A teachers' guide to integrating middle-grade science into language arts

Lou Anne Carder

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A TEACHERS' GUIDE TO INTEGRATING MIDDLE-GRADE SCIENCE INTO LANGUAGE ARTS

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

by
Lou Anne Carder
December 1993
A TEACHERS' GUIDE TO INTEGRATING
MIDDLE-GRADE SCIENCE INTO LANGUAGE ARTS

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Abstract

Science is not being taught effectively in the elementary grades because teachers do not feel qualified to teach science, nor do they feel that there is enough time to plan or implement science lessons in the instructional day. A way to solve this problem is to integrate science into the language arts curriculum by using children's literature as a stepping-stone into science.

This guide to integrating science into the middle grades language arts curriculum uses stories chosen from California's Recommended Readings in Literature. This guide was developed to not only assist teachers but also to help students understand the relationships between science and other subjects, sustain their interest, and increase their development in science.
Acknowledgements

Thanks to my Mother and Dad who always believed I could do it. Special thanks to my husband, Bob, who assisted me and kept prodding me along.
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Introduction

Science seems to be disappearing from classrooms. The amount of time devoted to teaching science in the elementary school may have fallen to an unacceptable level. Rowe (1980) suggests that the reasons for this decline are (a) teachers feel inadequately prepared for science, (b) there is not enough planning time, and (c) there is not enough time in a school day to fit science in. Cohen and Frederick (1982) have a remedy for this problem, and that is to integrate science into the general curriculum. Not only will this help students see the relationship between science and other subjects, it will also sustain their interest, increase their achievement, and heighten the teachers' confidence in their ability to teach science.

The Science Framework states that the use of science to teach other fields has been shown to be quite successful in many exemplary elementary science programs (California Department of Education, 1990). According to this framework, scientific literacy can receive a considerable boost if science is used as a vehicle to enhance other areas in the curriculum.

The History-Social Science Framework stresses the role of science and technology in societal development
as an important component of history, particularly as it relates to contemporary issues and events (California Department of Education, 1988). This framework emphasizes that incorporating the achievements of people from diverse cultures in the history of science, whether it be discussed in history or science or both, is a particularly appropriate approach. It also makes clear that the themes of evolution (directional change) and patterns of change (cyclical change) are important bridges between history-social science and natural science. The ideas of systems and interactions and stability are further links between these fields (California Department of Education, 1988).

The English-Language Arts Framework is centered on the construction of meaning (California Department of Education, 1987). Its focus is an integrated curriculum in which the language arts of reading, writing, speaking, and listening are treated together in meaningful contexts rather than separately, apart from context. With an emphasis on literature, it exposes students to significant literary works, rather than brief narratives constructed to teach skills (California Department of Education, 1987). The
framework states that this approach is particularly well suited to coordination with science and social studies instruction.

Given this new emphasis on subject matter integration, the question is how will teachers change from narrow subject area concentration to interrelated studies and new course arrangements.

The purpose of this project is to develop a guide for middle grade teachers to assist them in the instruction of science as part of their language arts and social studies curriculum. This guide will serve as a handbook to help teachers feel at ease as they make this transition.

In a world that is becoming more technically oriented, the science instruction in the public schools becomes increasingly more important (Fort, 1990). Students need to learn how to observe, investigate, and hypothesize in order to deal with the complicated issues that they will face, both technologically and personally throughout their lives. Many of these skills are not taught in the other areas of the curriculum. Therefore, without science instruction, many children are deprived of opportunities to develop necessary problem-solving skills.
Unfortunately, many elementary school teachers do not believe that science is as important as other areas in the curriculum (Rowe, 1980). One major trend in education these days is the "Back to Basics" movement. This movement stresses the "three Rs" leaving very little time for other subjects such as science and social studies. Rowe (1980) speaks of science as "a vanishing species" and says too many teachers say there is too little time for planning and not enough time in the school day to teach science. In fact, Gerlovich (1981) states researchers discovered in a national study that teachers allocate only eighteen minutes per day to science. In one study according to Rowe only twenty-two percent of the teachers polled felt qualified to teach science. This perhaps shows how inadequately prepared teachers feel to teach science.

Rowe (1980) cites Robert Stake in that teachers who do teach science "rely almost exclusively on a textbook", and these textbooks have problems. Teachers report that the children cannot read well enough to use the books independently, and the concepts are too difficult for them to understand. Elliott and Nagel (1987) examined nine, recently published, science textbooks and found that "they cover content well..."
but; do not encourage the development of scientific thinking. Science programs that rely solely on these texts may inadvertently teach students to think of science mainly as a collection of conclusions to be memorized. Without supplementary activities, students neither gain an adequate understanding of the nature and methods of science, nor do they have sufficient opportunity to explore the relationship of science to technology and problems of living in the modern world.

Elliott and Nagels' study reveals that science textbooks are directed at only one of the goals found in the California Science Framework, that of "achieving knowledge". The other goals include achieving scientific attitudes, achieving rational and creative thinking processes, and achieving manipulative and communititive skills. In other words, just using the textbook is not an effective way to teach science. To find an effective way to teach science and to achieve the recommended state goals, elementary teachers need to look beyond the textbook. Teachers need resources that are easily accessible and user friendly.

One way to effectively deal with the problems teachers face as they attempt to teach science is to
integrate science into the curriculum. Scientific discoveries should be presented in the social, political, and historical contexts in which they took place, much as they are treated in the History-Social Science Framework. Writers need to bring out the historical, cultural, and social aspects as the context of scientific discoveries in instructional materials. This can show students that science is put to work for people, that research is stimulated because of real needs of real people, and that discoveries in science help us to make informed decisions about critical problems that face humanity. Fort (1990) stated the same thing when she referred to a comment made by Dewey. Dewey said, "Studying science should lead not only to a better understanding of that subject but also to a better understanding of social problems." Put another way by Fort, "World views begin with in-the-fingers knowledge" (p.668).

Teaching science by using literature is effective (Martin and Miller, 1980). They suggest that stories help children "make associations and to see relationships among the facts they are studying". Smardro (1982) reports that using fictional books is also good because "sometimes a storybook that distorts
or ignores scientific law will arouse a child's interest more easily than a factual book". Furthermore, "the instructional possibilities of using a good book to awaken scientific curiosity and increase scientific skills and knowledge are practically limitless" (Butzow, 1988).

Given the problem based on the perspective of research and the nature of the problem, the question facing teachers is how to successfully implement the integration of science into the general curriculum.
Literature Review

Former California State Superintendent of Public Instruction, Bill Honig, stated in the Science Framework Addendum (California State Department of Education, 1984) that he believes science is a perfect way to improve a student's reading and writing skills and that science should be taught as an integral part of the school curriculum. When the Science Framework was published, it confirmed that science be used to enhance other areas in the curriculum (California State Department of Education, 1990).

The English-Language Arts Framework (California State Department of Education, 1987) supports this by emphasizing the incorporation of children's literature into the school curriculum. The framework stresses an emphasis on a literature-based approach that is well suited to coordination with science and social studies instruction.

Despite solid research support, the popularity of core-type integrative programs varies in intensity from year to year, as education shifts primary attention from student concerns to subject matter acquisition to social problems and back again (Vars, 1991). The continuing challenge is to design curriculums that
simultaneously take into account solid subject matter, the needs of the learner, and society's problems. Therefore, the question facing teachers is what is effective science instruction.

Effective Science Instruction

Cohen and Stanley (1982) report that children need science instruction because "it has the most potential of developing children's critical thinking skills" (p.566), and it helps them become independent, creative thinkers (Donnellan, 1981). To teach science, elementary school teachers need to know how children develop mentally and how they learn.

According to Gega (1982), Jean Piaget and his colleagues have extensively studied the mental development of children. Piaget and others involved in the constructivist movement argue that children develop and pass through four stages of cognitive development which proceed sequentially, and although children advance through these stages in order, they do not go through them at the same time or age. Therefore, it is likely that there could be up to three cognitive stages within one classroom, requiring teachers to have a good understanding of the preoperational, concrete-
operational, and the formal-operational stages of development (Gega, 1982).

Piaget describes the preoperational stage (2-7 years) as the stage in which language develops. Children's concept of space advances from only dealing with their immediate location to realizing there is a yard, other rooms in the house, and even a neighborhood. Children can now also think of the past and future in a limited way (Carin and Sund, 1980).

Piaget's preoperational stage refers to children who cannot do "if-then" problems, combine ideas or objects, or organize objects in order. In other words, children who are at the preoperational stage cannot carry on logical or rational thinking processes (Carin and Sund, 1980).

Piaget's study shows most children in the third grade to be at the concrete-operational stage (7-11 years). Carin and Sund (1980) report these findings: The children can do logical thinking, but it must be tied to concrete experiences. Children's stories allow students to gain experience that may be otherwise impossible to achieve. These stories and other concrete experiences help them conceptually organize their environment into ideas. With the use of stories,
personal experiences, and the manipulation of objects, students will slowly begin to move into the formal-operational stage (11-14 and over years).

As reported by Carin and Sund (1980), Piaget characterizes these children as children who can think abstractly. Dependency on concrete materials is no longer important. Children at this stage are capable of reviewing their own thinking processes, can understand probability, formulate more than one hypothesis, and deal with multiple variables.

