:	Discuss the health risks of living near a landfill or waste dump.
Mathematics:	Calculate individual household waste production.

EVALUATION:
Teams will orally present their articles to their English class. Students are individually accountable for successful completion of their team role, and must complete all instructions. The English and science teachers will jointly design a rubric for assigning a point or letter grade for each student and team.

EVERETT RUESS — Wilderness

SUBJECTS:
Integrated Physics and Chemistry,
English, Health, Mathematics

APPROXIMATE DURATION:
4 hours per week for 4 weeks

SKILLS:
analyzing, calculating,
evaluating, map reading

ENVIRONMENTAL CONCEPTS:
- People develop different modes of adaptation to life in different environments.
- The best way to enjoy nature is to observe nature.
- Beauty is a matter of personal opinion.
- The beauty of the natural environment provides a feeling of well being.
- Feelings about the environment may be expressed through literature.

OVERVIEW:
Notice that traditional lesson objectives have been replaced by environmental concepts. Students will learn and apply map-reading skills throughout the reading and analysis of the diary of a teenage boy who disappeared after walking alone from California to Utah in the 1930s. Students will examine and analyze the changes in his writing style and estimate the location of his disappearance on topographic maps.

MATERIALS:
1. Topographic maps of California, Arizona, and Utah
2. Metric rulers
3. Calculators
4. Reference text:: Everett Ruess: A Vagabond for Beauty by W. L. Rusho
5. Supplies as listed under CONTENT INTEGRATION on page 34

PROCEDURE:
1. Read or distribute chapters or sections of Everett's letters to the class.
2. Determine his location on the maps daily, including distance traveled between letters and mileage. Develop concepts of map scale, symbols, longitude and latitude, and measurements.
3. Compare Everett's prose to other writers, if applicable. Discuss style and how the information in his letters changes with time.
4. Discuss Everett's feelings towards wilderness. Do any other authors with similar feelings come to mind? Why was wilderness important to him? Is wilderness important to any class members? Why is wilderness important to humans? How did wilderness relate to Everett's mental health?
5. Encourage students to bring photographs or slides of family vacations into wilderness areas. Discuss their experiences.
6. Locate the current wilderness areas in Everett's southern Utah. Obtain photographs from National Geographic magazine or other books or periodicals on southern Utah. Discuss any uniqueness determined in these parks.
7. If map quantities allow, have student teams estimate the latitude and longitude of Everett's last letters.

CONTENT INTEGRATION:

Physics: Discuss "center of gravity" as related to walking comfortably with an 80 lb. backpack.
Extension- Bring in an empty backpack, clothes to last one week in a variety of weather, cooking gear, a week of food, and 4 empty gallon milk jugs. Fill the empty jugs with water. Select a student to fill the backpack with the supplies. Afterwards, fit the pack on the student and instruct the student to walk around campus for several minutes. Rearrange the contents of the pack so that the heavier items are on top, and later on the bottom. Strap the water jugs on the outside of the pack. Discuss the relative ease of movement with the different packing strategies.

English: Read the book orally or individually.

Health: Discuss the effects and physiologic symptoms of dehydration.

Mathematics: Calculate Everett's daily and average hourly mileage on his trips.

EVALUATION:

1. Ask students to write an essay on the need or non-need of wilderness areas today. They may also discuss any wilderness areas they have visited and their impressions of those areas.
2. Student teams of 2-4 will develop a "treasure hunt" style map with clues leading finders to a specific location. They must include references to latitude, longitude, and map scale and measurement in their clues.
3. Students are to write a letter they feel would represent Everett's feelings regarding the status of wilderness and land use today. Cite specific local examples if possible.

ENERGYVILLE — Energy and Power

SUBJECTS:
Integrated Physics and Chemistry, Health, Mathematics

APPROXIMATE DURATION:
4 hours per week for 4 weeks

SKILLS:
analyzing, calculating, classifying, evaluating, researching

ENVIRONMENTAL CONCEPTS:
- People cause environmental change.
- Due to technological advancements, people change their sources of energy.
- People are dependent upon the environment for energy.
- Living thing are dependent upon the environment.

OVERVIEW:
Notice that traditional lesson objectives have been replaced by environmental concepts. Student team members will redesign a city in an assigned world location on the basis of available, efficient, and clean energy sources.

