DOCUMENT RESUME

ED 357 973 SE 053 275

TITLE Nuclear Age Issues: A Teacher's Resource Guide for Kindergarten through Grade Twelve. Publication No. X-127.
INSTITUTION Los Angeles Unified School District, CA. Office of Instruction.
PUB DATE 87
NOTE 272p.
AVAILABLE FROM Los Angeles Unified School District, 450 N. Grand Ave., Room A-303, Los Angeles, CA 90012.
PUB TYPE Guides - Classroom Use - Teaching Guides (For Teacher) (052)

EDRS PRICE MF01/PC11 Plus Postage.
DESCRIPTORS *Controversial Issues (Course Content); Critical Thinking; Educational Objectives; Elementary Secondary Education; *History Instruction; Holistic Approach; Integrated Activities; Integrated Curriculum; *Interdisciplinary Approach; Learning Activities; Lesson Plans; *Nuclear Energy; Nuclear Technology; Science Activities; Science Education; Science Experiments; *Science Instruction; *Social Sciences; Units of Study
IDENTIFIERS California (Los Angeles); Environmental Issues; *Nuclear Education; Nuclear Weapons

ABSTRACT

This teacher's resource guide is designed to facilitate the planning of science and history/social science classroom instruction concerning nuclear age issues for elementary and secondary students. The materials introduce this topic with an interdisciplinary approach to a broad range of nuclear topics. The booklet is divided into five sections. The first section discusses the psychological impact that nuclear age issues have on children and suggests classroom techniques and strategies teachers can use to approach the topic that take into account the students' grade level. The second through fifth sections present instructional units that integrate nuclear age issues into: elementary science; elementary history/social science; secondary science; and secondary history/social science. Each subsection identifies the behavioral objectives for the instructional units and provides teacher directed lesson plans to meet those objectives. Appendices provide the following information: (1) a nuclear glossary of key terms useful in studying nuclear issues; (2) annotated lists of 158 print and media resources, 36 curriculum materials for teachers, 24 organizations and public agencies involved in nuclear issues, and 16 audiovisual materials available through the Los Angeles Unified School District; and (3) Skills Continuums for elementary science, elementary social studies, secondary science, and secondary social studies. (MDH)

NUCLEAR AGE ISSUES

A TEACHER'S RESOURCE GUIDE

FOR KINDERGARTEN THROUGH GRADE TWELVE

LOS ANGELES
UNIFIED SCHOOL DISTRICT
OFFICE OF INSTRUCTION
Publication No. X-127 1987

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for Kindergarten Through Grade Twelve

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ACKNOWLEDGMENTS

Grateful appreciation is expressed to the following teachers for writing this teacher's resource guide.

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Secondary -- Joel Colbert, Adviser, Human Resources Development Branch

History-Social Science Sections

Elementary -- Arlene Chatman, Teacher, 75th Street School
Deloris Holt, Teacher, 97th Street School
Secondary -- Merrell Frankel, Teacher, Berendo Junior High School
Cecelia Locklear, Teacher, Monroe Senior High School

Sincere appreciation is also extended to the following persons for their contributions in preparing the materials dealing with behavioral approaches:

Andrew Wang, Psychiatrist, LAUSD School Mental Health Center, for preparing the section titled "Point of View: The Psychological Impact of Nuclear Age Issues"
Janice Goldblum, Coordinator, LAUSD Psychological Services, who developed the section titled "Nuclear Age Issues: Suggested Classroom Techniques and Strategies"

Grateful acknowledgment is expressed to the following individuals who contributed their expertise to the preparation of this resource guide:

Sheldon Alpert, Resource Teacher, Office of Secondary Instruction
William H. Blahd, Director, Department of Nuclear Medicine, UCLA/Wadsworth Medical Center, and Chairman, American Board of Nuclear Medicine, Inc.
Mary Cronin-Courtney, Resource Teacher, VISTA Programs
Bill Harris, U.S. Committee for Energy Awareness
Steven Lamy, Assistant Professor, School of International Relations, and Director, Center for Global Education, University of Southern California
Janet Minami, Director, Media Services
Cosetta Moore, Specialist, Social Studies, Office of Elementary Instruction
Sue Quinn, Supervisor, Audiovisual Services
Tomas Roybal, Consultant, History-Social Science Unit, California State Department of Education
Walter Wolf, Chairman, Department of Radiopharmacy, USC School of Medicine
E. Leroy Zimmerman, Formerly Research Physicist, Oakridge National Laboratory, and presently member of technical staff, "Radiation and Nuclear Effects on Electronics," Litton Industries

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Sincere thanks are also extended to the following persons whose contributions helped to make this publication possible:

Herbert Bauer, Former Teacher, Los Angeles Unified School District
Blanche Friedman, Consultant, Early Childhood Education
Leon Furgatch, Supervisor, Educational Services,
Department of Water and Power, City of Los Angeles
Gerald Garner, Specialist, Science, Office of Secondary Instruction
Lynn Greenberg, Thursday Night Group
Margaret Hobble, Southern California Edison
Robert A. Ireland, Education Specialist, Department of the Navy
Joseph P. Linscomb, Former Associate Superintendent, Instruction,
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INTRODUCTION

Nuclear Age Issues: A Teacher's Resource Guide for Kindergarten Through Grade Twelve is designed to facilitate the planning of science and history-social science classroom instruction in nuclear age issues for elementary and secondary students. The materials provide teachers and administrators who choose to introduce this topic in appropriate science and history-social science classes with an interdisciplinary approach to a broad range of nuclear topics.

The publication incorporates goals, concepts, skills, instructional strategies, and objectives currently emphasized by the District's Guidelines for Instruction in science and social science, the State Model Curriculum Standards, and the State Frameworks.

The lessons contained in this publication include specific recommendations for a directed lesson sequence as well as guided group practice, independent practice, and provisions for individual differences. Using these instructional approaches, varying ability levels and special needs may be addressed.

It is the purpose of this resource guide to provide teachers and students with a balanced and objective approach to the broad topic of nuclear age issues. Teachers and students should have the opportunity to examine a variety of viewpoints so that they can develop an understanding of the often complex questions and issues that are a part of this important contemporary topic. Students must be given ample opportunity to review and analyze evidence from a variety of sources so that they might arrive at their own conclusions. The role of the teacher in this process is to provide learning experiences that represent all sides of these critical issues. The function of the teacher is neither to advocate nor to encourage a particular point of view.

A fundamental goal for all teachers is to assist students to become participating citizens in a society committed to shaping and maintaining democratic values. There are profound implications for our society--and our world--whether students assume their future roles as adult citizens and voters with or without an informed awareness of nuclear age issues. To achieve the goals of citizenship participation and intellectual competence, students need teachers' help to develop a foundation of understanding, interest, and skills. This resource guide provides opportunities for growth, practice, and mastery of all of the skills listed in both the science and social science continuums published by the District. (In this publication, the terms social science and social studies are interchangeable for the elementary level.) Emphasis is placed on investigative activities; interpreting graphic materials and data; exercising critical-and creative-thinking, problem-solving, and decision-making skills; valuing; and participating in society.

The content of nuclear age issues and the methodology for teaching critical-thinking skills and concepts should be taken from the science and the history-social science curriculums. Although this publication concerns itself directly with these two disciplines, the topic has implications for instruction in other disciplines as well. In this sense, nuclear age issues can be considered to be interdisciplinary subject matter.

Approaches to instruction in nuclear age issues might also utilize materials from mathematics, literature, and the visual arts as well as materials from the sciences and the social sciences. History and science are not meant to be treated in isolation. Indeed they support, and are in turn supported by, other subject area disciplines.

The search for solutions to problems and the enhancement of knowledge are dynamic processes that, if used in appropriate ways, can enable students to apply the methodologies of the sciences to their own experiences and to the decisions they all will have to make as they participate in society.

TEACHING CONTROVERSIAL ISSUES

In selecting instructional materials for use with students as they study nuclear age issues, teachers should be aware that most authors are expressing particular points of view. The use of a variety of publications and other resources will afford an opportunity for students to develop skills in distinguishing fact from opinion and in evaluating sources.

History-social science and science instruction includes controversial issues that must be introduced in a sensitive manner so as not to be offensive to participants. The policy of the Los Angeles Unified School District is to provide students with an opportunity to study current public problems in an atmosphere as free as practicable from partisanship or emotional approach; to assume responsibility for distinguishing between teaching and advocating; and to defer the discussion of highly controversial issues until sufficient facts and perspective can be secured to base discussion on reason rather than on undue emotion.*

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*Refer to Guidelines for Instruction: Secondary School Curriculum, Administrative Directives and Curricular Information, (Los Angeles Unified School District: Office of Secondary Instruction, Publication No. SC-863.1, 1985), page 6.

DEALING WITH NUCLEAR ISSUES:

BEHAVIORAL APPROACHES

POINT OF VIEW: THE PSYCHOLOGICAL IMPACT OF NUCLEAR AGE ISSUES

ANDREW WANG, M.D.

Nuclear energy has always been a double-edged sword. On the one hand, it appears to provide an answer to our earth's dwindling energy supply; yet on the other hand, we have also come to witness the absolute horror of its destructive power. For a while, it seemed to be the answer to all of our problems. After all, it ended World War II instantly, didn't it? But the problem lies not in nuclear energy itself, but rather in the question: Can humankind control nuclear energy? Like the vulnerable boy who released the all-powerful genie out of the bottle, how we put it to use will determine our ultimate destiny. Are we capable of controlling the genie? Or shall we have trouble resisting the temptation to abuse the power we have and thus become a slave to our own greed? The trouble is, however, once the genie is out of the bottle, we must learn to live with it. Any attempt to return it to the bottle, if it were possible, would be as much an escape as simply letting it go unchecked. Our task then lies in a commitment to face the issue realistically and to find new ways of solving our problems through self-inspection and mutual cooperation.

In a way, a child's growing mind is analogous to the development of nuclear energy. It has immense constructive and destructive potential, and it requires appropriate shaping and molding in order to blossom properly. Nuclear education is neither experimental nor controversial. It has been our responsibility all along, and we have been doing it for years. When it comes down to it, the essence is basically to teach the young to contain and take control of their own immense potential and put it to constructive use.