Carin and Sund (1980) stress the importance of this knowledge of all stages of cognitive abilities for elementary teachers. Teachers need to know these abilities because some of their students may be at that transitional stage. Children may work at one stage for some things and another stage for other subjects. A teacher should also know this information in order to avoid requiring students to work beyond their cognitive level (Carin and Sund, 1980).

There are two important concepts put forth by Piaget that are essential to the elementary school science curriculum (Gega, 1982). These are peer interaction and solving problems that deal with objects.
Since children of the same age may cognitively be at different stages of mental development (Gega, 1982), all children may benefit from shared experiences such as stories (Carin and Sund, 1980). Those who are at the preoperational stage may begin the transition toward understanding a concrete-operational thinker's organization. A child working at the concrete-operational stage may, in turn, gain insight from a child who is beginning to work at the formal-operational level. Finally, according to Gega (1982), the most cognitively advanced student will be forced to re-examine his/her own ideas in order to explain them to others.

The concept of peer interaction is important to science education for many reasons. First, the heterogeneous grouping of students provides them with the opportunity to practice cognitive and social skills (Gega, 1982). It also enables teachers to act as facilitators, directing students instead of lecturing to them (Carin and Sund, 1980). Finally, having students work in groups allows teachers to have more time to focus on individuals and small groups (Gega, 1982).

Both Gega (1982) and Carin and Sund (1980) state
that Piaget contends that children must work with objects and materials before they can work with abstractions. They say that students need to do more than just play with objects. They stress the need for students to have many experiences manipulating objects and solving problems that deal with those objects. This manipulation will enhance the mental growth of children.

Like peer interaction, the concept of manipulating objects also is important to science instruction (Carin and Sund, 1980). Manipulation allows students to become involved mentally, physically, and socially with their learning. By manipulating objects, children are provided with concrete experiences to build upon. Science teachers must use concrete materials if they are going to increase their students' mental capacities and have a meaningful science program.

Although Piaget's influence on elementary science instruction is well known, three other learning psychologists, Jerome Bruner, David Ausubel, and Robert Gagne have also affected how science is taught.

Jerome Bruner believes that children should discover solutions to problems by themselves (Abruscto, 1982). He believes children learn best when they work
from the specific to the general. Therefore, he feels that teachers should provide activities, assist only when needed, and develop categories so students understand how the new information fits into the major concepts.

On the other hand, David Ausubel believes children should learn the general concepts first and then work with the specifics (Abruscoto, 1982). The teacher's role is to organize the concepts and the students' experiences so that students understand an activity before they experience it.

Finally, Robert Gagne believes students at the elementary level improve their thinking skills if lessons are planned in a step-by-step fashion with testing occurring before, during, and after the lessons (Gega, 1982).

Although the theories of Piaget, Bruner, Ausubel, and Gagne differ, they offer insightful information to science teachers. As educators, teachers have many objectives to meet and a variety of children to work with. Therefore, to be effective science teachers, educators need many different methods to reach their goal. Unfortunately, there appear to be many obstacles
standing in the way of these teachers.

The Difficulties of Teaching Science

Public elementary schools are required to teach reading, writing, mathematics, health, physical education, social studies, and science. Many teachers are overwhelmed by these requirements and feel they cannot fit science into the instructional day. For example, teachers assert that there are not enough minutes in the school day after the "basics" are taught and that there is not sufficient time for planning lessons and experiments (Rowe, 1980). Another concern teachers have is that resources and supplies are not readily available. Eighty percent of elementary schools do not have a budget for materials, and eighty-four percent do not purchase science equipment (Rowe, 1980). In addition, teachers consider science difficult to teach because they do not feel qualified to teach it. Only twenty-two percent of the teachers polled in one study felt qualified to teach science as opposed to sixty-three percent who felt qualified to teach reading (Gerlovich, 1981).

To address the challenges of time and resource constraints, teachers turn to the resource readily
available: The science textbook. Recent studies, however, have suggested the inadequacies inherent in relying exclusively on a science textbook (Rowe, 1980).

Rowe (1980) cites Stake and Easly in that three problems occur when only a textbook is used to teach science. First, the science instruction was "a procession of assignments-recitation-test-discussion cycles occasionally accompanied by 'show and tell' sessions". This made instruction routine and boring, with minimal time for investigation and/or observation. The next problem encountered was that many of the students could not read well enough to use the textbooks on their own. Finally, if the students were able to read the books, teachers complained that they had to use most of their instructional time explaining the concepts introduced in the books. Therefore, instead of teaching observational and investigational skills, the textbooks only developed skills in memorization (Rowe, 1980).

In a study of nine textbooks published between 1984 and 1986, researchers concluded that these books taught a "cookbook" kind of science in which children did not experience the suspense or monotony needed to develop observational skills (Elliot and Nagel, 1987). The
study also reported that these textbooks rarely applied the scientific skills and concepts to daily life, societal issues, or science related fields.

Integrating Science Into the Curriculum

One way to effectively deal with the problems teachers face as they attempt to teach science is to integrate science into the Language Arts and Social Studies program. Walton and Butler (1990) report how the Anchorage School District has been using a hands-on science curriculum which includes ideas for extension activities or ways to integrate what has been learned into such areas as language arts, math, art, or social studies. This Elementary Science Center is modeled after the Highline (Washington) School District Elementary Science Center in Seattle.

Another approach to science-related social issues is the extended case study (ECS) strategy (Kronholm and Ramsey, 1991). This program requires insertion into an existing curriculum and enables students to establish the relevance of science by empowering them to make sense of real-life issues in a responsible way. Kronholm and Ramsey (1991) report unlimited interdisciplinary opportunities afforded by any ECS.
They mention writing essays, poems, songs, reports, preparing skits, and doing library research.

It appears that some teachers are using thematic units to integrate science, social studies, and language arts. Rosenbloom (1991) suggests that teachers select a concept and then develop a theme centered around it. Classroom language and literature guide the development of curriculum in her class. "Connecting social studies themes by using literature increases the students' chances of making relevant connections about new knowledge" (Rosenbloom, 1991, p.54). However, in planning thematic units one must keep in mind that curriculum integration is not an end in itself but a means for accomplishing basic educational goals. Furthermore, recommended activities may not help achieve those goals, nor are they always implemented effectively. In the course of examining some thematic units, it appears that many suggestions made in the name of integration are counterproductive. Many of the activities seem to be pointless busywork lacking educational value.

Through integration all of these teachers seem to be accomplishing the following: (a) adhering to the recommendations of the California frameworks--English--
Language Arts Framework, History-Social Science Framework, and the Science Framework; (b) increasing their students' reading readiness and reading achievement; and (c) enhancing their science and social studies programs.

California's Frameworks

Critically processing information is a skill that is taught in science, and correlating science and language arts is recommended in the Science Framework (California State Department of Education, 1990). It states that science can serve as a catalyst to enhance language development and provide opportunities to encourage organizational skills. Therefore, integrating science and language arts is a logical extension of both frameworks.

The English-Language Arts Framework (California State Department of Education, 1987) emphasized the incorporation of children's literature into the school curriculum. The creators of the framework compiled a list of important literary works. Currently, school districts are to choose works from its list to enhance their language arts programs. By thoroughly studying these core works, the intention is that children will
improve their reading and writing, thus leading them more readily towards critical thinking skills. (California State Department of Education, 1987).

Additionally, the History-Social Science Framework emphasizes the importance of history as a story well told (California State Department of Education, 1988). It states that teachers of history and teachers of language arts must collaborate to select representative works. The framework mentions the use of poetry, novels, plays, essays, documents, myths, legends, tall tales, biographies, and religious literature to help shed light on the life and times of the people.

Although these frameworks recommend that connections be made between these three subjects, there has been little research dealing with their integration. It's Elementary!, a report of the Elementary Grades Task Force and the California Department of Education published in 1992, gives suggestions to assist teachers, administrators, parents, and community leaders in achieving excellence in public schools. The report states that good elementary reading programs recognize that reading is not a subject in itself so much as it is a tool of discovery that students can use to enter enticing
worlds. Skill in reading is acquired and perfected by practicing it across the curriculum (Elementary Grades Task Force and the California Department of Education, 1992). In those subject areas, the emphasis in reading is kept where it belongs—on reading for meaning—rather than on the mechanics of the operation. No studies could be found which focus on using literature to introduce science concepts as an effective way to teach science. Research has been conducted, however, on the effectiveness of literature-based reading programs. There has also been research on how science experiences increase reading readiness and reading achievement. The intention of reviewing these separate studies is to understand the benefits that might be achieved if a literature-based reading program were used as an inspirational point or stepping stone to an investigational science program.

**Literature-Based Instruction**

Several studies have compared literature-based reading instruction and basal reading instruction. Over the last twenty years, studies conducted by Cohen, Cullinan, Jagger and Strickland; and Veatch and Eldredge, all showed that literature-based groups
scored significantly higher in knowledge, comprehension, and vocabulary (Bader and Veatch, 1987) and (Tunnell and Jacobs, 1989). In addition, Eldredge and Butterfield (1986) conducted a study comparing the traditional approach to five other methods of reading instruction. The students that scored the highest on the three tests (the Gates-MacGinitie Reading Test, a pictorial self-concept scale, and a phonics test created by Eldredge) were those that had been taught in a literature-based program that included decoding lessons. Eldredge and Butterfield conclude that "the use of children's literature to teach children to read had a positive effect upon the students achievement and attitude towards reading--much greater than the traditional methods used" (Eldredge and Butterfield, 1986, p. 35).