MATERIALS:
1. Information on primary and alternative energy sources as obtained by student electronic research.
2. Calculator
3. World atlas
4. Rulers, meter sticks, markers, supplies as needed

PROCEDURE:
Part One:
- The teacher will choose 8-12 actual cities from an atlas. Choose cities with unusual names, such as "Dingo, Australia" or "Sombrero, Chile" or "Mother Goose Lake, Alaska." Write these on an overhead slide *without* the country or state name visible.
- The teacher should show one city name at a time and allow a group spokesperson to claim it with a raised hand. Show them the country name. Reveal the next city for another group to claim.
- After all groups have claimed their cities, students will research the location from an atlas or internet resource and submit to the teacher the latitude and longitude for approval.
- Students will research the energy potential in the area, and determine their primary energy source. That choice may change later when they analyze the environmental and economic costs of their choice. They will also select two secondary choices.

Part Two:
- Ask the students to assign responsibilities within their group: researcher and writer, artist and composer, engineer or designer, and mathematician and data analysis.
    1. The researcher/writer (linguist) uncovers the necessary energy information from all campus sources.
    2. The artist/composer (musical) produces a flag and anthem for the city, and will be spokesperson during presentation.

3. The engineer/designer (visual-spatial) lays out the city's physical design and districts (power, residential, business, education and government, industrial, recreational.).
4. The mathematician/data analyst (logical) does the calculations and keeps the group on time and task.

- Students are given free-reign to present their projects in multimedia or model format. All projects must include: flag and/or anthem, primary and secondary energy sources, with justification for their choice including economic and environmental cost comparison, city design map with neighborhoods.

CONTENT INTEGRATION:

Chemistry:	Discuss the atmospheric reactions occurring with the addition of the various compounds produced by the burning of fossil fuels.
Health:	Students will be responsible for researching the pro's and con's of their chosen energy sources on human health.
Mathematics:	Calculate the environmental costs involved with energy production.

EVALUATION:
Groupwork is judged jointly by their science and mathematics teachers on their project completeness, justification for water use choices, accurate mathematics, and energy research.

EXTENSION:
Many extensions are possible, including government design, transportation systems, etc.

WATER LOGGED — Wise Water Use

SUBJECTS:
Integrated Physics and Chemistry, Health, Mathematics

APPROXIMATE DURATION:
4 hours per week for 4 weeks

SKILLS:
analyzing, calculating, classifying, evaluating, record keeping

ENVIRONMENTAL CONCEPTS:
- Living things are adapted to the environment in which they live.
- People can make personal choices which affect natural resources .
- Living things can live only where their requirements for water are met.
- People have a responsibility to conserve and protect their natural resources.

OVERVIEW:
Notice that traditional lesson objectives have been replaced by environmental concepts. Students are arranged in groups of 3-4 in a simulation of living together in an off-campus college apartment during a simulated water-rationing period. They must make water use choices, conserve, and calculate a monthly bill accurately.

MATERIALS:
1. Calculator
2. Water bill from home
3. Water usage data sheet

PROCEDURE:
1. Divide students into teams of three or four "roomies."
2. Students are given a choice of floorplans (1, 2 or 3 bedrooms and baths) and a choice of college class schedules (morning classes, afternoon classes, evening classes). They are given an "apartment rules" sheet also, detailing allowable pets, vehicles, etc.).
3. Students will individually list all possible uses of water in and around their apartment according to their needs. They will then prioritize their uses, #1 being most important, etc.
4. Students will compare their list with their group members, and develop a master list agreeable to all, of uses and priorities, in order.
5. Students will then estimate the gallons per use for each item on their list. They will compare their estimates to the real data on the data sheet provided.
6. Next, the students will calculate gallons per use per day and per month.
7. A grand total of gallons per month will be calculated. Students will use their home water bill to calculate a real dollar value of their apartment water.
8. The drought hits and rationing occurs! The teacher (landlord) will dispense rationing values to all groups (I write various values, some bare-bones, some moderate, on paper scraps they draw from a hat. My values range from 400 gallons per month to 900 gallons per month.).
9. Groups shall develop reasonable and innovative conservation methods to meet the rationing value. All methods must be explained on paper and must be reasonable!
10. New monthly water bills will be calculated assuming no increase in water costs.