With the above general introduction in mind, it is now possible to focus more specifically on the psychological consequences of unregulated nuclear proliferation. Why is it so frightening to all of us? Nuclear destruction often conjures up images of horror, coupled with overwhelming anxiety and fear. It is difficult even to imagine the aftermath of a nuclear explosion. We hear about radiation sickness, nuclear winter, and other things we have never experienced. It is like dealing with aliens from outer space. The mystery and uncertainty give us a feeling of total vulnerability, helplessness, and inadequacy. Worst of all, we as ordinary citizens <u>are</u> truly helpless. There is no escape. It is precisely this feeling of doom and helplessness which is so threatening to all of us. We can speculate that this feeling has its roots in our earliest infant experiences, when we were entirely dependent on our caretakers for survival. As infants, we neither had the physical strength nor the psychological maturity to cope with all of the stresses around us. We were truly at the mercy of our environment then. A nuclear explosion can instantly return us to that primitive helpless state. We stand to lose everything we have worked for in our lifetime, and more. We are reminded starkly of all things which make us so human: our vulnerabilities, fears of loss, dependency needs, needs to be in control, and needs for a purpose in life.

Now just imagine how this will impact upon our children, who are not yet equipped with all of the stress-coping skills of adults and are still dependent on their caretakers for their comfort and survival. To a child, the immediate concerns are the loss of parents, being left alone, not having physical and psychological needs met, and not knowing what to do next. These anxieties and fears are certainly not new to the classroom setting. We often see children react to these stresses with the following symptoms: fear of being left alone; fear of the dark; fear of leaving mother; clinging behavior; crying episodes; irritability; hyperactivity; disruptive, attention-seeking behaviors; sadness; increased escape into a fantasy world with increased daydreaming; poor concentration; social withdrawal; and intolerance to changes in routine activities. Of course, the manifestation of each child's symptoms may vary, depending on the child's earlier life experiences and level of cognitive maturity. For example, an adolescent will handle losses very differently from a five-year-old. Similarly, children who have gone through multiple foster home placements will react to losses quite differently from children from intact families. Further specific discussion on methods of classroom intervention for these symptoms are beyond the scope of this point of view statement. We can get more out of discussing intervention in a workshop setting. Nevertheless, it is important to make the point that children should be allowed to express (either verbally or through play) their fears and concerns. They should also be listened to and reassured using language which is appropriate to their particular level of cognitive development.

Now we should turn to an area of nuclear education which is as important as interacting with and teaching children. What are our personal feelings toward nuclear disasters? How are we coping with our anxieties? These questions are raised because we cannot objectively address and soothe our children about separations, losses, wars, etc., unless we are ready to confront and understand these troubling issues ourselves at a personal level. Obviously, our own reactions are heavily biased by our prior life experiences. Whether we like it or not, these personal reactions will ultimately be communicated to those we teach through our everyday interactions. Care must be taken that we do not unconsciously preach our biases but rather show the children objectively all of the available facts and options so they can make rational choices for themselves. Some of the factors which may influence our outlooks toward nuclear war may include our own experiences with wars (World War II, Korea, Vietnam) and devastations (natural disasters, car accidents); our own early experiences with separation from our caretakers; our level of physical and emotional independence; our sense of limitation, strength, and power; our trust in people and in our political system; our own background and philosophy; and our flexibility towards new ideas and changes. Needless to say, all of these factors play a crucial role in shaping our outlook towards life. Unless we are keenly aware of these powerful "hidden" forces within ourselves, we are at the risk of attributing inappropriate emotions and reactions to various issues at hand. We all know how often we find ourselves feeling threatened by or angry at a student without knowing exactly why.

Even after a thorough self-examination of our own vulnerability, it is still very important to bear in mind the exact purposes of various forms of nuclear education. Before we walk into a classroom, we must be clear as to how we want to conduct the class and what we wish to accomplish. Is there a particular topic or message to bring across, or is it an open discussion designed to stimulate and provoke further thinking? The approaches are obviously different. We also must realize that often there are no right or wrong answers. The teacher must learn to withstand the anxieties aroused by simply not knowing. It is important to realize that students often react to uncertainty and ambiguity with disruptive behavior or direct challenges to authority. The teacher's skill must be used to avoid being "trapped" in a defensive role and instead to point out the anxiety which is being experienced. Again, the goal of nuclear education is to teach how people can work with each other peacefully and solve a common problem together, despite individual differences.

In summary, nuclear education requires the combined efforts of science, the social sciences, psychology, and philosophy. As our knowledge and capability advance, we must find within ourselves an inner strength to take control and regulate our potential power and impulses. We know, as human beings, that we all fall prey to fears of annihilation which stir up primitive existential anxieties. Children are specially vulnerable to these fears because they are ill equipped to handle overwhelming stresses. We must also be aware of how our past experiences greatly influence our own current outlook towards life. As educators, we must ultimately teach children about themselves. As role models we must show our children that we are in control and worthy of shaping our destiny. It is only through the understanding of our limitations as well as our powers that we can hope to survive our blunders.

NUCLEAR AGE ISSUES: SUGGESTED CLASSROOM TECHNIQUES AND STRATEGIES
JANICE GOLDBLUM, PSYCHOLOGIST, PSYCHOLOGICAL SERVICES

A. Research

Within the past few years, research regarding the reactions of children and adults to nuclear issues has increased greatly. A study by the American Psychiatric Association (reported in 1983) confirms that fear of a nuclear holocaust--either through war or a power plant disaster--is prevalent among children and adolescents.

In a 1983 California study of 913 high school students, nuclear issues ranked second to a parent's death as a source of greatest worry. When asked who they talked with about their nuclear fears, 73 percent mentioned their friends, but few mentioned adults; 57 percent said they did not talk about such things with parents, and even more said they did not discuss them with teachers or counselors. A majority (56.4 percent) said their parents were afraid of nuclear war. Adults' unwillingness, or inability, to calm children's fears contributes to a sense of helplessness and hopelessness.

The daily lives of American children give evidence of their interest in and knowledge about nuclear issues. MAD magazine devoted an issue to satirizing nuclear war. Video games of the type found in arcades or those played at home on personal computers are tremendously popular with young people. Among popular games are Missile Command, Battlezone, and Defender, all of which have high-tech warfare as themes. Television and movies have always had a powerful impact on young people, and the entertainment industry has capitalized on children's curiosity about nuclear war. The movie War Games, in which a teenager accidently taps into a Defense Department computer and brings the world to the brink of nuclear disaster, was seen by millions of young people.

One of the most potent of all external influences on the thoughts and behavior of young people is music. Popular rock music has included social and political criticism over the years, and recent song lyrics have delivered antiwar/antinuke messages. Rock superstars are among the most visible of all peace activists, and many of their fans have embraced the nuclear disarmament crusade. The universal popularity of rock music suggests convincingly that young people are regularly reminded of the threat of nuclear war.

During the Cuban Missile Crisis of 1962 when air raid drills and bomb shelters were prevalent, researchers at Albert Einstein College of Medicine wanted to determine what children knew about the tense world situation. They interviewed children from first grade through high school. According to psychology professor Sibylle Escalona, who reported the results of the study, they did not ask children any questions about war or weapons. They asked in what way the children thought the world would be different in ten years. Around 70 percent of the children mentioned the Bomb and that they might not have a future. But almost all of them had incorporated the knowledge of what was then the most dreadful weapon one could imagine into their conscious thoughts about the future.

"There have been a number of different studies since then," Escalona says, "but what I find most astonishing is that, no matter who did it, no matter what the population, no matter what their particular approach, the percentage of children who say that they know about nuclear war, think about it, worry about it ... has always been between 70 and 85 percent. Children of every age state very clearly their awareness of having to live on two levels, with the full, constant background awareness that none of their plans, none of their expectations may be realistic."

"What has increased over the years, as you compare studies," she continued, "is the number of children who report grave concern and anxiety about the prospect of nuclear war. When children are asked, 'Do you worry about nuclear war seldom, sometimes, often, or a great deal,' the proportion which answers 'often' or 'a great deal' has steadily risen."

In the late 1970s, an American Psychiatric Association task force investigated the psychological reactions of children and teens living in a world in which they feel thermonuclear war is a constant danger. The study team distributed 1,000 questionnaires to elementary and high school students between 1978 and 1980, and conducted an additional 100 interviews for more detailed responses.

Harvard psychiatrists William Beardslee and John Mack authored the study. They found the students' comments to be "quite disturbing and demonstrate that the imminent threat of nuclear annihilation has penetrated deeply into their consciousness." Some typical responses:

> What does the word nuclear bring to mind? "Danger, death, sadness, corruption, explosion, cancer, children, waste, bombs, pollution, terrible, terrible devaluing of human life."
>
> "Nuclear means a source of energy which could provide the world with energy needed for future generations. It also means the destruction of marine life whose environment is ruined by nuclear waste. Also the destruction of human life when used in missiles."

Massachusetts Institute of Technology staff psychiatrist Eric Chivian and Boston educator Roberta Snow interviewed 150 children from grades 1 through 9. They talked to the students in groups so that they would not feel alone and would be comfortable in speaking out. They interviewed them at school so they would see how their peers felt and would realize that adults are taking time to listen to them.

Chivian and Snow studied the comments closely. They learned that many first-graders worry about war, and saw all war as similar. Although apt to giggle during discussion, many admitted to nightmares.

Third-graders felt helpless. They were interviewed during the 1982 Falklands War, and they confused this conflict with a nuclear war which many thought was erupting. These youngsters fantasized that they would be the sole survivors and were keenly aware that they might not grow up. There were fears of abandonment and loss of parents, family, and friends.

Fifth-graders displayed greater knowledge about nuclear war, and also more anger: "Why don't we march?" "Why don't we do more about it?" Early signs of despair were evident.

Seventh-graders reacted with cynicism and distrust of governments, civil defense plans, and the cool rationality of adults. They wondered why we have weapons we don't plan to use and indicated a real willingness to involve themselves in peaceful solutions.

Ninth-graders felt angry, cynical, and helpless: "I don't want to survive if everything else is gone." Or, "If someone makes a mistake, we all have to die."

These children were acutely aware that they would pay the biggest price in a nuclear war. They feared death at an early age, and were terrified of having deformed babies.