Clearly, the research in favor of a literature-based program is convincing, and this trend in reading instruction appears to be gaining momentum. But typically, research is slow to be translated into classrooms. Cullinan (1992) surveyed the Directors of Reading and Language Arts in the fifty states in studying the spread of literature-based programs. The results of her survey showed that nine states had
statewide initiatives centered on literature. Sixteen others had statewide initiatives focused on an integrated language arts program. Literature played a central role in the integrated program. Twenty-two states that did not have statewide initiatives reported that at least five to ten local districts used literature programs. In summary, Cullinan (1992) reports, "Literature-based programs are spreading like wildfire across the country--not only through state departments of education but also in the classrooms of individual teachers as they gain power to make curriculum decisions" (p. 429).

Science Instruction Increases Reading Skills

In addition to using literature-based programs, experiences with science also increase a child's reading readiness (Ayers and Mason, 1969; Janke and Norton, 1983; California State Department of Education, 1987). Wellman (1978) reports about a study conducted by Renner. In Renner's study he hypothesized that the experiences provided by the Science Curriculum Improvement Study (S.C.I.S.) were more likely to increase reading readiness than those of an average reading program. Renner studied four first grade
classes in Ada, Oklahoma. Two of the classes were randomly chosen as the control group; the other two were the experimental group. The control classes used a commercial reading readiness program while the experimental group used the "Material Objects" S.C.I.S. unit. After six weeks, both groups were tested on numbers, listening, matching, word matching, and copying by taking the Metropolitan Reading Readiness Test (M.R.T.). The researchers discovered that the control group, using the S.C.I.S. unit made more gains in every area except copying (Wellman, 1978).

Another study that supports the concept of science experiences improving reading was conducted by Neuman. Neuman's studies indicate that science activities promote perceptual skills (tactile, kinesthetic, visual, and auditory) and these skills contribute to the development of listening and speaking skills needed for reading. Neuman used three kindergarten groups to test his hypothesis that kindergarten children who have had no science instruction would score lower on the M.R.T. than those that had science instruction. His data indicated that the children who had no science instruction tended to score lower on the reading readiness test (Wellman, 1978). Moreover, when these
groups progressed through first grade, the children with the science background scored higher in the reading achievement test (Wellman, 1978).

A long-term study was conducted to test the effects that science experiences had on reading achievement. This study tested selected cognitive behaviors of third graders who had participated in a hands-on science program entitled *Science-A Process Approach* (S.A.P.A.) since the first grade (Kolebas, 1971). The students chosen for this study were those who had progressed from grades one to three in the same school, had not repeated any grades, and had taken the M.R.T. at the beginning of first grade. Of these students, those that participated in the study were randomly selected. Kolebas, the author, determined that on reading and skill development, the test group significantly outscored the control group (Kolebas, 1971).

Reading instruction based on literature improves reading and critical thinking skills (Bader and Veatch, 1987; Eldredge and Butterfield, 1988; Tunnel, 1989). These skills, in turn, promote higher degrees of understanding in science. In addition, science experiences improve reading skills. Therefore, incorporating these two subjects would enhance both the
language arts and the science programs.

Using literature works is a beneficial method to enhance a science program (Cohen and Stanley, 1982). Two programs, such as Project Wild and Project Learning Tree, provide lessons that use literature as a starting point to teach science.

Project Wild (1986) is a supplementary environmental education book for teachers of kindergarten through high school. Its primary sponsor is the Western Association of Fish and Wildlife Agencies with participating members from the California Department of Education and the California Department of Fish and Game. Its lesson plans are also consistent with the recommendations of the National Science Teachers Association. "Going Wild," a newsletter printed biannually by Project Wild, dedicated one entire issue to using children's literature as a "springboard" to teach lessons in science. (Stoner, 1988).

Project Learning Tree (1975) sponsored by the Western Regional Environmental Education Council and the American Forest Foundation, also includes lesson plans that incorporate children's literature into its science curriculum. For example, it has a lesson plan
entitled "Folklore" in which students listen to tall tales and North American Indian myths to discover how humans used and/or related to forests.

Summary

Civilization is becoming more technologically advanced and although teachers have difficulty fitting science into their instructional day, students need to learn the skills science can teach them. Teachers also need to know how to teach science effectively. An effective option for teaching science, recommended by the English-Language Arts Framework, (1987); the History-Social Science Framework, (1988); and the Science Framework, (1990) is to incorporate science into these programs. Although very few studies have been conducted to test the integration of these subjects, research clearly indicates that reading instruction based on children's literature improves comprehension and critical thinking skills (Rowe, 1980) and that science instruction also improves reading skills. Therefore, integrating these subjects could be expected to lead to the enhancement of all three subjects. Moreover, in Rowe's (1980) own words, "With sixty-three percent of teachers feeling very well
qualified to teach reading, their confidence will assist them when literature is used to help them teach science" (p.20).
Goals and Objectives

The goal of this project is to develop a curriculum guide for middle grade teachers to assist them in the instruction of science as part of their language arts curriculum. This guide will serve as a handbook to help teachers feel at ease using these activities. The objective of this guide is to help meet the need for inclusion of science in the middle grade classroom curriculum.

Reforming California teachers to become practitioners and advocates of a meaning centered interdisciplinary curriculum may take time and guidance. For teachers to carry off this curriculum successfully, however, they need to have a clear vision of what they are trying to accomplish in each content area that day, week, month, and year—lest the rigor of the individual subject area be lost. The guide provides sample units using integration that is consistent with the principles found in the frameworks.
Design and Procedures

This guide was created to help middle grade teachers integrate science, social studies, and language arts into a meaningful program. This program contains opportunities for interdisciplinary studies, enriched with primary sources, varied genres of literature--both of the period and about the period.

The California English/Language Arts Framework and the Recommended Readings in Literature require school districts and teachers to choose children's stories from a list of approved literature works. Teachers, at each grade level, are to choose one book from each of the following categories: Picture Books, Folklore, Modern Fantasy and Science Fiction, Poetry, Contemporary Realistic Fiction, Historical Fiction, Nonfiction--Information, Nonfiction--Biography, Plays and Foreign Language Books. The developers of the framework believe that literature should be used throughout a school's curriculum. Therefore, this guide was created to help middle grade teachers integrate science into these literature works.

With the emphasis on children's literature in the new language arts curriculum, students are now being
required to "go into, through, and beyond" specific works of literature. A viable way to go "beyond" a piece is to extend it into the science field. Other such programs that combine science and language arts are Project Wild and Project Learning Tree.

The guide includes four themes to be used with four of the books from the California Recommended Readings in Literature-Kindergarten through Grade Eight list. The guide is divided into four chapters, and each chapter focuses on one general science concept that coincides with the chosen story. Each chapter provides science lesson plans, a synopsis of the story used, how to transition from or "go beyond" the story into science and additional stories that can be used to supplement the unit.

The children's literary selections and the science themes covered in the guide are:
2. Strega Nona by Tomie de Paola--The States of Matter.
3. Hailstones and Halibut Bones by Mary O'Neill--The Characteristics of Sound.

The lesson plans in each unit include a title, objective, references, material needed, procedures, notes (if needed), teacher evaluations, work sheets, and answers.

This guide can be used along with a regular science program and textbook, or as a total curriculum in and of itself. Each activity is designed to be used for whole class instruction; however, the lessons may be modified for small group or individual instruction.

There may be some slight limitations in the use of this guide. Depending upon the student population, alterations may need to be made in the choice of literature selected and activities planned. The scope of the program could also be a limitation.

The scope of the curriculum suggested for language arts, social studies, and science should emphasize depth of understanding, not encyclopedic breadth of coverage. Clearly, a thematic orientation of textual material requires shortening or eliminating some material currently found in most instructional programs.
The guide will be field tested by teachers during intersession at a year-round elementary school. It will be used with third, fourth, and fifth graders in classrooms of thirty students. Assessment will be through observations and journal readings.

Finally, assessment of student performance may need to change if teachers make the transition away from the skill based curriculum. California is in the midst of making a fundamental revision of its assessment program at the elementary school level. The purpose of these changes is to develop an assessment scheme consistent with the ambitious goals of the new curriculum design.
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Social Science Framework for California Public Schools
Appendix A

Survey
Dear Teachers:

I am currently working on my M.A. project at California State University, San Bernardino, and I need to collect some data for my research. I am interested in developing a guide to assist teachers in integrating science into the language-arts curriculum. This guide will contain activities that can be used along with a regular science program or as a total curriculum in and of itself. To do this, it would be helpful to know something about your current science program.

Please return the survey to your school secretary by Monday, January 17.

Thank you for your cooperation.