CONTENT INTEGRATION:

Chemistry:	Discuss the unique molecular properties of water, including phase changes and bonding.
Health:	Discuss diseases associated with poor water quality.
Mathematics:	Various calculations.

EVALUATION:

Groups are judged by their science teacher on completeness, reasonable conservation methods, and the accuracy of their calculations.

IMPACT!   Solar System Dynamics

SUBJECTS:
Integrated Physics and Chemistry
English, Health, Mathematics

APPROXIMATE DURATION:
8 hours per week for 4 weeks

SKILLS:
analyzing, calculating, evaluating

ENVIRONMENTAL CONCEPTS:
- The population of plants and animals vary with changing environmental conditions.
- Environments change naturally.
- People utilize the environment to secure their needs.
- People develop different modes of adaptation to life in different environments.
- Living things in a natural community depend on each other.

OVERVIEW:
Notice that traditional lesson objectives have been replaced by environmental concepts. Students will predict the social, political, geological, and environmental changes on Earth following a small cometary impact.

MATERIALS:
1. Personal computer with internet access to astronomy sites
2. Photographs or images of impact craters in the solar system
3. Calculator
4. Reference book: Lucifer's Hammer by Larry Niven

PROCEDURE:
1. The teacher will read excerpts from Lucifer's Hammer analyzing the ramifications of a cometary impact on southern California and the world.
2. The class will discuss the probability of such a strike, and evaluate the amount of rocky and icy debris in the solar system as determined by researching NASA/JPL web pages.
3. Examples of past collisions with the Earth will be discussed or viewed from photographs, satellite images, and internet sources.
4. The class will be divided into groups for research and brainstorming on possible effects of a collision. The groups are: society and daily living, political and military, geological and meteorological, and biological and environmental.
5. Groups will be given sufficient time to research their topics in the library and computer lab.
6. Groups meet together in the class to relate findings. Many discussion directions will occur, and student interest and sensitivity to these issues should be considered by the instructor.

CONTENT INTEGRATION:

Physics:	Discuss impact dynamics. Extension- construct a "sandbox" consisting of six inches of sand topped with a thin layer of flour. Drop various-sized round objects from various heights and observe and discuss the results.
English:	Read the suggested novel "Lucifer's Hammer".

Health:	Discuss the health issues involved with the catastrophe of an impact.
Mathematics:	Students perform various calculations.

EVALUATION:
Student groups will orally present their conclusions to their science class. Presentations must include a visual/multimedia aide, printed copy of the report, and be available for web publishing.

GREEN CAREERS — Evaluating Careers

SUBJECTS:
English and Health

APPROXIMATE DURATION:
4 hours per week for 3 weeks

SKILLS:
analyzing, classifying,
evaluating, researching

ENVIRONMENTAL CONCEPTS:
- Human health is related to a healthy environment.
- The values of a society affect the natural resources.
- People can make personal choices which affect the environment.
- People's use of natural resources has led to the destruction of some natural environments.

OVERVIEW:
Notice that traditional lesson objectives have been replaced by environmental concepts. Freshmen students are required to evaluate and choose a "career path" to enter as sophomores. As a part of this process, they will research the impacts their chosen career area has upon the environment. This will entail generating a list of specific sub-careers within their path, and researching the job requirements and ecological reach of each.

MATERIALS:
1. Macintosh or IBM PC with <u>Microsoft Word</u> software
2. Calculator
3. Eureka Career Program Software
4. Telephone book or Internet browser

PROCEDURE:
1. Select a "Career Academy" from the Lancaster High School current offerings.
2. Log into the "Eureka Career Program" in the campus computer lab.
3. List all occupations related to your career academy.
4. Access the job synopsis section of Eureka, and take notes on the various job requirements and descriptions of your selected professional area.
5. Research and brainstorm further environmental consequences (resource usage, air-water-land pollution, etc.) caused by your career area.
6. If possible, research the economic costs of these consequences.
7. In an essay, summarize and comment on your environmental and economic findings.
8. Compose a resume for submission to a company or employer.

CONTENT INTEGRATION:

English:	Students will compose resumes for submission to employers.
Health:	Extension- Discuss the health consequences of smoking in the workplace.

EVALUATION:
This assignment will become part of the students' career portfolio, and will be evaluated by each teacher at year's end.