Another researcher, Vivienne Verdon-Roe, is both a kindergarten and college-level educator. She spent six months interviewing children and adolescents for a book and documentary film entitled Growing Up in the Nuclear Shadow: What Can the Children Tell Us? Verdon-Roe found that "many young people express a very real fear that their lives are going to be unnaturally shortened."

Her study focused on children, ages six to eighteen, from diverse social and economic backgrounds. Each child told his or her fears about the nuclear arms race. Their statements were simple, direct, and from the heart. "The difference between adults' and young people's understanding of what nuclear war would really entail is apparent in how they speak of weapons," Verdon-Roe noted. "Adults tend to depersonalize them and refer to statistics, while a child thinks of a nuclear bomb as something that blows up people, imagining blood, mutilated bodies, and dreadful suffering. We (adults) block off any consideration of such war because it is simply too painful to imagine."

Benina Gould, a social worker with the Family Therapy Institute of California, has led workshops designed to help parents and children talk about their fear of nuclear war. She has found that most adults need to first come to terms with their own emotions--hopelessness, confusion, despair, doubts about their profession--before they can effectively communicate with children. One family she interviewed had great difficulty talking about their emotions, even though they were very active in disarmament work.

Many adolescents see little value in striving for personal gain and improvement; they expect a nuclear war to interrupt their life and end it prematurely. "Sometimes I feel real depressed, like there's no point in going to school, because I'm going to die soon. A lot of times, I'm really convinced that I'm going to die in a nuclear war." Or, "Once I found out what was going on . . . it seemed to me that everything was useless."

Others are hell-bent on coping. One teenager designed a space ark to rescue survivors of a nuclear holocaust. Another reported that his friend is learning "survival training" so that he can live in the wilderness while city dwellers perish in a nuclear attack.

A basic difference between those children who felt hopeless and helpless and those who were feeling positive and optimistic about their future was that the former were not involved in any way in changing what causes them anxiety, while the latter were actively doing something to alter the situation. These children emphasize that a way to lessen feelings of despair and helplessness is through personal involvement.

We appear to be at a very critical time in history, a time that may decide the fate of both our species and our planet. On one hand, we possess scientific, medical, and psychological resources undreamed of forty years ago. We have gone to the moon, fathomed the intricacies of the brain, and sent probes to the far reaches of the solar system. On the other hand, millions of people starve, our ecosystem is endangered, and nuclear arms threaten global suicide. We face unprecedented opportunities, yet we also face unprecedented threats.

Rutgers University professor Milton Schwebel feels that American schools have been burdened with many problems and criticisms since World War II. He says, "We can hardly expect the schools to solve the problems of the nuclear threat. However, this topic is not some unrelated extra. It is the curriculum; it's science and history, literature and economics and drama. It's their life experience, a source of relevance and motivation for students."

B. Anxieties: What are they?

Thoughts and feelings about nuclear issues must be acknowledged and dealt with in an intelligent manner. In order to do this, many of us must first understand our own reluctance to think or talk about the issues, particularly with children. We need to be receptive to the increasing evidence that some children, in both their waking and sleeping hours, think about nuclear war. We need to consider why we treat the issue in a cursory or incomplete manner, or ignore it altogether. Are we embarrassed because we are illinformed? Are we uncomfortable expressing our deep feelings? Do we find the topic too depressing? Are we so afraid of saying the wrong thing to a child that we say nothing? Do we feel that questioning our government's nuclear policies is unpatriotic?

We need to work through our own reluctance or denial before we can help children. Then, if we choose to talk about nuclear issues with them, we will be able to talk with attention to the emotional level as well as to the factual level.

The fear of nuclear war and the suspicion that their lives may be unnaturally shortened is as much a crisis for children as are the trauma of death in the family, illness and hospitalization, abuse, foster care, or family drug and alcohol problems. Talking with children about these heavy truths of their lives can be difficult.

But if we cannot communicate our understanding of their experiences, or our acknowledgment of their hurt, their fear, their anger, or our caring enough for them to admit the truth about their lives, they will remain untouched by our efforts to reach them--and they may fail to consider or adopt necessary alternatives for coping.

When adults don't let children voice their fears, the fears can multiply or be acted out indirectly. However, when adults listen to children's concerns, and when they help youngsters talk about their feelings in the context of caring relationships, children become less puzzled, less troubled. They feel cared about, understood, loved.

Lack of communication of shared feelings and strong emotions can lead to isolation and indifference between ourselves and family members and others with whom we come in contact. Philip Zimbardo, Stanford University psychologist and author, stated that he knew of no more potent killer than isolation. "There is no more destructive influence on physical and mental health than the isolation of you from me and us from them. It has been shown to be a central agent in the etiology of depression, paranoia, schizophrenia, rape, suicide, mass murder..."

Caring adults who may want to calm the fears of children may have difficulty doing so because the topic is so painful. Yet research shows that denial of unpleasant truths greatly increases children's sense of anxiety and isolation.

For adults to realize that children know when they are seriously ill or worried about the threat of nuclear war is one thing; to be able to talk competently and sensitively with them about it is another. Both topics require that we know how to help them face crises: events that originate outside themselves, but which intrude upon their lives and undermine their emotional and physical well-being.

Dr. Elizabeth Kubler-Ross, a psychiatrist who has led the way to a deeper understanding of the needs of dying people, says one of the greatest challenges facing those in her profession is developing the ability to "hear our patients."

When people are hurting, confused, troubled, anxious, alienated, terrified, doubtful about their self-worth, or uncertain of their identity or future, genuinely supportive comments will help them feel understood, which in turn will activate strong and positive responses.

Joanna Rogers Macy, author of How to Deal With Despair and lecturer on comparative religion, has been involved in "despair work" in numerous settings. She helps individuals label their despair, accept it as a real and natural part of their lives, and learn to use it constructively.

Our times bombard us with signals of distress, Macy says. "As a society, we are caught between a sense of impending apocalypse and an inability to acknowledge it." When political activists, religious leaders, and other social reformers confront us with our apathy, their chastisement generally fails to move us. Our real problem is not indifference, it is dread: we are afraid to face that sense of helplessness and hopelessness that pervades our lives.

The suppression of despair, like the suppression of any strong emotion, has its price. Macy suggests that when we try to banish our despair with "injections of optimism," our other emotional responses to the world become muted, blunted, even deadened. So what do we do with our despair? "Like grief, it must be worked through. It must be named and validated as a healthy, normal, human response to the planetary situation. Faced and experienced, despair can be used: as the psyche's defenses drop away, new energies are released."

The nuclear threat is real, and one human response to the threat is despair ". . . the loss of the assumption that the species will inevitably pull through," as Macy puts it. "It represents a genuine accession to the possibility that this planetary 'experiment' may fail. At the prospect of the extinction of our civilization, feelings of grief and horror are natural. We tend to hide them, though, from ourselves and from each other."

Some people are afraid to acknowledge their despair for fear that it is a final state of mind, a rock-bottom depth from which they will never recover. Macy stresses that despair is a point along a continuum; it is a part of a natural process that leads to hope.

As psychoanalysts have pointed out, defenses operate to reduce our awareness of suffering, not only in ourselves but also in the world. When suffering must be discussed, its emotional impact can be reduced by the mechanism of intellectualization. This is the process by which emotionally charged issues are thought of or discussed in abstract emotionless terms. This defense mechanism is used frequently by nuclear strategists in their communications. For example they speak of "reentry vehicles" in referring to missile war heads; "counter-value" in referring to the destruction of cities; and "collateral damage" in referring to killing civilians. War often provides vivid examples of this language of military science in its avoidance of direct reference to killing people.

When defenses such as those described above are examined, we can see that they represent attempts to deal with fear. Current international and nuclear threats may also be seen as expressions of fear: fear of attack, fear for our survival, fear of losing our comforts, lifestyles, ideologies, and economic supplies.

We must learn to explore both the world outside us and the world within us, learning from our subjective experience, our hopes, fears, thoughts, and emotions as much as from events outside us. To be most effective, education should include information about both the state of the world around us and the psychological forces within us. Sages and educators have long extolled the importance of education as crucial for social well-being. In our own time it is probably crucial for global well-being and survival.

C. Teachers' Role: How teachers can deal with students

The relationship between nuclear weaponry and nuclear energy is frequently misunderstood by children and adults alike. This confusion is understandable. Both nuclear arms and nuclear energy rely on similar technology. Both are extremely controversial and emotionally charged topics. Both raise questions that are similar, yet different from one another. Simply put, atomic bombs and nuclear energy are not the same, and it is important for adults to make that distinction when talking to children about nuclear war.

Many people who oppose nuclear weapons are also opposed to nuclear energy. They claim it is not safe. Other are against nuclear arms but in favor of nuclear energy. They see it as the answer to America's (and the world's) energy problems. Still others support both. Given the disagreements and debate surrounding both issues--and the likelihood that "atoms for peace" and "atoms for war" will be eternally linked--it is vital for adults to be able to discuss intelligently with children the pros and cons of nuclear energy. Children must know the facts in order to clarify their feelings.

Learning to distinguish between our needs and the needs of our children has been the focus of workshops led by Donna DeMuth, a clinical social worker in Portland, Maine. DeMuth asks participants to consider the question, "How can I help my children grow up in a dangerous world?"

"I help them sort out their feelings, right then, there in the session," DeMuth explains. "They usually express one of two basic motivations: 'I want to learn how to talk about this for my kid's sake,' or 'I have to come to grips with my own feelings before I can talk with kids about theirs.'" Some participants wanted technical information. "That's okay," DeMuth says. "Education is important. But I believe that it has to come after people have dealt with their emotions." She believes effective parent-child communication occurs only after the adults have begun to:

- Face their own fears.
- Let go of the need to "make everything nice."
- Say "I don't know" gracefully.
- Deal wtih guilt.
- Acknowledge feelings of helplessness.
- Become part of a larger support network.
- Help children verbalize their thoughts and feelings.
- Help children feel safe despite our lack of trust in the world.
- Comprehend the finality of nuclear war.
- Live a normal life in spite of our fears.

In describing her workshops, DeMuth explains that a bonding of the group takes place very quickly. "The subject is so emotional that people connect much quicker than a group that talks about marital problems, self-improvement, or some other topic. People feel free to say that they are totally stumped, that they don't know how to talk to kids about nuclear war, that they're afraid of saying or doing the wrong thing. By coming to the workshops and trying to discover how other adults handle this matter, they've already taken an important step."