Lou Anne Carder
1. Do you teach science everyday? yes____no____
2. What is the daily average time you spend on science?________
3. Do you feel qualified to teach science? yes____no____
4. Do you feel a need for staff inservicing in science? yes____no____
5. When teaching science, do you use hands-on activities? yes____no____
6. Do you rely exclusively on a science textbook or do you utilize other resources when teaching science? Explain and list resources. ________________________________ ________________________________ ________________________________
7. Do you integrate science with other subject matter? yes____no____
8. With which subjects do you most often integrate science?
   mathematics____ language arts____
   reading____ technology____
   social studies____ other (name)____
9. Do you use a storyline when teaching science? yes____no____
10. Would you be willing to review the handbook and pilot the integrated science/language arts lessons?

   yes____ no____

____________________(name)
Appendix B

Lessons For Integrating Middle-Grade Science Into Language Arts
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Introduction

It has come to my attention that all too often as teachers we are not effectively teaching science and meeting the recommended state goals. This shortcoming can be easily attributed to various factors, many of which are beyond our control. There are ways, however, that we can remedy this problem.

One way is to integrate science into the language arts and social studies curriculum. Not only will this help students see the relationships between science and other subjects, it will also sustain their interest, increase their achievement, and heighten the teachers' confidence in their ability to teach science.

This guide has been developed for middle-grade teachers to assist them in making the change from narrow subject area concentration to interrelated studies and new course arrangements. The following lessons show how such a program can be successfully implemented in the classroom. The lessons have been developed as a result of this project.
Overview of the Themes

1. States of Matter

Lesson 1

Book: *Strega Nona*

By: Tomie de Paola

Strega Nona is a good Italian witch. She hires a boy named Anthony. Anthony magically makes spaghetti that engulfs the town. Strega Nona returns and saves the day.

In lesson 1, the students will state the three states of matter and learn the song "States of Matter".

Lesson 2

Book: *Strega Nona*

In lesson 2, the students will observe a demonstration of water coming to a boil and graph the changes in temperature.

Lesson 3

Book: *Strega Nona*

In lesson 3, the students will participate in a dance that demonstrates how molecules react when they are heated.
Lesson 4

Book: Strega Nona's Magic Lessons
By: Tomie de Paola

Strega Nona will only teach magic to girls, so Anthony dresses up as a girl and the trouble begins.

In lesson 4, the students will examine what happens to spaghetti when it is cooked. The students will eat spaghetti.

2. Characteristics of Sound

Lesson 1

Book: Hailstones and Halibut Bones
By: Mary O'Neill

This is a collection of poems about colors.

In lesson 1, the students will observe and demonstrate how sound is made.

Lesson 2

Book: Hailstones and Halibut Bones

In lesson 2, the students will explain volume and feel how an increase makes radio speakers vibrate.
Lesson 3

Book: Hailstones and Halibut Bones

In lesson 3, the students will experiment with changing the pitch of a vibrating plastic ruler.

Lesson 4

Book: Hailstones and Halibut Bones

In lesson 4, the students will observe a variety of models to help them understand how sound travels.

Lesson 5

Book: Hailstones and Halibut Bones

In lesson 5, the students will experiment with air, wood, and metal to discover which is the best conductor of sound.

3. Forms of Energy

Lesson 1

Book: Alexander and the Terrible, Horrible, No Good, Very Bad Day

By: Judith Viorst
Alexander wakes up with gum in his hair and announces it is going to be a bad day. He has a very bad day.

In lesson 1, the students will define force, work, and energy.

Lesson 2

Book: *Alexander and the Terrible, Horrible, No Good, Very Bad Day*

In lesson 2, the students will feel how sound energy vibrates speakers. They will also observe and discuss how motion energy affects their lives.

Lesson 3

Book: *Charlie Malarkey and the Belly-Button Machine*

By: William Kennedy

Charlie wakes up and discovers his belly-button is missing. He investigates and solves the mystery.

In this lesson, the students will make a paper chain listing the uses of electricity. They will also participate in a demonstration showing how electrons move in electricity.
Lesson 4

Book: Alexander, Who Used to be Rich Last Sunday
By: Judith Viorst

Alexander just cannot save any money.

In lesson 4, the students will observe and state what light energy can do to their eyes. They will also create a picture showing the uses of heat energy and the fuels people use to get heat.

Lesson 5

Book: Arrow to the Sun
By: Gerald McDermott

A Pueblo Indian boy discovers that his father is the sun. He is turned into an arrow and shot to the sun. The boy survives trials set by his father. His father gives him life and shoots him back to the earth. The Indians believe the sun gives them life.

In this lesson, the students will diagram how we get energy from the sun. They will also build a solar cooker.
4. Changes in the Earth's Crust

Lesson 1

Book: The Magic Schoolbus Inside of the Earth
By: Joanna Cole

While studying the Earth, Ms. Finkle takes her class on a magical fieldtrip to the center of the Earth.

In lesson 1, the students will create a picture of the layers of the Earth.

Lesson 2

Poem: "Erosion"
By: Lou Anne Carder

This is a poem about erosion.

In this lesson, the students will learn a poem and experiment with erosion.

Lesson 3

Book: The Wave
By: Margaret Hedges

or The Burning of the Rice Fields
By: Lafcadio Hearn
An old Japanese man sets his fields on fire after an earthquake. The villagers come to his fields to help put the fire out and are saved from a devastating tidal wave.

In lesson 3, the students will write a paragraph on how earthquakes change the Earth's crust. They will also make an "earthquake sandwich".

Lesson 4
Book: Hill of Fire
By: Thomas Lewis
This is a true story about a Mexican farmer who is bored with his work until one day when his plow starts an eruption.

In lesson 4, the students will draw a diagram of the inside of a volcano.

Lesson 5
Book: Hill of Fire
In this lesson, the students will observe a model of a cinder cone volcano erupting and write a paragraph describing how these volcanos are formed.
States of Matter

Strega Nona

By: Tomie de Paola

Lesson 1: Matter.

Objectives:

1. The learner will read the first 9 pages of the story.
2. The learner will discuss how Strega Nona made something out of nothing (spaghetti) and how that is not possible.
3. The learner will name three states of matter.

Materials:

1. 30+ copies of Strega Nona
2. Paper for a word bank

Procedure:

2. Discuss how Strega Nona made spaghetti.
3. Explain that this is a fictional story and that no one can make something out of nothing.
4. Tell students in science all "things" or objects are made of matter and that anything that takes up space is matter.

5. Elicit examples of things that are made of matter until the students realize that everything is made of matter. (Do not forget to include air)

6. Tell students there are 3 states of matter: solids, liquids, and gases.

7. Elicit some examples of liquids and gases.

8. Create a new word bank and write matter, solid, liquid, and gas to it.

9. Explain that molecules make up matter. When the matter is solid the molecules are very close together and do not move around very much (Figure 1). When they are in the liquid form the molecules move around within their container, like a glass of milk (Figure 2). When the molecules are a gas, they move around a lot (Figure 3).
10. Teach students the "States of Matter" song to the tune of "Are You Sleeping? Brother John?".

"States of Matter"
States of matter,
States of matter,
Molecules,
Molecules,
Sometimes they're a solid,
Sometimes they're a liquid,
Or a gas,
Or a gas.

Now ask the students what are the three states of matter.
States of Matter

Strega Nona

By: Tomie de Paola

Lesson 2: Liquids, Solids, and Gases.

Objectives:

1. The learner will finish reading Strega Nona.
2. The learner will watch a demonstration of bringing water to a boil, noting how the thermometer reacts. They will graph the change of temperature.

Materials:

1. 30+ copies of Strega Nona
2. 1 sauce pan
3. 1 hot plate
4. A cooking thermometer with mercury
5. A timer
6. Graph paper

Procedures:

1. Fill the sauce pan half full of water and place it on the hot plate.
2. Put the thermometer in the water and let one student read the temperature.
3. Write the temperature on the board.
4. Turn on the hot plate. Set the timer for 3 minutes.
   (Make sure the thermometer is not touching the bottom of the pan. This will ensure an accurate reading.)
5. Have the students read the rest of Strega Nona.
6. After 3 minutes, choose a student to read the thermometer. The teacher will write the temperature on the board.
7. Students continue reading.
8. Reset the timer for 3 minutes and repeat the process every 3 minutes until right before the water starts to boil. Read and record the temperature.
9. Take the thermometer out and leave the hotplate on.
10. After the students have finished reading the story, discuss what happened to Anthony.
11. Review the states of matter. Ask what is the state of the pan. (solid)
12. Explain that heat energy makes the water molecules move faster and bump into the thermometer--forcing the molecules in the thermometer to heat up and move apart. This makes the liquid mercury move up the stem.

13. Ask the students what they think would happen to the water molecules if there was no heat at all? (The water molecules would move very slowly and be very close together. They would form ice.)

14. Pass out the graph paper. Have the students graph the temperature.

15. Review that the reason the mercury rose was because the water molecules hit it. The hotter the water, the more often and harder the molecules hit the thermometer.

16. Bring the students' attention back to the boiling water. Ask them to explain what is happening to the water. (The molecules are hitting each other so hard, they are bouncing out of the pan! The molecules move far apart.
When they go into the air it is called water vapor.)

17. Add all new words to the word bank.

States of Matter

Strega Nona

By: Tomie de Paola

Lesson 3: Molecule Dancing

Objective:

1. The learner will participate in a dance acting out what happens to water molecules when water heats up.

Materials:

1. Masking tape or chalk

Procedures:

Using either chalk or tape, outline a sauce pan resting on a hotplate. Make the pan big enough to accommodate every student in your class (approximately 20' x 20'). Outline the thermometer. The bulb should
be able to accommodate 10 students standing close together (Figure 1).