GROUNDWATER GUNK — Investigating Pollution

SUBJECTS:
Integrated Physics and Chemistry, Health, Mathematics

APPROXIMATE DURATION:
4 hours per week for 4 weeks

SKILLS:
analyzing, calculating, classifying, evaluating, record keeping

ENVIRONMENTAL CONCEPTS:
- Changes in the environment, including water pollution, may affect food chains.
- Human health is related to a healthy environment.
- Work, rules, responsibilities, and beliefs are important for maintaining a healthy environment.
- People's actions have environmental consequences.

OVERVIEW:
Notice that traditional lesson objectives have been replaced by environmental concepts. Students will use their previous knowledge of groundwater geology to solve a realistic water pollution problem. The students must locate the source of the pollution and where it is entering the water system. Current issues of water source quality will be researched from newspapers and magazines also.

MATERIALS:
1. Water pollution test kit or chemical testing equipment and reagents from the lab
2. Calculator and computer
3. Classroom data supplied by the instructor:
    - a list of water wells and data
    - topographic map of the area
    - a list of fictitious local industries and the chemical products they provide to the local water system
4. art supplies: colored pens or pencils and rulers
5. Microsoft Excel spread sheet program
6. Library or Internet access of periodicals

PROCEDURE:
1. Students will use a topographic map showing a city and the location of potential industrial, manufacturing, and agricultural sites capable of the pollution.
2. After analyzing the well data posted in the room, students will draw equipotential lines to determine the direction of groundwater flow.
3. Students will design a water sampling plan which includes testing water at several local well sites. A budget can be given to all students allowing them only a limited number of well tests. Test tubes containing clean and polluted water are pre-made by the teacher and dispensed as the students design their plan. Simple indicators and solutions can be obtained from the school lab.
4. Students will determine where the contamination is coming from the analysis of their well tests.
5. Students will calculate the velocity of the polluted water.

6. Write a brief report detailing the group's findings.

NOTES:
The teacher needs to make fictitious samples of well water representing conditions in the different wells. Many samples can be plain distilled water, and various pollutants can be added according to the teachers needs and familiarity with chemicals. All samples should be put into test tubes and labeled, then put away so students cannot read them.

Look at the topographic map of the area. (It is possible to locate real case studies of polluted regions through the USGS, EPA, or a local university, or to use Bob Whitney's master map at LnHS.) Decide which wells will be polluted. On the master well list, locate the well number, depth, elevation of the water table, and what the well contains. Assign each student group a single pollutant to check for, and a budget of $13,000.00. This allows several wells to drill and several chemical analysis. See activity information sheet for details.

CONTENT INTEGRATION:

Chemistry:	Discuss the chemical nature of the groundwater pollutants.
Health:	Discuss diseases associated with groundwater pollution.
Mathematics:	Students will perform numerous calculations.

EVALUATION:
Completion and presentation of all assigned components and lab report.

EVEN *BETTER* HOMES AND GARDENS — Energy

SUBJECTS:
Integrated Physics and Chemistry, English, Mathematics

APPROXIMATE DURATION:
4 hours per week for 3 weeks, then flexible

SKILLS:
analyzing, calculating, classifying, evaluating, researching

ENVIRONMENTAL CONCEPTS:
- People utilize the environment to secure their needs.
- People have a responsibility to conserve and protect natural resources.
- Resources are available in different quantities throughout the world.
- Unique uses of materials available in the environment lead to the development of special architectural forms.
- Due to technology, people change in their sources of energy.

OVERVIEW:
Notice that traditional lesson objectives have been replaced by environmental concepts. Students will study the architecture, materials, and purpose behind house designs in different parts of the world. The energy efficiency of each design will be researched, as will the resources required to build each type of structure. Students will also analyze alternative construction methods such as straw bale and rammed earth, and the Earthship concept.

MATERIALS:
1. internet browser and library for research
2. literature on sustainable building practices (Real Goods)
3. simple drafting equipment

PROCEDURE:
1. Students will spend time viewing various architectural styles from the west, Asia, middle East, the tropics, polar regions, and native American regions.
2. Students will identify resources required for each type of structure, and develop an economic and environmental rating scale for each.
3. Heating and cooling needs and methods will be analyzed for each style.
4. Students will choose and defend the style and materials they feel is the most energy efficient, and that has the least impact on resources and the environment.
5. This activity may be expanded to several days of outdoor construction techniques (plaster, wood, earth, cement, etc.) with heat transfer and density studied.