Role playing is an integral part of DeMuth's workshops, and this exercise yields interesting results about the way many adults tend to talk with children about nuclear issues. In these exercises, participants are paired: one plays a child, the other plays an adult. "You're an adult, and this is a child. This child comes to you with some concern about the world." The "child" is told to "push the adult hard, be persistent, don't settle for unsatisfactory answers."

Two things happen. "First, the adult who plays the child gets a chance to safely ventilate his or her deepest feelings," DeMuth says. "These people really pour their hearts and souls out. They have permission, being only 'six' years of age. It's a permission they don't grant themselves as adults. Second, the person who plays the adult has to struggle with their own intuitive responses. Then, in a debriefing, the person who played the child gives them feedback about what helped and what didn't. That's very powerful."

People who played the adult are always surprised when they fail--when they don't get favorable feedback from the "children," and DeMuth finds that most adults fail. "Once you reverse roles, things get better. Now the 'parent' gets to play the 'child.' It's easier the second time. Participants have many opportunities to practice, rehearse, and learn better ways of responding to a child's questions."

Some ways adults can talk to children of different ages and states of emotional development about nuclear issues are presented in the following pages of this section.

MAGIC-YEARS CHILDREN (Ages Three to Six)

"Magic-years children," as Selma Fraiberg refers to them, are learning to be part of a world which is larger than their immediate family. They are immersed in discovery, wonder, play, reckless abandon, and fantasy. Yet the magic that colors their thoughts does not simply refer to their belief in the tooth fairy, Santa, and the Easter Bunny; it also refers to their belief that their own thoughts can influence objects and events in the world around them. They feel responsible for a sibling's illness if they have been "mean" to that sibling; for accidents that happen to others; or for parental fights or divorce. They believe that their thoughts about an event can cause it to happen.

Magic-years children are beginning to control their emotions and impulses, and sometimes their feelings frighten them. Anger is particularly real because they are struggling to control it, and suggestions of violence in their environment (television, movies, scary stories, family feuds) can be extremely upsetting, often causing nightmares because the violence implies that adults on whom they rely cannot control it either. Consequently, references to nuclear war can be traumatic.

It would be best if these children were allowed to grow up in relative innocence and concentrate on mastering the challenges of their environment before being burdened with "grown-up" problems. However, we cannot always insulate children from the world around them. Many four- and five-year-olds pick up allusions to atomic bombs from other children, or from television, music video games, and comments spoken by adults. These inquisitive youngsters zero in on the negative aspects of this information and dwell on it.

Adults need to acknowledge young children's concerns, to be accessible to their questions, to be perceived as someone children can always turn to when troubled, and to assure children that they are protected and loved. Most important, adults should answer young children's questions about nuclear warfare as positively and reassuringly as possible, redirect their attention to the good things in the world, and let them know what people are doing to make the world safer.

Think twice about admitting your fears to magic-years children. It may be all right to say that you worry about nuclear war in a conversation with a fifteen-year-old; it is ill-advised to tell the same to a six-year-old. Young children need positive and reassuring messages: if adults project fear and uncertainty, the child will absorb these feelings and become distressed.

MIDDLE-YEARS CHILDREN (Ages Six to Twelve)

Because middle-years children do not think abstractly, their reflections about death are specific and detailed. Adults might view their preoccupations as morose, macabre, and morbid, but they are normal for children of this age. For example, a six-through twelve-year-old may ask, "Why is Grandma so hard and cold?" or "Will the body rot in the ground?" Such questions help children master their fears.

One mother and her nine-year-old daughter visited an exhibit of art by survivors of the bombing of Nagasaki. The daughter asked, "Would my skin come off in a nuclear war like in those pictures?" The astonished mother responded in the most positive way she knew: "That's a very scary question for me to think about because I love you so much. But yes, the truth is it would . . ." and went on to explain that many people are working hard to prevent nuclear warfare.

Be a good listener with middle-years children and observe their nonverbal cues. Pay attention to their play, writing, and artwork. Create a climate in which they can voice their concerns, at their own pace. Do not force discussions on them, but try to find out what they are thinking. Ask questions that might help them say what's on their mind. ("Do you think about this often?") Summarize things occasionally. ("It seems you're trying to say . . ." or "Does that answer all your questions?") Remember that the truth is less frightening than mystery, and many children have misperceptions about living in a nuclear age. Plain accurate answers to simple questions like, "What are atom bombs?," "How are they set off?" or "Who makes them?" may give youngsters a more realistic understanding of the matter.

Middle-years children, for whom school is an intimate part of their lives, may be reluctant to admit their incomplete understanding of the nuclear problem or may avoid discussion for fear of saying "something dumb." Reassure them that nuclear issues are very complicated, and that there are no right or wrong questions.

Sometimes a question may stump you. By saying, "I don't know the answer to that question, but it's a really good question and we'll have to find the answer," you communicate to the child that his or her concern is valid. Children rarely expect as much of adults as adults do of themselves. Learn together with your children by listening to experts debate on TV, reading about the subject and discussing what you have read, attending public meetings, talking about the themes of popular movies, books, and music; and by pursuing education about nuclear issues through the vast variety of resources available.

Once an adult has established a relationship in which childrer feel free to ask whatever is on their minds, heavier themes may surface. Sometimes a question about nuclear war conceals deeper concerns. Just as questions about x may mask musings about "Where did I come from, really?" factual queries about nuclear war may cloak fears and anxieties related to "How will I end?" "Is life worth living?" or "How long will we be together?"

Finally, we are not suggesting that children worry night and day about nuclear issues. They do not. The intent of this section is to offer information and advice to those adults who think nuclear weapons and nuclear war are worth discussing with children, either now or at some future time.

TEENAGERS

Penny Jaworski, Youth Activities Coordinator for the Catholic Archdiocese of Chicago, has participated in hundreds of discussions with teenagers about important issues over the years. Nuclear war is one of these issues.

In her experience, most teenagers do not want to talk about nuclear war, just as most adults do not, even when they are deeply troubled by it. "It seems to me that kids today don't have a lot of hope; there's a feeling that the world isn't going to be around for them. They feel powerless, almost as if they're treading water. They don't look ahead any more. They have less ambition to achieve. They're holding back a lot, and I think it's because other people are making decisions for them--important decisions about bombs and missiles and war."

Jaworski says that nobody likes to admit that they are afraid of something, but once rapport has been established between people, they begin to talk more openly. "I think adolescents need to hear from adults that we all have questions, we all doubt sometimes, we all wonder what's going on, and that we aren't always in control. But it would be phony to say that nuclear war scares you if you never think about it."

"For example, when I talk with kids about alcohol, I share with them incidents about people in my life who've been hurt by it. I think the same applies to a frank discussion of feelings about nuclear war. You have to share a real experience. If you really do wonder, it's okay to say, 'I have questions about this,' without shaking a kid's foundation. If you know something, or believe something, you should be able to say it. But if you don't, the same holds true. "It's important to get the word out to adults that they can be themselves when they talk about nuclear war," Jaworski emphasizes. "This will enable young people to be themselves, too."

Many adults who talk with teens about nuclear weapons and war get caught up in the political debate surrounding the issues: the advisability of various weapons systems and strategies; the advantages and disadvantages of disarmament or a freeze; the ulterior motives of the superpowers who have nuclear arsenals. But we usually feel more comfortable, more in control, and more intelligent when we talk on a factual level rather than an emotional one.

Although "the facts" are vitally important when talking to children of this age, it is neither necessary nor always advisable to begin a dialogue on nuclear issues with reference to factual details. Merely asking exploratory questions such as "What do you think about the nuclear arms buildup?" or "How does all this talk about nuclear war affect you?" offers teens an opportunity to voice their opinions, ask other questions, learn how their peers feel, and examine what they can do in helping find a solution to the problem.

Jaworski has faced this situation many times. Her recommendation: "In any class, group, or individual discussion, you have to ask teens to listen to both sides, and you need to model this ability for them." But she emphasizes that everyone needs facts on which to base an opinion.

Sometimes we base our decisions on emotions. "This is okay, but we have to know when we're doing it. We need to be able to say to ourselves, 'This is not a logical position. I'm basing it on my feelings, and if I'm doing this, I have to respect the decisions of others who are doing the same thing.'"

Jaworski counsels everyone: Get the facts. "If I'm called upon to make a serious decision, a commitment about something important, my decision should be based not only on feelings, but on facts," she says. "We have to consider both sides. Often, with controversial subjects like drugs or alcohol or abortion or nuclear arms, we try to show others how 'horrible' the opposing side is. A better way--especially when you work with kids--is to help them make informed decisions based not just on their feelings, but on the facts and values presented by opposing sides."

"I encourage kids to respect other people's opinions, but also to evaluate if others have checked their facts. Encourage them to read things that disagree with their viewpoint so that they can make solid, informed decisions."

Roberta Snow, president of Educators for Social Responsibility and coordinator of a high-school curriculum project entitled, "Decision Making in a Nuclear Age: Confronting Nuclear Weapons," says the goals of this program are "to educate students about the arms race and the issues of responsibility and to give them different perspectives on it. The key is to help them become socially responsible for the world they live in."

Snow is frequently asked this question "How do we talk to children about nuclear weapons?" She thinks the question itself is the problem. "Maybe it should be 'How do we listen to children when they talk about nuclear weapons and how do we prepare them to live in a real democracy by caring about how they think?' Not just caring about how they think about the social problems that are important to them, but by helping them understand that the problems we're facing now are not just about nuclear weapons. It's about teaching people to be socially active in the world, to take risks, to find the courage to stand up for what they believe in."

Planned classroom activities and age-related reading material can be beneficial both as preparation for possible environmental, community, or personal disaster and as a way of helping students to deal with their experiences after such an event has occurred.

The following listed activities can be used to assist students to express feelings and to facilitate discussion related to a crisis situation. They are also meant to stimulate teachers' ideas, and they may be adapted to meet unique student needs.

PRE-SCHOOL AND KINDERGARTEN ACTIVITIES

PLAY REENACTMENT: Toys that encourage play reenactment of the children's experiences and observations during the traumatic experience can be helpful in integrating these experiences. Toys might include fire trucks, rescue trucks, dump trucks, ambulances, building blocks, dolls, etc.