1. Review what happens to liquids when heat is added:
   a. Heat is conducted when molecules bump into each other.
   b. Molecules move slowly and bump into each other gently when they are cold.
   c. When an object is hot its molecules move more quickly and bump into each other with more force.
   d. A thermometer reads how hard the molecules around the bulb are hitting the bulb.

2. Tell the students they are now going to act out a molecule dance.

3. Assign students to the following roles:
   a. 2 leaders who set the temperature by clapping. The teacher must assist in order to keep the right tempo.
   b. 4-5 students as bulb molecules. (Pick well-behaved children)
   c. 4-5 students as stem molecules. (Pick well-behaved children)
d. The rest of the students will be water molecules.

4. Arrange the molecules in their proper places.
   a. The leaders will stand in the hotplate.
   b. The stem and bulb molecules will stand in the bulb.
   c. The water molecules will stand in the pan.

5. The Dance
   a. When all are still, the teacher and leaders call out "COLD" and start clapping at a slow tempo.
   b. All molecules slowly dance to that tempo. The water molecules gently bump the bulb molecules and the other water molecules. The bulb molecules gently bump the stem molecules. The stem molecules stay close together.
   c. After a short time, the leaders call out "WARM" and speed up the clapping tempo. All molecules speed up their dance and gently bump into the other molecules often. The stem molecules move a little bit apart and up the stem.
d. After another short interval, the leaders call out "HOT" and increase the tempo. All molecules speed up their tempo to match the leaders.

e. The stem molecules spread farther apart. 2 or 3 water molecules jump out of the pan and become water vapor. (Pick these students before the dance begins)

IMPORTANT: Do not let the bumping get out of hand. Take the "overly active" molecules out of the pan.

f. The leaders call "WARM" and slow down the tempo. All molecules slow down and the stem molecules move closer together.

g. The leaders call "COLD". Everyone slows down and the stem molecules move back into the bulb.

h. The leaders call "END" and the dance is over.

(The dance should last about five minutes. Try to do it at least two times so the
students will understand what they are supposed to do.)

6. Discuss what happened.
a. Why did the molecules move faster?
b. What does heat do to molecules?
c. What would happen to the water molecules if they got hotter?
d. Why did some of the water molecules leave the pan?
e. Did the water molecules change shape when they got hot or left the pan?
f. Are they still water molecules if they are not in the pan?
g. What happened to the stem molecules?


8. Explain how when water changes into vapor, the molecules are still water molecules. They are just farther apart than when they are in their liquid form.
9. This kind of change is called a physical change. The molecules do not change, they just get farther apart (vapor) or closer together (ice).

States of Matter

Strega Nona's Magic Lessons

By: Tomie de Paola

Lesson 4: Chemical Change: Spaghetti!

Objectives:

1. The learner will guess how many bowls one 32+ oz. package of dry spaghetti will become once it is cooked.

2. The learner will examine dry and cooked spaghetti and describe the differences.

3. The learner will help construct a graph.

Materials:

1. 32+ oz. of dry spaghetti

2. 1 large pan to cook spaghetti in

3. 4-5 medium sized bowls--enough to hold 32+ oz. of cooked spaghetti
4. 1 cup butter
5. 30+ small plates
6. 30+ plastic forks
7. 1 hotplate
8. 1 colander
9. poster paper for a class graph
10. ditto
11. scissors
12. 1 serving spoon
13. 1 copy of *Strega Nona's Magic Lessons*

Procedure:

Before beginning the lesson, put the water on and bring it to a boil. Leave one bowl out for the students to see.

1. Show the students the dry spaghetti and tell them you are going to cook it.
2. Put the dry spaghetti in the bowl for the children to see.
3. When the water is boiling, put in the spaghetti and stir.
4. Pass out the ditto. Each child will guess how many bowls the cooked spaghetti will fill.
5. The students will color and cut out their guess and glue it in the appropriate place on the graph.

6. While the spaghetti is cooking, read Strega Nona's Magic Lessons to the class.

7. When the spaghetti is done, strain the water out of it.

8. Take out the other bowls. Pour the spaghetti into the bowls. Have the children check their guesses.

9. Add the butter.

10. While serving and eating, ask why there is so much spaghetti? (It absorbed the water.)

11. Put a couple of strands of spaghetti on a plate. Lay them as straight as possible. Ask the students if the spaghetti went through a physical change?

12. Does the cooked spaghetti look the same as the dry spaghetti?

13. Will it look the same when it is dried out?

14. Put the spaghetti in a dry place for a day. Bring it out and have the students compare it to some uncooked spaghetti.
15. The students will write down their observations.

16. Tell the students when matter goes through a change where it cannot be changed back to its original matter, it is called a "chemical" change.

17. Have students think of other chemical changes i.e. wood burning, a hard boiled egg...

States of Matter
Strega Nona's Magic Lessons
By: Tomie de Paola

Lesson 4.
Characteristics of Sound

Hailstones and Halibut Bones

By: Mary O'Neill

Lesson 1: How Sound is Made

Objective:
1. The learner will investigate and demonstrate how vibrations make sound.
2. The learner will read the first poem "Purple" in Hailstones and Halibut Bones aloud.

Materials:
1. 30+ copies of Hailstones and Halibut Bones
2. 15+ plastic rulers
3. Journals
4. 1 yard stick
5. Paper for word bank

Procedures:
1. Children will silently read "Purple".
2. Discuss how the poem makes them feel about that color. Brainstorm why it makes them feel that way.
3. Have students read the poem in unison. How does it make them feel when it is read aloud?

4. Tell students they are going to see how the poem makes their necks feel when they repeat the poem. Have them put their first two fingers on their necks about 2 inches below their chins.

5. Speaking in their normal voices, have them repeat the poem. Ask them what they felt.

6. Explain to them that what they felt was their vocal cords vibrating or moving as they pushed air out of their lungs. The vibrating was what caused the sound they made.

7. With their fingers on their throats again have them whisper the first line of the poem. Explain that they cannot feel the vibration because the sound/vibrations are too soft.

8. Ask them how they could make their vocal cords vibrate a lot.

9. Have them shout the first word of the poem. Ask them how it feels.
   a. Put students in groups of two.
   b. Pass out rulers and papers, one of each per group.
c. Students will write down their predictions of what kind of sound they will make if they snap the ruler quickly, slowly, hard, or softly.

d. Demonstrate with the yardstick how to hold their rulers so that half of it is on the table.

e. Students will experiment snapping their rulers.

f. Students will write down their observations.

g. After the students have finished, share what they discovered.

Characteristics of Sound

Hailstones and Halibut Bones

By: Mary O'Neill

Lesson 2: Volume

Objective:

1. The learner will explain what volume is and what causes it to increase.
Materials:
1. A big radio, i.e. a "ghetto blaster" or "boombox" with visible speakers
2. A whistle
3. 30+ copies of Hailstones and Halibut Bones
4. Journals

Procedure:
1. Review what makes sound and how students make the rulers give off more sound. (Sound is caused by vibrations and when the ruler is pushed harder, the vibrations are bigger, thus producing more sound.)
2. Tell students the loudness of the sound is called VOLUME. Read "Black" softly. Read "Black" louder.
3. Show the students the radio and the volume dial.
4. Increase and decrease the volume and let students see or feel the speakers vibrate. (Some speakers may not vibrate very much. Try turning up the bass.)
5. Elicit ideas from students what they think causes changes in volume. (Changes in energy.)
6. Demonstrate blowing softly through a whistle and then ask students how to make it louder.

7. Let children who know how to whistle practice changing the volume of their whistle.

8. Make sure the students record observations in their journals.

Characteristics of Sound

Hailstones And Halibut Bones

By: Mary O'Neil

Lesson 3: Pitch

Objective:

1. The learner will differentiate between high pitch sound and low pitch sound.

Materials:

1. 30+ copies of Hailstones and Halibut Bones
2. 15+ plastic rulers
3. Journals
Procedure:

1. Read "Brown".
2. Tell students to pretend that the poem was just recorded and that you want to hear what it is like in fast motion.
3. Elicit from students that your voice would sound higher or squeaky.
4. How would it sound if the sound was slowed down? (Lower)
5. Explain that the highness and lowness of sound is called high and low pitch.
6. Using a ruler half-way over the edge of a desk, snap it. Let students listen and watch the ruler.
7. Snap it again, but this time only let a quarter of the ruler hang over the edge. When there is less of the ruler vibrating, it vibrates faster and the pitch is higher.
8. Pass out a ruler to every two children. Let them experiment by shortening the length of the ruler to be snapped.
9. As a group, discuss what happened to the sound and vibration. Elicit that as the ruler is
shortened, the sound the ruler makes is higher because the vibrations are faster.

10. Fast vibrations equal high-pitch; slow vibrations equal low pitch.

11. Record observations in the journal.

Characteristics of Sound

Hailstones and Halibut Bones

By: Mary O’Neill

Lesson 4: How Sound Travels (2-3 days)

Objectives:

1. The learner will observe how vibrations travel away from their source.
2. The learner will state how sound travels.

Materials:

1. 30+ copies of Hailstones and Halibut Bones
2. A guitar or three rubber bands stretched around a box
3. A Slinky (plastic or metal)
4. A tub or pail of water
5. Journals
Procedure:

This lesson is a series of demonstrations to illustrate how sound travels. The reason that so many models are used is because not one model will demonstrate the movement of sound. A quick review of states of matter is imperative to remind students that air is made of molecules.