CONTENT INTEGRATION:

Physics:	Students will research heat transfer properties of various building materials such as adobe, concrete, wood, and straw.
English:	Extension: Students will write letters or electronic mail to students in a foreign country. Information on local building materials will be solicited.
Mathematics:	Students will calculate heating and cooling costs.

EVALUATION:
The students will justify their conclusions orally and with an accompanying multimedia presentation on the classroom monitor. Students observing from their seats will rate the presenters for accuracy and content. The teacher should compile the students evaluations and include feedback as well.

LIFESTYLES OF THE INDIGENOUS — Living Lightly

SUBJECTS:
Integrated Physics and Chemistry, English, Health

APPROXIMATE DURATION:
4 hours per week for 4 weeks

SKILLS:
analyzing, calculating, classifying, evaluating, record keeping

ENVIRONMENTAL CONCEPTS:
- In any environment, living things have similar needs.
- A family depends on the help and talents of others in the community.
- People utilize the environment to secure their needs.
- Cultures are characterized by their special ways of reacting to the environment.

OVERVIEW:
Notice that traditional lesson objectives have been replaced by environmental concepts. Students will be assigned a region or culture and study their daily routines, type of home, dietary needs, fuel use, population growth, and educational levels of the native people. Comparisons to western cultures will be made, with attention give to the general impact on the environment. (This activity may be used in conjunction with Even Better Homes and Gardens and Energyville.) Students will present their findings in newsletter or newspaper format, with required photographs and images obtained from their internet research.

MATERIALS:
1. Macintosh or IBM PC with Pagemaker or Microsoft Publisher software
2. Internet browser
3. World Atlas
4. other periodicals, such as National Geographic magazine

PROCEDURE:
1. Students in groups of 2 will be assigned one of the following regions or cultures: The Hopi of Arizona, the Aleut of Alaska, rural China, the Bedouin, a rainforest tribe in Brazil, an equatorial village in Africa, urban India, native Tahiti, Moscow, Russia, and the Aboriginal culture of Australia.
2. Begin a discussion of the criteria western populations use to assign "standard of living" to other cultures.
3. Develop a class rating scale from responses.
4. Begin student research, with students responsible for accurate information on the inhabitant's diet, housing, and daily routines. Images or photographs required.
5. Students will develop a 2-page newsletter containing their research.
6. The newsletter will include an editorial section containing student's personal interpretations of the standard of living of their assigned region or culture and how it compares to our generalized western standards in the United States.

CONTENT INTEGRATION:

Integrated Physics and Chemistry:
Students learn about global geography.

English: Students develop a newsletter to publish their research.

Health: Discuss lifespans of the various cultures and examine causes for mortality rates.

EVALUATION:

The newsletters will be photocopied on used printer paper accumulated in the classroom or computer lab. Teams will present their newsletters to the class. Students are individually accountable for successful completion of their team role. Classroom discussion will focus on the student essays on standard of living.

SOLAR COOKING — Solar Energy

SUBJECTS:
Integrated Physics and Chemistry, Health, Mathematics

APPROXIMATE DURATION:
4 hours per week for 4 weeks

SKILLS:
analyzing, calculating, designing, evaluating

ENVIRONMENTAL CONCEPTS:
- Living things return matter to the environment through decomposition.
- People have a responsibility to conserve and protect the environment.
- People can make personal choices which affect the conserving, recycling, and destroying of natural resources.
- People can take action to create a better environment.
- Solar energy is ultimately responsible for all other forms of energy.

OVERVIEW:
Notice that traditional lesson objectives have been replaced by environmental concepts. Student team members will design and build a functional solar oven, using recycled materials as much a s possible. Ovens will be donated after completion.

MATERIALS:
1. The Solar Cooking archives on the internet
2. Traditionally: 2 cardboard boxes with lid flaps (size dependent upon what you are cooking), Reynold's oven cooking bag, 8 oz. white glue (or wheat paste) ,aluminum foil, non-toxic flat black paint or black tempera paint, metal coat hanger, scissors, pencil, old newspaper or other used material for insulation.
3. Inexpensive oven thermometers.