PHYSICAL CONTACT: Children need lots of physical contact during times of stress to help regain a sense of security. Games that involve physical touching within a structure are helpful in this regard.

NOURISHMENT: Extra amounts of finger foods and fluids can provide the emotional and physical nourishment children need in times of stress. Oral satisfaction is especially necessary as children tend to revert to more regressive or primitive behavior in response to feelings that their survival or security is threatened.

PUPPETS: Play with puppets can be effective in reducing inhibitions and encouraging children to verbalize feelings.

ART: Have the children make a mural on butcher paper depicting something that takes place, such as What happened when . . . the earthquake struck, the wind blew 100 miles an hour, or the roof blew off? This is recommended for small groups, with a discussion afterward directed by an adult. Have the children draw individual pictures about the events and then discuss or act out elements of their pictures in small groups. This activity allows for venting experiences and assists children to discover that others share their fears.

STORIES: Read stories to the children that tell about other childrens' (or animals') experiences in a disastrous event. This can be a non-threatening way to convey common reactions to frightening experiences and stimulate discussion. It is helpful to emphasize how people resolve feelings of fear.

FANTASY: Have the children make up stories about what Superman, Wonder Woman, Mighty Mouse (or other current hero) might have done to "save the day" during the event.

PHYSICAL ACTIVITY: When the children are restless or anxious, any activities that involve large muscle movements are helpful. You might try your own simple version of "Jazzercise" (doing exercises to music, skipping, jumping, etc.)

ELEMENTARY SCHOOL ACTIVITIES

PLAY REENACTMENT: For the younger children, availability of toys that encourage play reenactment of their experiences and observations during the traumatic event can be helpful in integrating these experiences. Toys might include ambulances, dump trucks, building blocks, and dolls.

PUPPETS: Play with puppets can be effective in reducing inhibitions and encouraging children to talk about their feelings and thoughts. Children will often respond more freely to a puppet's asking about what happened, than to an adult's asking the questions directly. Help or encourage the children to develop skits or puppet shows about what happened in the event. Encourage them to include anything positive about the experience as well as those aspects that were frightening or disconcerting.

ART AND DISCUSSION GROUPS: Do a group mural on butcher paper with topics such as What happened in your neighborhood (or school or home) when . . . ? This is recommended for small groups with discussion afterward facilitated by an adult. This type of activity can help them feel less isolated with their fears and provide the opportunity to vent feelings. Have the children draw individual pictures and then talk about them in small groups. It is important in the group discussion to end on a positive note (e.g., a feeling of mastery or preparedness, noting that the community or family pulled together to deal with the crisis) after providing the opportunity to talk about their feelings concerning what took place.

SHARE YOUR OWN EXPERIENCE: Stimulate group discussion about disaster experiences by sharing your own feelings, fears, or experiences. It is very important to legitimize feelings and to help children feel less isolated.

DISASTER PLANS: Have the children brainstorm about their own classroom or family disaster plan. What would they do if they had to evacuate? How would they contact parents? How should the family be prepared? How could they help the family?

READING: Read aloud or have the children read stories or books that talk about children or families dealing with stressful situations, pulling together during times of hardship, etc.

CREATIVE WRITING OR DISCUSSION TOPICS: In a discussion or writing assignment, have the children make up a "happy ending" to a traumatic event or disaster. Have the children make up a disaster in which their favorite superhero "saves the day." Have the children describe in detail a very scary moment and a very happy moment in their experience. Create a group story, recorded by the teacher, about a dog or cat that was in an earthquake, flood, etc. What happened to it? What did it do? How did it feel? Teachers can help the students by providing connective elements; emphasize creative problem solving and positive resolution.

PLAYACTING: In small groups, play the game "If you were an animal, what would you be?" You might adapt discussion questions such as "If you were that animal, what would you do when _______________?" Have the children take turns acting out an emotion in front of the class (without talking), and have the rest of the class guess what the feeling is and why they might have that feeling. (You might explore "good" as well as "bad" feelings.)

OTHER DISASTERS: Have the children bring in newspaper clippings on disasters that have happened in other parts of the world or in other times. Ask the students how they imagine the survivors might have felt or what they might have experienced. "Have you ever had a similar experience or feeling?"

TENSION BREAKERS: A good tension breaker when the children are restless is a "co-listening" exercise. Have each of the children quickly pair up with a partner. Child #1 takes a turn at talking about anything he or she wants to while child #2 simply listens. After three minutes they switch roles, and #2 talks while #1 listens. When the children are anxious and restless, any activities that involve large muscle movements are helpful. You might try doing your own version of jazzercise (doing exercises to music, skipping, jumping, etc.).

JUNIOR HIGH AND HIGH SCHOOL ACTIVITIES

Classroom activities that relate the traumatic event to the course of study can be a good way to help students integrate their experiences and observations while providing specific learning experiences. In implementing the following suggestions (or ideas of your own), IT IS IMPORTANT TO ALLOW TIME FOR THE STUDENTS TO DISCUSS FEELINGS THAT ARE STIMULATED BY THE PROJECTS OR ISSUES COVERED.

HOMEROOM CLASS: Group discussion of their experiences of the event is particularly important among adolescents. They need the opportunity to vent as well as to normalize the extreme emotions that may have come up for them. A good way to stimulate such a discussion is for the teacher to share his or her own reactions to the event. The students may need considerable reassurance that even extreme emotions and "crazy thoughts" are normal in a traumatic event or disaster. It is important to end such discussions on a positive note (e.g., bring up heroic acts that were observed, etc.). Break up the class into small groups and have each group develop a disaster plan for their home, school, or community. This can be helpful in regaining a sense of mastery and security, as well as having practical merit. The small groups then share their plans in a discussion with the entire class. Conduct a class discussion and/or support project on how the students might help a community recovery effort. It is important to help them develop concrete and realistic ways by which they might be of assistance. Community involvement can help overcome the feelings of helplessness and frustration and deal with "survivor's guilt" and common reactions in disaster situations. Have a home safety or preparedness quiz. What would you do under certain circumstances (e.g., a hurt child is found; water is cut off; electricity is cut off; an earthquake hits the area, etc.). Talk about what it is necessary to do to survive in the wilderness. How does this knowledge apply to a community following a disaster?

Encourage students who have had first aid training to demonstrate basic techniques to the class.

SCIENCE: Involve students in special projects on stress: physiological and neurological responses to stress and how to deal with them.

CREATIVE WRITING: Ask the students to write about an intense moment that they remember very clearly (not a day nor an hour, but a short period of no more than three minutes). Or have them create a critical but humorous situation. Or "pretend you are a 'superperson' and have the opportunity to save the world from a terrible calamity." "Or write a story about a person who is in a disaster and give it a happy ending."

LITERATURE OR READING: Have the students read a story or novel about young people or families who have experienced hardship or disaster. Have a follow-up discussion on how they might react if they were the characters in the story.

PSYCHOLOGY CLASS: Initiate a discussion on how course content might apply to the stress reactions they observed during and following a traumatic event. Discuss post-traumatic stress syndrome. Have a guest speaker from a community mental health agency or a therapist involved in counseling disaster victims speak to the class.

PEER COUNSELING: Provide special information on common responses to traumatic events. Use structured exercises utilizing skills students are learning in class, then help them integrate their experiences. Point out that victims need to repeat their stories many times. They can help family and friends affected by the event by using the listening skills they are developing in class.

HEALTH CLASS: Discuss emotional reactions to the event and the importance of taking care of one's own emotional well being. Discuss health hazards in a disaster (e.g., water contamination or food that may have gone bad due to lack of refrigeration) and discuss health precautions and safety measures. A guest speaker from a public health and/or mental health agency might be invited to speak to the class. Invite someone from the local fire department to talk to the class about home safety.

ART CLASS: Have the students portray their experiences or observations of the event in various art media. Have the students do a group project, such as a mural, showing the community recovery efforts following a disaster.

SPEECH/DRAMA: Have the students portray the strongly felt emotions that come up in response to a traumatic event. Have the students develop a skit about some aspect of the event.

MATH CLASS: Have the class solve mathematical problems related to some aspect(s) of the event.

SOCIAL STUDIES/GOVERNMENT: Study governmental agencies responsible for aid to victims. How do they work? How effective are they? Write letters or petitions to local or federal agencies responsible for changing the way disasters are handled. Discuss the political implications of the event within a community.

HISTORY CLASS: Introduce historical events or disasters. Discuss how the victims or survivors of these events might have felt. Have the students bring in newspaper clippings on current events in other parts of the world. What kinds of experiences might the victims have had? Have you experienced anything similar?

INSTRUCTIONAL UNITS:

ELEMENTARY SCIENCE

NUCLEAR AGE ISSUES IN SCIENCE

FOR KINDERGARTEN THROUGH GRADE TWO

IN THEIR INVESTIGATIONS, STUDENTS DISCUSS, DESCRIBE, AND CLASSIFY TO DEVELOP THE UNDERSTANDING THAT MATTER CAN BE IDENTIFIED BY ITS PHYSICAL AND CHEMICAL PROPERTIES.

BACKGROUND INFORMATION: In addition to the three physical states of matter--solid, liquid, and gas--there are other properties that are used to classify and identify matter. Volume is defined as the amount of space that matter takes up. Other physical properties include color, hardness, solubility (how much an object will dissolve in a certain amount of liquid), and boiling and freezing temperatures.

ACTIVITIES:

DESCRIBING VARIATIONS IN MATTER: Students will discuss attributes of different materials and classify and categorize them. Students will find similarities and differences. Plan to provide materials so that only one attribute at a time changes (e.g., a white, rough, round rock should be followed by a brown, rough, round rock).

INVESTIGATING THE PROPERTIES OF MATTER: Students discuss the similarities of various substances. Students should be led to conclude that all things are alike in at least one way. All things are made of matter. All matter takes up space and has weight. Students use two balloons. Inflate one to show that air takes up space. Hang an inflated balloon on one end of a balance scale and a deflated balloon on the other to show that air has weight--that air is matter. Students use data gathered in previous investigations to predict what will happen when they add salt or gravel to a full cup of water.