1. The guitar: Vibrations are caused by an energy output.
   a. Elicit from students what sounds they can make and what energy they use to make that sound.
   b. Explain that the energy they used does not just "sit" there. The energy makes the vibrations move back and forth.
   c. Demonstrate vibrations by plucking the string of the guitar or the "rubber band guitar".
   d. Explain that as the string/rubber band moves up and down, it forces the air around it to vibrate. The molecules hit each other and carry the sound energy outward.
2. The Slinky:
   a. Have two students sit on the floor about eight feet apart. Stretch the Slinky between them so they each hold one end.
   b. Tell the student at one end to squeeze several loops together and then release them.
   c. The class will see the wave pass from one end to the other end. This is like a sound wave.
   d. Have two other students demonstrate it again.
   e. Have the class watch to see how far one loop moves. (It only moves enough to set the next loop into motion. Try putting tape on one loop to see the movement)
   f. Explain that because molecules do not move far to "pass on" the wave, there is no wind.

3. Pail of Water:
   a. Put the pail on the ground and let the water become still.
   b. Let one student put one finger into the water.
c. Explain that, like water ripples, sound waves travel outwards in circles.

4. Poem:
   a. To show that sound waves do not travel in one plane, place students around the room. Some should be sitting, while others stand. Have some stand farther away, etc.
   b. When all students are ready, read the poem.
   c. Ask each group of students if they heard the poem.
   d. Draw a figure of how sound waves travel.

5. Discuss with students what they learned about each demonstration. Write it on the board.
   a. Energy will start something vibrating and the air around the vibrating object will start to vibrate (rubber bands).
b. Sound travels in waves but does not cause wind because the molecules only move a little (Slinky).

c. Sound travels in circles away from the source and travels in all directions (water, poem).

NOTE: Journal writing may be done after each demonstration.

Characteristics of Sound

_Hailstones and Halibut Bones_

By: Mary O'Neill

Lesson 5: How Sound Travels Through Solids, Liquids, and Gases

Objective:

1. The learner will demonstrate how sound travels through solids, liquids, and gases.

2. The learner will listen to the differences in volume as sound travels through air, wood, and metal.
Materials:
1. 30+ copies of Hailstones and Halibut Bones
2. A free-standing metal column or pole outside (i.e. a tetherball pole works well.)
3. Journals

Procedure:

The first half of this lesson will take place inside the classroom. The second half will take place outside.

1. Read a poem from Hailstones and Halibut Bones. Ask students to tell how the sound gets to their ears. Vibrations from your vocal cords cause the air to vibrate. The vibrations or waves travel outward through the air to their ears.
2. Read the poem again. This time have the students plug their ears with their fingers.
3. Ask if they can still hear the poem.
4. Explain that they can still hear it because sound can also move through their fingers.
5. Sound can travel through air, water, and solids. When we listen to someone speak, sound is traveling through the air. When we are swimming with our friends, and we say things under water, we can hear
it. When we listen to someone on the phone, the sound travels through metal.

Experiment 1: Sound Travels Through Wood
1. Pass out journals.
2. Group students in pairs.
3. Each student will write a hypothesis about sound traveling through the air versus sound traveling through wood. (i.e. I think sound will travel better through _______ than it will through _______.)
4. Demonstrate to the class how one student will scratch the desk while the other one listens. As the student continues scratching (with the same force), the "listening" student will put his ear to the desk. Repeat the process so the other student may now hear the scratching.
5. Let the students test their hypothesis.
6. Discuss what they discovered.

Experiment 2: Sound Travels Through Metal
1. Students will write another hypothesis about sound traveling through metal versus air.
2. Take students to the playground.
3. Tap a tetherball pole (or other metal column) with a pencil. Have students listen to the sound.

4. Let students put their ears to the pole and listen again. (You may want to have two or three other students tap different poles so the process goes quicker.)

5. Discuss what they discovered. (Sound travels through solids better than it does through air.)

An Experiment To Do At Home:

1. Student will fill the bathtub full of water.

2. Student will let one faucet drip just a little and listen to the sound the dripping makes.

3. Student will put his/her ears under water and listen to the drip hitting water.

4. Student will write down his/her observations.

Ways To Conclude This Theme:

1. Have members of the school band perform for the class. Have students explain how the instruments produce sound.

2. Have students create instruments such as shoebox violins, drums of different sizes, kazoos made with combs and waxpaper, trumpets made from bottomless
soda bottles, recorders or whistles made from bottles or straws (change the pitch by bending the straw's end) and glasses filled with water. Have them perform for you.

3. Have students make "cup and string" telephones.
Form of Energy

Alexander and the Terrible, Horrible, No Good, Very Bad Day

By: Judith Viorst

Lesson 1: Force, Work, and Energy

Objective:
1. The learner will define force, work, and energy.

Materials:
1. 30+ copies of Alexander and the Terrible...Day
2. Word bank paper
3. Big books i.e. dictionaries, encyclopedias...
4. Journals

Procedures:
1. Pass out story books and paper.
2. Students will read pages 1-15 in Alexander and the Terrible...Day.
3. Discuss why Alexander was having such a bad day. What forced or made him have a bad day? What forced or made him fall in the mud?
4. Explain that in science the word "force" means to push or pull.

5. Write "force" and its definition on the word bank. Force: A push or pull that is needed to make something move.

6. Have the students push their books to the center of their desks, and then pull them back again.

7. Have students push and hold their books over their heads.

8. Have students take out the biggest book in their desks or pass out dictionaries and encyclopedias. Have them "push" the book over their heads. Keep them up.

9. Explain that it takes more force to push the big book above their heads and that what they are doing is more work.

10. Explain that the push or pull is force and when they use that force, they are doing work.

11. Write the definition of work on the word bank. Work: The use of force to move something.

12. Have students raise the heavy books above their heads 11-20 times or until they tire.
13. Explain that they feel tired because they used up a lot of energy. Energy is the ability to do work.

14. Write energy and its definition on the word bank.

15. Elicit from the students what work Alexander had to do in the story and how much energy did he use.

16. Cover the word bank.

17. Have students make observations in their journals.

Forms of Energy

Alexander and the Terrible, Horrible, No Good, Very Bad Day

By: Judith Viorst

Lesson 2: Sound and Motion Energy

Objectives:

1. The learner will feel how sound energy vibrates speakers.

2. The learner will discuss the effects of motion energy in their lives.

Materials:

1. 30+ copies of Alexander and the Terrible, Horrible, No Good, Very Bad Day.
2. Dittos

3. 1 rubber ball

4. 1 "ghettoblaster" or other radio with large speakers

5. Journals

Procedures:

1. Students will finish reading the story.
   Discuss what happened to Alexander.

2. Review the definitions of force, work, and energy.

3. Did Alexander do any more work in the story?
   (Do not forget to discuss moving his body and other objects.)

4. Explain that there are many kinds of energy, but in this theme, they will only study five kinds: sound, motion, electricity, heat and light.

5. Today they will learn about sound and motion.

Sound Energy

1. Review what the children know about sound.
   a. caused by vibration
   b. travels in waves
2. Review work, force, and energy.
3. Turn on the radio with the bass setting as high as possible. Allow students to touch the speakers to feel the vibration.
4. Explain that not only is sound caused by vibrations, it can cause things to move. Therefore, it is also an energy.
5. Discuss how loud sounds can break eardrums and how certain pitches can break glass.
6. Even though sound is an energy, humans have not discovered an easy and efficient way to use it.

Motion Energy
Pass out the ditto. Have students take the ditto and a pencil outside. The teacher will need to take a yard stick. Stand the children by a tall wall or a flag pole. Put a piece of tape at 3 feet, at 6 feet, and at 9 feet.

1. Have students predict how high the ball will bounce if it is dropped from a student's shoulder.
2. Have them write their predictions on the ditto.
3. Choose a student to drop the ball. Record how high it bounces on the first bounce.
4. Now have students write down their predictions of how high the ball will bounce if the student bounces it as hard as she/he can.

5. Have the student bounce the ball and measure the height of the first bounce.

6. Did anyone guess right?

7. Ask the students why the ball bounced so high when it was forced down?

8. Explain that this is motion energy.

9. Example:
   If you were hit by a tetherball, it would hit you with almost the same force as her hand hit the ball. It would be almost like the other person hit the ball. It would be almost like the other person hit you with her fist. The ball would hit you a little more gently because the tetherball had to use some of its energy gotten from the girl to get around the pole.

10. Have the students come up with other examples of motion energy. (Moving bikes, skateboards, cars, baseballs...
Forms of Energy

Motion Energy

Lesson 2:

1. How high will the ball bounce when it is dropped?

Mark your guess!

2. How high will the ball bounce when it is bounced hard?

Mark your guess!
Forms of Energy

Charlie Malarkey and the Bell-BUTTON Machine

By: William Kennedy

Lesson 3: Electricity

Objectives:

1. The learner will watch or participate in a demonstration of how electrons move in electricity.
2. The learner will list all the uses of electricity that he/she can think of.
3. The learner will make a paper chain. Each link will have a picture of one way humans use electricity.