PROCEDURE:
1. Students will be responsible for designing, building, and testing their own solar oven.
2. After completing a unit on insulation and heat transfer, this activity will be used as assessment and celebration.
3. Students will use only the materials provided or brought in from home.
4. Upon completion, alternative styles, such as panel cookers, may be designed and built.

CONTENT INTEGRATION:

Physics:	Discuss solar radiation input at various solar angles and seasons. Students will also discuss the best material for oven insulation.
Health:	Students may develop a menu based upon solar oven cooking.
Mathematics:	Students will perform various calculations.

EVALUATION:
Successful cooking of food items will be monitored, as will adherence to directions.

VERMICULTURE — Global Worming

SUBJECTS:
Integrated Physics and Chemistry, Health, Mathematics

APPROXIMATE DURATION:
4 hours per week for 2 weeks, then flexible

SKILLS:
analyzing, calculating, evaluating, record keeping

ENVIRONMENTAL CONCEPTS:
- Living things return matter to the environment through decomposition.
- People can make personal choices which affect the conserving, recycling, and destroying of natural resources.
- The population of plants and animals vary with changing conditions.

OVERVIEW:
Notice that traditional lesson objectives have been replaced by environmental concepts. Students will build "worm boxes" to recycle kitchen wastes (school. home) and produce compost for fund raisers.

MATERIALS:
1. plastic or wood box, approximately 1' x 2' x 1' deep
2. shredded newspapers or leaves
3. 1 kg red worms
4. fruit or vegetable waste

PROCEDURE:
1. Drill 12 small holes in the bottom of the box, and place the box on a few rocks above a shallow tray. The liquid which drips out may be used as liquid plant fertilizer.
2. Moisten the shredded newspapers or leaves and fill the box about 2/3 full.
3. Add the red worms. Do not use earthworms, as they prefer soil.
4. Chop or shred the vegetable wastes, egg shells, or tea or coffee grounds, and mix and bury to the box. To avoid flies and foul odors, do not add meat or dairy products or domestic animal wastes.
5. Cover with a plastic sheet if indoors, and secure the lid if outdoors. Moisten often, and aerate the mix. Harvest the garden compost after a few months.
6. Extension: Mass the box initially, and any added material for conservation of matter discussion or calculations.

CONTENT INTEGRATION:

Chemistry:	Discuss the nitrogen and carbon cycles.
Health:	Discuss why water is a necessary condition for the health of worms, and the physiological status of dehydrated worms.
Mathematics:	Students will calculate the weekly mass changes in the worm box.

EVALUATION:
Students may be evaluated by the success of their worm boxes, or by the lessons learned from the construction and maintenance of the boxes.

PEOPLE vs. VOLCANOES — Emissions

SUBJECTS:
Integrated Physics and Chemistry,
Health, Mathematics

APPROXIMATE DURATION:
4 hours per week for 3 weeks

SKILLS:
analyzing, calculating,
classifying, evaluating

ENVIRONMENTAL CONCEPTS:
- The environment is and has been in constant change.
- The population of plants and animals varies with changing conditions.
- People have made changes in the atmospheric environment that have led to the endangerment and extinction of plants and animals.

OVERVIEW:
Notice that traditional lesson objectives have been replaced by environmental concepts. Students will investigate the types of natural emissions put into the atmosphere from earth processes (volcanoes, solar-induced atmospheric processes, fires, geysers, etc.) as well as the sources of human-caused emissions. The ramification of these emissions will be analyzed.

MATERIALS:
1. Computer internet browser
2. Calculator

PROCEDURE:
1. Students will use the internet to research articles from the Los Angeles Times newspaper, national news magazines, and science journals such as Science and Nature. These articles should include information on natural and human-made emissions into our atmosphere, and the forecasting or recording of changes in atmospheric chemistry and their effects on living things.
2. Students will include personal opinions in their reports, and prepare to defend their summaries from class questions.

EVALUATION:
Students will present their findings in oral report form.

CONTENT INTEGRATION:

Chemistry:	Students will discuss and examine the various gases produced by volcanoes. These may be contrasted with industrial emissions.
Health:	Discuss the health implications of volcanic gas inhalation.
Mathematics:	Students will perform various calculations.

EXTENSION:
Students may research the fluctuations in atmospheric gas concentrations as published in various internet resources. Discussion questions may include possible impacts of such changes.

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