IN THEIR INVESTIGATIONS, STUDENTS IDENTIFY, HYPOTHESIZE, DISCUSS, AND RECORD INFORMATION TO DEVELOP THE UNDERSTANDING THAT PHYSICAL CHANGE IS A CHANGE IN SIZE, SHAPE, OR STATE.

BACKGROUND INFORMATION: A physical change in matter is different from a chemical change in that the chemical properties of a substance are not affected by the change. For example, when glass is broken the size and shape of the glass change, but the glass will still react as glass. When paper is cut, the size and shape of the paper are altered but it remains paper. However, when paper is burned, oxygen combines chemically with the atoms of paper and the resulting substance does not have the chemical properties of paper. Another method of classifying substances is by their physical states, that is, by whether the substance exists as a solid, a liquid, or a gas. A solid has a definite shape and volume. The atoms within the solid move very slowly and "touch" each other. Liquids also have a definite volume. However, they have no definite shape. The atoms of liquids move faster than the atoms of solids. Gases have the fastest moving atoms. Gases have no definite shape and will fill whatever space is available, so they are said to have no definite volume either.

ACTIVITIES:

EXPLORING A PHYSICAL CHANGE: The teacher holds a piece of paper in the air. Students identify it. Students then tear their own pieces of paper in half. Discuss whether it is still paper. Students tear the paper into the smallest pieces possible. Discuss whether the pieces are still made of paper. Through class discussion, hypothesize the results if it were possible to continue tearing the paper until they are the smallest bits that are still paper. Discuss the idea developed by Dalton that they would be so small that they would be impossible to see. Such a very small bit of paper is made of the molecules which form paper. All matter is made of atoms, but there are different kinds of atoms. Atoms join together to make different kinds of molecules.

INVESTIGATING A CHANGE OF STATE: The teacher shows the class a large piece of ice. Students describe it. The teacher records the data. Groups of students investigate properties of ice. Students chip off pieces and hypothesize if it is still ice. Students predict what will happen if they hold a piece of ice in their hands. Will it still be made of ice? What has changed? Why? What will happen if we heat the water? Is steam still water? Teacher explains that like water, many things can be found in different "states." When water is frozen, it is solid, but even though we call it "ice," it is still water. When it melts, it turns into a liquid. When it becomes steam, it is a gas. But the matter is still water. Students discuss what other kinds of things they can think of that change state.

DISCOVERING A VARIETY OF MATTER WHICH CHANGES STATE: The teacher assists students to make candles, using melted paraffin, melted crayons, and ice in a small milk carton. Teacher assists students to make chocolate and peanut candy by melting bars of chocolate and pouring the liquid over peanuts. Students record the various states of matter which they observe.

IN THEIR INVESTIGATIONS, STUDENTS HYPOTHESIZE, DISCUSS, AND RECORD INFORMATION TO DEVELOP THE UNDERSTANDING THAT INTERACTION OF MATTER AND ENERGY OCCURS IN LIVING AND NONLIVING THINGS.

BACKGROUND INFORMATION: Throughout the universe, matter and energy affect one another in a variety of ways. For example, the energy we receive on earth from the sun is produced by the fusion of hydrogen atoms (matter) to form helium atoms (another kind of matter) and excess energy. This energy in turn is used by green plants to help them grow and reproduce. We use this same energy to fuel our bodies by converting vegetable matter or animal matter into substances which our bodies need to grow and reproduce. The amount of light energy from the sun which is retained and converted to heat energy can be affected by the color of the matter which the light rays strike. All these are examples of ways in which matter and energy interact.

ACTIVITIES:

EXPLORING THE CONCEPT OF ENERGY: Students hypothesize as to what might happen if we were to stop eating. Would we have the energy to run and play? What do we need to have energy for? Do plants need to have energy? The teacher records students' responses. The teacher explains that energy is the ability to do work--to move things--and is necessary for body movement and growth.

IN THEIR INVESTIGATIONS, STUDENTS OBSERVE, LIST, ILLUSTRATE, AND DISCUSS TO DEVELOP THE UNDERSTANDING THAT THE SUN IS THE SOURCE OF ENERGY FOR LIFE ON EARTH.

BACKGROUND INFORMATION: All life on earth receives energy from the sun either directly or indirectly. Green plants are the only living forms able to convert the energy of light into chemical energy necessary to grow and reproduce. Therefore, they are known as primary producers. Animals which eat green plants convert the energy in the plants into energy which they can use for growth and reproduction. No animals produce energy on their own. All animals are dependent in some way upon plants for energy, and plants are dependent upon light from the sun. Animals which eat other animals get their energy indirectly from the sun as well. When certain parts of the ecosystem are destroyed, the primary consumers and secondary consumers are also affected. They have to find other consumers to eat or they will die. If all the plant life in an area were destroyed, all the animals would need to move to other areas or they would die. If secondary consumers were to die out, then primary consumers' populations might increase and the amount of vegetation available would be depleted. Thus a delicate balance exists in nature.

ACTIVITIES:

IDENTIFYING LIVING AND NONLIVING THINGS WHICH REQUIRE ENERGY: Students list as many things as they can which move things as they grow. Students draw a picture of where they think the energy to do this comes from. Discuss the results. Discuss how our bodies change food into energy so we can do work.

MATCHING ENERGY USERS WITH ENERGY SOURCES: Show pictures of various living and nonliving things which move and nonliving things which do not move. Students identify examples which do work because they move. Show another set of pictures which depict sources of energy for the previous examples. Students try to match (1) the examples which do work with (2) their sources of energy.

EXPLORING THE RELATIONSHIP BETWEEN SOLAR ENERGY AND PLANT GROWTH: Students deprive leaves of a light source by covering them with black paper and observe the results. They compare growth rate of plants in light with that of those placed in areas with no light. Discuss how light is a source of energy for plants.

DISCOVERING HOW MATTER AND ENERGY INTERACT TO DO WORK: Heat water in a teakettle over a hot plate. When steam comes out, use it to spin a pinwheel.

INVESTIGATING ELECTRICAL CHARGES: Students make simple electroscopes by placing puffed rice on a string. Fold a string in half with a rice puff hanging on each end. Rub a hard plastic rod or comb with a wool or silk scarf. Place the plastic rod or comb near the two rice puffs. Have students observe how the rice puffs are affected by the electrical charge. Rubbing various materials together, such as nylon stockings, rubs electrons off one material and leaves them on another.

DEMONSTRATING ELECTRON FLOW: Students charge a balloon with a piece of nylon and then use a fluorescent light bulb to show how the electrons flow through the bulb.

IN THEIR INVESTIGATIONS, STUDENTS RECALL, ROLE PLAY, EXPERIMENT, AND DISCUSS TO DEVELOP THE UNDERSTANDING THAT THE PHYSICAL CONDITIONS OF TEMPERATURE AND PRESSURE DETERMINE THE STATE OF MATTER.

BACKGROUND INFORMATION: Matter exists in three states: solid, liquid, and gaseous. Temperature affects the state in which certain substances are found. For example, when ice is heated, it melts and changes state so that it becomes a liquid--water. When heated still further, it becomes a gas--water vapor. Extreme pressure will also often cause the molecules to become "excited" and move about more rapidly, as they do when substances are heated. A change of state results. For example, the boiling point of water--that point at which liquid begins to change to gas--can be lowered if the air pressure above the water is lowered.

ACTIVITIES:

RECALLING PREVIOUS INFORMATION ABOUT CHANGES IN STATE: After students recall experiences of heating ice to change water from solid to liquid to gas, relate the idea to new information gained when sugar is melted to make almond brittle candy.

ROLE-PLAYING MOLECULAR MOVEMENT: Students role-play the movement of the molecules and their changes in motion as heat is added to make solid ice turn into liquid water and finally into water vapor.

OBSERVING A PROPERTY OF MATTER DURING A CHANGE OF STATE: Students weigh a sealed plastic bag of ice, let it melt, and reweigh the bag. They record the results to determine if the amount of matter has changed. The teacher melts chocolate over heat. Students predict what will happen if the chocolate is again cooled. The chocolate is placed in molds and cooled in the freezer. Children may eat the candy.

IN THEIR INVESTIGATIONS, STUDENTS EXPERIMENT AND CONSTRUCT A MODEL TO DEVELOP THE UNDERSTANDING THAT SOLAR ENERGY CAN BE CONVERTED INTO OTHER FORMS OF ENERGY.

BACKGROUND INFORMATION: As stated in earlier background information, solar energy is converted into chemical energy during photosynthesis in plants. Solar energy is also converted into heat when it strikes various objects. Darker colored objects retain more heat energy than do lighter colored objects. Solar energy is converted into the energy of motion when heated air rises and is replaced by cooler air, thus creating a wind. Solar energy is stored in fossil fuels and can be converted to heat energy and then to electrical energy. Without solar energy there would be no ocean currents, rain would not fall on the land, and life would not exist.

ACTIVITIES:

INVESTIGATING VARIOUS FORMS OF ENERGY WHICH CAN BE CONVERTED FROM SOLAR ENERGY: Students repeat experiments with plants which demonstrate their use of solar energy to produce food energy by a chemical process.

Students use a magnifier to focus solar energy to produce light and heat energy. Students make a model of a solar collector to demonstrate how solar energy can boil water, which produces steam, which will turn the turbine of a generator and produce electrical energy.

IN THEIR INVESTIGATIONS, STUDENTS EXPERIMENT TO DEVELOP THE UNDERSTANDING THAT ENERGY MUST BE APPLIED TO DO WORK.

BACKGROUND INFORMATION: Energy can be described as the ability to do work. Work can be measured in terms of the distance that a body is moved by a force against a resisting force. In the real world, much of the work done merely overcomes friction; only a part of the energy applied actually moves an object. Much energy is wasted.

ACTIVITIES:

INVESTIGATING THE RELATIONSHIP BETWEEN ENERGY AND WORK: Students form a circle in the center of the room and sit down. Students discuss different ways that a ball which is placed in the center could be moved and demonstrate each (e.g., a fan could blow on it, or a stick could strike it). After listing as many ways as possible that the work of moving the ball might be accomplished, discuss the types of energy necessary to do the work in each case. Can the ball move by itself? Why not? What must happen? What is used to cause the push or pull? What are other things that move? What is necessary to make them move?