Materials:

1. One copy of Charlie Malarkey and the Belly-Button Machine or any other book that has a special machine in it
2. Approximately 160 2"x6" strips of light colored construction paper. (Cut enough so that each child has at least 6 strips.)
3. Glue
4. A ditto with the outline of an electrical 2 prong plug. (1 copy for each student.)

5. Crayons

Procedures:
Read the story to the students. Discuss the machine. What could it do? Where did it get its energy? What kind of energy did it use? Electricity?

1. Explain that humans use a lot of electricity because it is easy to make and easy to use. Discuss how easy it is to use.

A. How Electricity Moves

1. Review how matter is made up of molecules and how molecules are made up of atoms. Use the example of water=H20

2. Introduce "Electrons" as a little part of an atom that is connected to the surface.

3. Electricity is named after electrons because when an electrical current passes through atoms, electrons are the parts that move.

4. In an ocean current, water moves around. In an electrical current, one electron bounces to the next atom forcing the other electron to bounce to the next atom.
5. Set 6 chairs in a straight line facing the class.
   a. Have a student sit in each chair.
   b. Explain that the chairs are the atoms and the students are the electrons.
   c. The teacher is also an electron.
   d. When a cord is plugged into an outlet, electrons are pushed through the wires.
6. To start the current, the teacher will ask the student in the end chair closest to her to move to the next chair.
7. The end student will sit in the next seat, moving the child in that seat to the next seat.
8. The process of changing chairs will continue until the last student is out of his chair.
9. Repeat the process again, explaining this is how electricity moves down a wire.
10. The "unseated" electron on the end is a free electron and will give you a shock. It does this because it is moving and trying to find another atom or "chair".
11. Have students re-explain how electricity moves.

B. Uses of Electricity

1. Have students brainstorm all the things they use electricity for. List them on the board.
2. Pass out strips of paper, ditto, and glue.
3. Students are to choose 6 things they use electricity for. They draw one thing and write its name on each strip. Color it.
4. They give one strip to the teacher for the class chain.
5. After they color their strips, they glue them together to form a chain. Have them color, cut out, and glue the plug to one end of their chain. They now have an electrical cord. The teacher puts together the class cord. (Let the students help.) Draw and cut out an electrical outlet that will fit the chain's plug. Hang the chain around the classroom so that the plug will be right next to the outlet.
Forms of Energy

Alexander, Who Used to be Rich Last Sunday
By: Judith Viorst

Lesson 4: Light and Heat

Objectives:
1. The learner will explain what light energy can do.
2. The learner will list some uses of heat energy.
3. The learner will list fuels used to make heat energy.

Materials:
1. 30+ copies of Alexander, Who Used to be Rich Last Sunday
2. A 60 watt or less light-bulb or flashlight
3. Dittos
4. 1 9"x12" piece of yellow construction paper per student
5. Crayons and scissors

Procedures:
1. Read this Alexander story to the class. Discuss why he cannot save money.
2. Show the students the illustration where Alexander is holding his breath.

3. What kind of energy is coming out of his mouth? (sound)

4. Elicit the other forms of energy.

5. Today they will learn about light and heat.
   Light and Heat
   1. Ask students where does most of the light we use come from? (The sun) Explain that they will learn where the light from light-bulbs comes from on another day.
   2. Tell the students that the sun gives off two kinds of energy: Light Energy and Heat Energy.
      a. Light Energy can cut things or break things.
         For example, if you looked directly into the sun, what would happen? (You would go blind because the rays damage your retina.) Lasers use light energy to cut things.
      b. Heat Energy is why you feel hot when you are in the sun and why you feel burnt.
   3. Turn off the lights in the classroom. Tell the students they will look at the light and be aware of what they "see" after the light is turned off.
4. Have students write down their predictions of what they think they will "see" after the light is turned off.

5. Quickly turn the light on and off. (If using a flashlight, move it so all the students can see the light.)

6. Without letting students discuss what they saw, have them write down what they "saw" when the light flashed off.

7. Have a few students read what they wrote.

8. Discuss that the "red dot" was caused by the light and that it momentarily changed how their eyes work. The light would not blind them unless it was very bright like the sun.

Heat

1. Turn on the classroom lights and the light-bulb or flashlight.

2. Ask how long will it take for the light-bulb to heat up?

3. Turn off the light and unplug it. Touch the light-bulb to make sure it is not too hot.

4. Let the students touch the light-bulb to feel the heat.
5. Ask the students: Why is it hot? (It is hot because the energy inside the bulb made the molecules move very quickly.)

6. Explain to the students that one of the byproducts of light is heat. When something burns it produces heat and light.

7. Ask the students how they think Alexander felt that terrible day? (Hot or cold)

8. Ask a student to describe how molecules act when they get hot. (The molecules move around quickly and hit each other.)


10. Put students in groups of two. Have each pair think of and write down on the ditto as many uses of heat energy as they can.

11. List all of the uses on the board.

12. Pass out the flame ditto. Have students list one use of heat energy on each flame.

13. Color and cut out flames. (Do not color over the words.)

14. Elicit from the students what people burn to get heat. (coal, natural gas, petroleum oil, charcoal, wood)
15. List these fuels on the Heat Energy fuel ditto. Color, cut out, and glue on the bottom of the construction paper.

16. Glue flames above the fuels.
Forms of Energy

Electricity

Lesson 4:

1. What do you think you will see when the light is turned off?

2. What did you see when the light was turned off?

3. List all the things you use heat energy for:

   __________________________________________
   __________________________________________
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Forms of Energy

Arrow to the Sun

By: Gerald McDermott

Lesson: 5: Solar Cooker

Objectives:

1. The learner will diagram how we get energy from the sun.
2. The learner will make a solar cooker.

Materials:

1. A copy of Arrow to the Sun
2. One shoebox for every child
3. 3 feet of aluminum for every child
4. Tag-board to fit into each box
5. Masking tape
6. Wooden skewers (2 per child)
7. Big marshmallows

It must be cut to fit snugly into each box.
8. Black tempra paint
9. Drawing paper

Procedures:

1. Read the story *Arrow to the Sun* and discuss what the boy got from his father, the sun. Discuss how the Pueblo Indians worship the sun because they believe life comes from the sun.

2. Discuss what the sun gives us. Explain that it gives us all the energy we need.

3. Draw the diagram (Fig. 1) on the board and explain how the sun not only gives us light, but it gives us food and energy.

Procedure for Making a Solar Cooker

Explain to the children that they are going to build a solar cooker. They are going to use the sun to cook the food.

1. Paint the inside of the shoeboxes with black tempra paint. Ask the students "Why black?" (Black absorbs the heat.)

2. Pass out the prefitted, precut tag-board.

3. Pass out an 18"x12" sheet of foil to each child. Some children may need more depending on their box.
4. Each child will need a 6-8" strip of tape.

5. Students cover one side of the board with foil, shiny side up. The foil should hang over the edges of the board. Tape the foil down so that the tape is on the back side of the board.

6. When the paint is dry, pass out 2 pieces of foil (approximately 6"x6") to each student.

7. Have students tape the foil on the inside, short sides of the box. Have them affix the tape on the outside of the box and on the long sides of the box.

8. Have students place tag-board on the inside of the box. The board should sit curved like a cradle and fit right to the edges of the box.
9. Punch a hole in the side of the box for the skewers. Slide the skewers through the holes. Put tape on the outside tips of the skewers.

10. Skewer a big marshmallow between the skewers and place the cooker in the sun.

11. Have a discussion about where and how the cooker should be placed to get the most energy. (Place the cooker in full sun so the shadow falls behind the cooker in a straight line. Put a rock or other support under the box so it is pointing toward the sun.)

(Fig.1)
Lesson 1: The Crust

Objective:

1. The learner will create a picture of the earth's crust, listing the different layers of rock found there.

Materials:

1. 8 1/2"x12" white construction paper per student
2. Crayons
3. One white glue bottle per student
4. Black glitter
5. Sand (Keep it outside)
6. 1 copy of The Magic Schoolbus...
7. Paper for a "word bank"

Procedures:

Read the story to the class. Discuss how the earth is made up of layers of rock. Discuss the layers. If possible, show the students rocks from each layer in
the crust. (Most school districts have rock collections that can be used by teachers.)

1. Pass out paper, glue, and crayons.

2. Students will draw a line down the 8 1/2" side of the paper, approximately 1" from the edge.

3. Turning the paper so that the line is on the left hand side, students will draw a "hill" starting from the lower left corner to the lower right corner. The "hill's" apex should be about 1/4 the way up the paper. (see Fig. 1.)

4. Label this area "The Mantle" and color it red. (Do not color over the words.)

5. Draw another layer about 1" above the mantle. In the small box on the left, write "IGNEOUS". (See Fig. 2)

6. Color the igneous layer black and gray.

7. Draw another layer 1" above the igneous layer. In the box write "METAMORPHIC".
8. Color this layer light blue with patches of other colors.

9. Draw a layer about 2" above the metamorphic layer and label the box "SEDIMENTARY". (This layer has two basic types of rock: sandstone and limestone.)

10. Draw a couple of lumps in this layer and write "LIMESTONE" in each lump. Leave these lumps white.

11. Write "SANDSTONE" somewhere in the layer and color the rest of the area grey. (Remember not to color over any words.)

12. Color the line above the sedimentary layer brown and label it "soil".

13. Write "The Earth's Crust" at the top of the paper.

14. Color the sky blue and draw a few trees in the soil.

15. Smear glue over the igneous layer.

16. Sprinkle glitter on it and let it dry.

17. Smear glue on the sandstone area.

18. Take the paper outside to the sand and sprinkle sand over the sedimentary layer. (Do not put
the paper in or on the sand for it will make the rest of the paper look messy.)

The students now have their own crust!

19. Put all the new words on the Word Bank (Fig. 2)

Changes in the Earth's Crust

Poem: "Erosion"

BY: Lou Anne Carder

Lesson 2: Erosion

Objectives:

1. The student will read a poem about erosion.
2. The student will do an experiment to discover how water erodes the crust.

Materials:
1. 15+ disposable pie tins.
2. 2-3 lbs. of dirt (not sand)
3. 15+ straws (see NOTE)
4. 15+ small cups to hold water
5. 30+ copies of the poem
6. Journals

 Procedures:
Pass out the poem to all students. Have them read it silently. Put the students in groups of twos. Have them read the poem to each other. Discuss the poem with the entire class.

1. Working with a partner, each pair will get a pie tin, a straw, and a container of water.
2. The teacher will put one cup of slightly moist dirt into each of the pie tins. (Putting the dirt in different areas of the tin will create different erosion patterns.)
3. The students will hypothesize what will happen to the dirt when one strawful of water is put
on it, then what will happen with 1-10 strawfulls. Students will write down their ideas.

4. Students will take turns dripping water on the dirt with the straw and writing down their observations. (Have students watch for canyons, valleys, and pebbles left on top of their dirt hills.)

5. Students will write down their conclusions of how water eroded their dirt and how they think water erodes the earth's crust.

6. Students will share their conclusions with the class.

7. The teacher will show students pictures of erosion, discuss the different forms caused by it and discuss how some erosion is not bad.

Extensions:

1. Students can collect pictures of the erosion taking place and decide if the erosion was caused by water, wind, or man.

2. Discuss how humans erode the crust and how some of this may be stopped by planting certain plants.
3. Students will write acrostic poems using the word EROSION.

NOTE: Straw Dripper

To make a straw dripper bend a plastic straw in half. Then bend that part back onto itself. Put the unbent end in water and squeeze the bent end. The water will rise up the straw. Let the students practice beforehand.

Erosion

By Lou Anne Carder

As water travels to the sea
It scrapes the path it goes in;
And when the soil gets worn away,
That's what we call erosion.

Waves will break against the shore
And wind blows out and blows in.
Those also wear away the soil.
That's what we call erosion.

Trees and plants can help to block
The path that water's chosen.
Still somewhere soil is worn away.
That's what we call erosion!
Changes in the Earth's Crust

The Wave

By: Margaret Hedges

or

The Burning of the Rice Fields

By: Lafcadio Hearn

Lesson 3: Earthquakes (Lesson 3 and 4 may be combined.

Objective:

1. The learner will write a paragraph on how earthquakes change the earth's crust.

Materials:

1. 1 copy of The Wave or The Burning of the Rice Fields
2. Posters, photographs, and pictures of faults and geological changes caused by faults
3. Journals

Procedures:

1. The teacher will read the story to the class.
2. The class will discuss the story.
3. The teacher will show the class the different kinds of changes earthquakes cause (mountains, valleys, cracks...).

4. The learner will write a paragraph about how quakes change the crust.

Lesson 4: Earthquakes

Objective:

The learner will demonstrate the different ways the earth's crust breaks during an earthquake by using a sandwich.

Materials:

1. 12 oz. chunky peanut butter
2. 12 oz. jelly
3. 6-8 oz. raisins
4. 15+ slices of dark rye bread
5. 15+ slices of wheat bread
6. 15+ slices of white bread
7. 30+ paper plates
8. 15+ tongue depressors or plastic knives
9. ditto for each student
Procedures:

Before beginning the lesson, mix together the peanut butter and the raisins and set aside. Put one slice of each kind of bread on 15 plates. On the other 15 plates put about 2 tablespoons of jelly, 2 tablespoons of peanut butter, and a knife. Students will work in pairs during this lesson.

1. Review the different layers of the crust. Show samples of white and brown sandstone, slate, shale, and conglomerate. Conglomerate is a mixture of different kinds of rock glued together.

2. Discuss how layers are not in the same order everywhere on the earth, but for today everyone is going to have the same layers.

3. Pass out the ditto.

4. Students fill in the names of the layers on the ditto. (Fig. 1.)

5. Pass out one jelly plate and one bread plate to each pair of students.

6. Students will put the rye bread on the bottom and spread the peanut butter on it.

7. Place the wheat bread on top of the peanut butter.
8. Spread the jelly on the wheat bread.
9. Place the white bread onto the jelly.
10. On the ditto, each student will label the new food layers and color them. (Fig. 2.)
11. Using the knife, each student will cut his/her sandwich in half.

To Create a Lateral Fault:
Have the students gently push the white bread halves together. Notice how it starts to bend upward! Now slide one of the white halves on top of the other. This is what happens in a lateral fault.

To Create a Vertical Fault:
Hold both halves. Shift one half upward so that the peanut butter layer is next to the jelly layer. This is what happens in a vertical fault.

Discuss the difference between a lateral fault and a vertical fault, how much force it must take, and what causes that force. (These are good questions for the student to look up in an encyclopedia.)
Children can now finish filling in the worksheet.
<table>
<thead>
<tr>
<th>The Earth</th>
<th>The Sandwich</th>
</tr>
</thead>
<tbody>
<tr>
<td>white sandstone</td>
<td>white bread</td>
</tr>
<tr>
<td>shale</td>
<td>jelly</td>
</tr>
<tr>
<td>brown sandstone</td>
<td>wheat bread</td>
</tr>
<tr>
<td>slate</td>
<td>peanut butter</td>
</tr>
<tr>
<td>sandstone</td>
<td>rye bread</td>
</tr>
</tbody>
</table>
Earthquake

Directions:

Label in the layers of the earth's crust. Label the parts of the sandwich after you have made your sandwich. Color the sandwich.

The Earth's Crust

The Sandwich


3. What is the difference between the faults?

4. Why is it difficult for geologists to date layers of rock?
Changes in the Earth's Crust

Hill of Fire
By: Thomas Lewis

Lesson 5: Volcanoes

Objectives:
1. The learner will read the first 16 pages of
Hill of Fire.
2. The learner will draw a diagram of the inside
of a volcano.

Materials:
1. 30+ copies of The Hill of Fire
2. Crayons
3. Journal

Procedures:
Put the students in pairs according to reading
ability. Put the good readers with the average readers
and the average readers with the poor readers.
1. Students read to each other to page 16.
2. Brainstorm with children to list the parts of a volcano.

3. Tell students they are going to learn about the insides of a volcano.

4. Draw a diagram of the insides of a volcano. Label and describe the parts as you draw them. (Fig. 1.)

5. Erase the labels and put all the new words on the word bank.

6. Students will use their journals to draw the diagram and label it. They may work with their partners.

![Diagram of a volcano with labels: Ash, Lava, Magma, Steam]
Changes in the Earth's Crust

Hill of Fire

By: Thomas Lewis

Lesson 6: Volcano


Objectives:

1. The learner will finish reading Hill of Fire with his/her partner.
2. The learner will write a paragraph describing how a cinder cone volcano is formed.

Materials:

1. 30+ Hill of Fire books
2. 1 box--30x30 cm. and at least 18 cm. deep
3. 1 m. laboratory tubing
4. Masking or duct tape
5. Sand
6. Compressed air
7. Journal
Procedures:

Set up the demonstration before doing the lesson.

a. Cut a hole in the side of the box for the tube to fit through.

b. Slide the tubing through the hole to the center of the box.

c. Tape the tubing so that it is in an upright position. (Fig. 1.)

d. Attach the other end of the tubing to the compressed air source.

e. Fill the box with sand until the end of the tubing is covered with about 10 cm. of sand.

f. Gently open the compressed air valve so the air will begin to blow grains a few cm. above the surface. The grains will fall back and develop a circular cone-shaped mound and crater.

IMPORTANT: Practice building the volcano before demonstrating it to the students. To start building another volcano, just smooth down the sand to its original height.
1. Have students finish reading the Hill of Fire.
2. Ask students:
   a. Was there any lava coming out of the volcano when it first erupted?
   b. What was coming out of the ground?
   c. Why do you think there was no lava? (Gas escapes first, shooting hot surface rock into the air.)
   d. Did lava ever come out?
3. Tell students this type of volcano is called a Cinder Cone Volcano.
4. Demonstrate the Cinder Cone Volcano
5. Children will write about how a cinder cone volcano is formed.

NOTES: Hill of Fire is on an excellent video produced by the "Reading Rainbow" series. There are also many good films and videos on volcanoes.

Ways to Conclude This Theme:
1. Contact a college or university in the area and have a geology professor or student talk to the class.
2. Contact the fire department and have an officer speak to the class about earthquake safety.

3. Have the students make small clay volcanoes. Glaze and fire them. When they are finished, put baking soda in the craters. Have the students pour red food coloring and vinegar in and have 30 little eruptions.
Resources


Science-New Directions in Assessment. 1993-CLAS TOPS Learning Systems. Canby, OR.