IN THEIR INVESTIGATIONS, STUDENTS OBSERVE AND THEN DISCUSS IN ORDER TO GAIN THE UNDERSTANDING THAT THERE ARE VARIOUS FORMS OF ENERGY.

BACKGROUND INFORMATION: A number of specific forms of energy are used by people in daily living. Among them are light energy, heat energy, mechanical energy, sound energy, chemical energy, electrical energy, solar energy, and nuclear energy. The ability to move an object from one place to another or to set an object at rest in motion requires energy. Energy can be classified into five classes: mechanical, magnetic/electrical, chemical, nuclear, and radiant energy. Light and heat energy are forms of radiant energy. The energy that moving objects have is called mechanical energy. Chemical energy is produced by certain substances when combined with other substances.

ACTIVITIES:

IDENTIFYING AND MATCHING ENERGY USERS WITH ENERGY SOURCES: Students use pictures of a variety of living and nonliving things which move...do work (such as people, animals, cars, nuclear submarines, rockets, water wheels, airplanes, record players, toy cars, mechanical clocks, sun, and wind generators). Discuss their perceptions of what type of work is done in each case.

The teacher lines up the pictures on the chalkboard and brings out pictures of things which represent various types of energy (mechanical, chemical, energy of motion, nuclear, solar, etc.). Students match the things which do work with their sources of energy. The class should discuss how these sources may overlap and be interdependent.

IN THEIR INVESTIGATIONS, STUDENTS HYPOTHESIZE AND EXPERIMENT TO DEVELOP THE UNDERSTANDING THAT ENERGY CHANGES FROM ONE FORM TO ANOTHER.

BACKGROUND INFORMATION: Energy can be converted from one form to another. For example, the food we eat is converted by our bodies into heat energy. Fossil fuel and nuclear materials are used in power plants to produce electrical energy. However, in all energy conversions, energy is neither created or destroyed. Likewise, matter cannot be created or destroyed, but only converted from one form to another. Einstein later concluded that matter and energy are interchangeable, but that neither can be created or destroyed. Therefore if energy is created, matter is used in the process and vice versa. Therefore, the total amount of matter and energy is constant in the universe.

ACTIVITIES:

INVESTIGATING ENERGY MADE BY FRICTION: Students rub their hands back and forth on the table as rapidly as possible. Observe and record the results. Students hypothesize about what types of energy are used to move their hands and to produce the resultant heat energy. How can heat energy be changed to another form of energy?

DISCOVERING A USE OF RADIANT HEAT ENERGY: The teacher heats water on a burner, and uses steam to turn a pinwheel. Students record the various forms of energy observed. The teacher heats air with a hot plate to make a hot air balloon rise.

INVESTIGATING VARIOUS WAYS TO GENERATE ELECTRICAL ENERGY: Students use a hand generator to demonstrate how electrical current can be produced. Show pictures to stimulate discussion of the hydroelectric generators which convert the energy of falling water into electrical energy. Using a hose as a source of running water, construct a class model of a hydroelectric generator.

IN THEIR INVESTIGATIONS, STUDENTS OBSERVE, IDENTIFY, COMPARE, AND CONSTRUCT TO DEVELOP THE UNDERSTANDING THAT MOST NATIONS, INCLUDING OURS, ARE CURRENTLY DEPENDENT ON PETROLEUM AS AN ENERGY RESOURCE.

BACKGROUND INFORMATION: Currently the United States and most other industrialized nations use petroleum and other fossil fuels as a main source for producing electrical energy and for powering machinery. Petroleum furnishes almost half of the energy used in the world. It provides most of the energy for transporation and heats millions of homes as well. Coal provides about 30 percent of the energy used in the United States. The major uses of coal are for the production of electricity and of steel. Natural gas accounts for about 20 percent of the energy used in the world. The people of the world are rapidly using up sources of energy that have taken millions of years to accumulate. The rapid growth of energy use threatens to exhaust the world's supply. When people have removed all the oil and natural gas from the earth, they will have used up the "easy energy" supplied by nature. Experts estimate most reserves of petroleum and natural gas will last only another 20 to 40 years. Eventually people will have to find and use different sources of energy.

INVESTIGATING A VARIETY OF ENERGY SOURCES IN THE PRODUCTION OF ELECTRICITY: The teacher shows pictures of other energy sources, such as fossil fuel, solar energy, or nuclear energy, which are used to heat water and produce steam which turns turbines to produce electricity. Students identify and discuss positive and negative aspects of each source. Students in groups research the amount of energy provided by each of these sources and discuss the results. Compare the energy used from each source with the estimated amount available.

COOKING WITH SOLAR ENERGY: Students construct a solar cooker, which will convert solar energy to heat energy, to cook a hot dog.

IN THEIR INVESTIGATIONS, STUDENTS EXPERIMENT, MEASURE, AND RECORD INFORMATION TO DEVELOP THE UNDERSTANDING THAT THERE IS A CONTINUOUS INTERACTION BETWEEN MATTER AND ENERGY THROUGHOUT THE UNIVERSE.

BACKGROUND INFORMATION: Refer to previous pages.

ACTIVITIES:

INVESTIGATING WITH STATIC ELECTRICITY: Students observe the effects of electrical charges with plastic rulers, wool, and plastic wrap.

DISCOVERING THE EFFECTS OF FRICTION ON MOLECULES OF WATER: Students pour 20 ml water into each of two glass jars. Measure and record the temperature of each. Cap the jars and wrap them in several rolls of newspaper to act as heat insulators. Shake one jar vigorously for four minutes (take turns to avoid fatigue). Move it back and forth less than two inches. Do not shake the second jar. Unwrap the jars. Remove the lids and record the temperatures of the water in each. Did the temperature of the water change? Why? How did energy and matter interact?

INVESTIGATING THE EFFECTS OF SOLAR ENERGY AND VARIOUS TYPES OF MATTER: Students place a thermometer in two different jars. One jar should contain water; the other sand. Place both in the sun. After twenty minutes read the thermometers. Students record the results. Is there a difference? Students should hypothesize as to the cause of the difference.

INVESTIGATING THE PROPERTIES OF ELECTROMAGNETIC ENERGY: Students use a prism to break up visible light. The teacher should explain that this is only a small part of all of the electromagnetic energy in the universe. The teacher provides pictures showing that radio, television, and radar signals are forms of low-energy electromagnetic waves. Infrared radiation is an electromagnetic wave. When such radiation is absorbed by matter, heat is produced, as in the above investigation. Ultraviolet rays and X-rays have greater amounts of energy. X rays and gamma rays have so much energy that they can travel through solids. Use X-ray photographs obtained from a hospital as examples of this power.

USING A GEIGER COUNTER TO DETECT MATTER WHICH EMITS RADIATION: Students use a Geiger counter to detect which of a variety of rocks emit radiation. Record the type and characteristics of rocks which indicate that they are radioactive. Place sheets of paper, sheets of aluminum, and various other materials between the radioactive source and the Geiger counter. Record the results. Record the amount of background radiation. (Remember to subtract this amount from the other readings.) Discover whether water can shield against radiation.

IN THEIR INVESTIGATIONS, STUDENTS EXPERIMENT TO DEVELOP THE UNDERSTANDING THAT RECENT HUMAN DISTURBANCES OF NATURAL ECOSYSTEMS, SUCH AS BY POLLUTION AND NEW LAND USE, AFFECT THE ENVIRONMENT.

BACKGROUND INFORMATION: In recent years people have begun to discover the long-term effects of mary things they have done to the environment. Ecosystems are delicately balanced, and even seemingly small changes can affect large populations of plants and animals. Examples of changes might be the world-wide concern over the diminishing ozone layer caused by the widespread use of aerosol cans. The ozone layer filters out some of the harmful rays of the sun which can kill living things. Without this layer, life out of the ocean would not survive. Fallout from atmospheric testing of nuclear devices has been discovered to be unhealthful to all living things. For this reason, above-ground testing has been banned. When large areas of land are cleared for construction, the effect upon native plant and animal life is devastating. We are just beginning to understand that large-scale changes in ecosystems not only affects those plants and animals living in the ecosystem, but all the surrounding areas and their life forms.

ACTIVITIES:

INVESTIGATING THE EFFECT OF RADIATION ON THE GERMINATION OF SEEDS: Students plant irradiated seeds in one pot, plant seeds of the same kind which have not been irradiated in another pot, and provide similar care for each. They record the rate of growth, color, and other observations. Students hypothesize as to the effects of radiation on animals and humans.

(Scientists discovered that matter can be changed into energy. Nuclear energy comes from changes in the nucleus or the main body of an atom. The sun's matter can be changed into energy. Man needs to protect himself from dangerous radiation.)

IN THEIR INVESTIGATIONS, STUDENTS PREDICT AND EXPERIMENT TO DEVELOP THE UNDERSTANDING THAT EARTH'S MATTER IS IN CONTINUOUS CHANGE.

BACKGROUND INFORMATION: While we all know that mountains are continually building through earthquakes and volcanic eruptions, and that they are continually wearing down because of wind, rain, and temperature erosion, we sometimes forget other ways in which matter changes. Matter changes through chemical changes. Certain elements combine chemically to create new compounds with specific properties. This has happened since these elements were first on earth. Plants and other life forms are continually growing, dying, and decaying or providing energy to other life forms. Matter continually changes state, depending upon the temperatures and pressures exerted on it. For example, water evaporates into the air and then condenses in the form of rain. Water freezes to ice when the temperature drops. Often one change causes another.

ACTIVITIES:

INVESTIGATING OXIDATION: Students place steel wool in one test tube with a drop of water and observe and record data over several days.

OBSERVING EVAPORATION: Students leave water in a pan and predict what will happen. Students hypothesize about the process of evaporation.

DEMONSTRATING A FORM OF EROSION: Students investigate erosion by experimenting with running water over soil which has been plowed across a hill and with soil plowed down a hill. They observe and record the results of the two trials. Look at pictures or filmstrips to see evidence of wind and water erosion over time.

OBSERVING THE PROCESS OF DIFFUSION: Students investigate diffusion by adding drops of colored water into a vial or glass of clear water and observing the results over time. Students infer how this process affects living and nonliving matter.

DISCOVERING PHOTOPERIODISM: Students use pyramids of red, clear, yellow, green, and blue plastic wrap to cover growing plants in an investigation of the relationship between the color of light and the growth of plants.

NUCLEAR AGE ISSUES IN SCIENCE

FOR GRADES FIVE AND SIX

IN THEIR INVESTIGATIONS, STUDENTS EXPERIMENT TO DEVELOP THE UNDERSTANDING THAT MATTER CONSISTS OF PARTICLES.

BACKGROUND INFORMATION: The general arrangement of atomic particles was suggested by Ernest Rutherford. He suggested that the protons, which are concentrated in a small volume, contain the most mass. This small, positively charged mass of protons is called the nucleus of the atom. The negatively charged electrons are in constant motion around the nucleus in what Rutherford called an electron cloud. James Chadwick identified the neutron after Rutherford conducted his experiments. Neutrons have no charge but have a mass nearly equal to the mass of a proton and are located in the nucleus with the protons. Today scientists believe that the electrons do not spin in circular orbits or at a definite speed, but they use the term energy levels to describe the paths of the electrons. In addition, it now appears that atoms are mostly empty space. Other smaller particles have also been recently identified as part of the atomic structure.

ACTIVITIES:

REVIEWING DALTON'S EXPERIMENT AND THEORY: Students break a wooden tongue depressor in half. Is it still wood? Observe and discuss whether the type of matter changes as students sand the stick, using various grades of sandpaper. Is it still wood? Reintroduce the concept of atoms and molecules.

EXPERIENCING INDIRECT OBSERVATIONS: To illustrate how we know about atoms when we cannot see them, students put objects into a box and use inductive reasoning techniques to discover what is inside the box.

CONSTRUCTING MOLECULAR MODELS: Students make models of molecules such as that of H_2O using marshmallows and toothpicks.

CONSTRUCTING AND USING AN ELECTROSCOPE: Construct an electroscope, using a mayonnaise jar, a plastic lid for a coffee or butter container, copper wire, and scope, they will observe and record what the foil leaves do. Students should discuss electrons and diagram atomic structure.

DISCOVERING ALPHA PARTICLES: Students repeat the accident in which Becquerel made his initial discovery of radiation, using film, a watch with a luminous dial, and a paper clip. Students record the results and hypothesize as to why this happens.

ROLE-PLAYING ALPHA PARTICLES STRIKING ATOMIC NUCLEI: Students act out a model of Rutherford's experiment with nine students lined up at arm's-length distance to represent the gold foil and a tenth student about five meters away with a tennis ball which represents an alpha particle. Blindfold the student with the ball, and ask him to roll the ball towards the other students. Record the number of times the ball bounces off the feet of one of the students per 30 rolls of the ball.

A similar effect can be achieved by attempting to hit a small group of marbles placed in the center of the room with another marble rolled from the side of a room.

OBSERVING THE RESULTS OF ATOMIC DISINTERGATION: Students use a clock or watch which has parts of the face painted with a mixture of a radioactive substance and zinc sulfide. (Zinc sulfide is a chemical that glows when its atoms are struck by particles such as alpha particles.) In a very dark area, students examine the watch face through a good magnifying lens or microscope. Students may be able to observe a tiny flash each time a zinc sulfide atom is hit by an alpha particle.

CONSTRUCTING ATOMIC SHELL MODELS: Students draw or construct models of various types of atoms, including their outer electron shell, in order to discuss the fact that different elements have a different number of electrons. The teacher uses this to introduce chemical bonds, molecules, mixtures and compounds.

IN THEIR INVESTIGATIONS, STUDENTS EXPERIMENT, DISCUSS, AND DEMONSTRATE TO DEVELOP THE UNDERSTANDING THAT CHEMICAL CHANGE IS A CHANGE IN THE MOLECULAR STRUCTURE OF MATTER.

BACKGROUND INFORMATION: A chemical change is one in which new substances are formed. The new substances have different properties from the substances out of which they were formed. The process by which a chemical change occurs is called a chemical reaction. There are different kinds of chemical reactions; ones in which new compounds are formed, and ones in which compounds are broken down, or decomposed. A replacement reaction simply replaces elements in a compound with others. Chemical reactions only realign elements in molecules, they do not change the structure of the atoms themselves.

ACTIVITIES:

DISCOVERING THE DIFFERENCE BETWEEN MIXTURES AND COMPOUNDS: The teacher presents various types of mixtures such as pennies and sugar, iron filings and sand, or peas and beans for the students to separate. Discussion follows as to whether items which have been separated have changed as a result of the separation. Students discuss whether water is a mixture or a compound. Demonstrate electrolysis of water. Discuss the resultant gases. Ask if they are different from what they were when combined. Discuss the difference between physical change and chemical change.

IN THE INVESTIGATIONS, STUDENTS EXPERIMENT, CONSTRUCT A MODEL, AND DEMONSTRATE TO DEVELOP THE UNDERSTANDING THAT ENERGY CAN CHANGE FROM ONE FORM TO ANOTHER AND AN UNDERSTANDING OF THE FINITE NATURE OF MANY CURRENT ENERGY RESOURCES.

BACKGROUND INFORMATION: See page 28 of this publication for information concerning energy changing forms.

Today's most popular energy sources, the fossil fuels, are nonrenewable and therefore must be conserved. Fossil fuels such as oil, coal, and natural gas are a product of the decomposition of ancient plant and animal life. We are using these fuels up at many times the rate at which they were produced. We must therefore find other sources of energy which either are renewable, such as solar energy, wind energy, geothermal energy, or electric energy produced by falling water, or simply different, such as the energy produced when fission occurs in atoms. If society is to continue to be as industrialized and energy-dependent, it must locate and develop alternate energy sources.

ACTIVITIES:

REVIEWING EXPERIENCES WITH ENERGY CHANGES: Students repeat the experiment with static electricity. They charge a balloon and hold a flourescent light tube near it. Students record their observations as electrical energy changes to light energy.

INTRODUCING NUCLEAR FISSION AND FUSION: The teacher introduces the fact that a great deal of energy is locked up in the nucleus of an atom. When matter is changed into energy, a great deal of energy is produced. Discuss the two different ways to get energy from an atom.

CREATING A MODEL OF NUCLEAR FISSION: Students can demonstrate what happens during a fission reaction by shooting a marble (representing a neutron, or "atomic bullet") into a group of marbles which represent the nucleus of another atom. As the nucleus splits, neutrons are scattered, just as the marbles are in the demonstration.

MAKING A MODEL OF A CHAIN REACTION: The teacher places several mousetraps in a box. Place ping-pong balls or small corks on each. Students record results and infer what might happen in a chain reaction of atoms.

BUILDING A REACTOR MODEL: Students construct a model of a reactor using dominoes, straws, wire, pencils, and foam polystyrene. The straws represent fuel rods and the pencils, control rods. The dominoes represent the graphite blocks in Enrico Fermi's first atomic pile. The foam is used as shielding. When the wire indicators tell controllers that the pile is getting too hot, they push the pencil control rods in to control the reaction. Introduce the concept of radioactive waste. Research what scientists have done to dispose of it. Discuss the disposal possibilities. Form a factfinding panel which critiques a variety of proposals to find the good and bad points of each. Refer to pages 102-105 for additional information relating to the positive and negative uses of nuclear energy.

IN THEIR INVESTIGATIONS, STUDENTS LIST AND DEMONSTRATE TO DEVELOP THE UNDERSTANDING THAT OUR NATION AND MOST NATIONS ARE CURRENTLY DEPENDENT ON PETROLEUM AS AN ENERGY RESOURCE.

BACKGROUND INFORMATION: See pages 25-26 for information about energy dependency.

ACTIVITIES:

GENERATING ELECTRICITY: Students use a hand generator to illustrate how mechanical energy can be changed to electrical energy. Discuss how the nuclear reactor might produce heat energy to boil steam which could turn a turbine in a generator, producing electrical energy.

APPLYING THE CONCEPT TO EVERYDAY LIFE: Students list a variety of appliances (radio, toaster, light bulb, etc.) to illustrate how electrical energy is changed into other forms of energy.

IN THEIR INVESTIGATIONS, STUDENTS DEVELOP A MODEL TO DEVELOP THE UNDERSTANDING THAT ENERGY CANNOT BE CREATED OR DESTROYED BUT CAN BE TRANSFERRED FROM ONE OBJECT TO ANOTHER OR CHANGED FROM ONE FORM TO ANOTHER.

ACTIVITIES:

MODELING A FUSION REACTION: The teacher initiates a discussion of a fusion reaction such as those occurring on the sun or in a hydrogen bomb. What are the various forms of energy produced? Students model the reaction using four disks marked "+" to represent protons and another four disks marked with "-" to represent electrons. Two other disks representing neutrons have no charge and are not marked. The teacher should explain that this type of reaction, like a fission reaction, changes the nucleus of atoms and is thus different from a chemical reaction. The eight "+" and "-" disks represent four hydrogen atoms. The neutrons, two electrons, and two protons combine to create one atom of helium. This reaction occurs only at extreme temperatures--more than a million degrees Fahrenheit such as you might find on the sun or during an uncontrolled fission reaction.

ILLUSTRATING CHEMICAL BONDING WITH "CHARGE CARDS": Students manipulate atomic shell models to demonstrate chemical bonding. These models make it easy to visualize how elements combine when electrons are transferred from one atom to another during bonding to form compounds without losing matter.

Teacher explains that in chemical reactions, the total mass of matter and the total amount of energy remains the same. Neither is created or destroyed. However, during nuclear reactions, the matter in the nucleus of atoms is changed and this change produces a great deal of energy. Therefore the more recent theories of mass-energy can be introduced to explain that the total amount of mass-energy is neither created nor destroyed.

IN THEIR INVESTIGATIONS, STUDENTS DO RESEARCH TO DEVELOP THE UNDERSTANDING THAT THE INTERACTION OF MATTER AND ENERGY OCCURS IN LIVING AND NONLIVING THINGS.

BACKGROUND INFORMATION: See pages 25-27 for background information about interaction of matter and energy.

ACTIVITIES:

RESEARCHING USES OF RADIOACTIVE ISOTOPES: Students do research reports on the use of gamma rays to sterilize surgical instruments or to aid in lengthening the storage periods of fruits and vegetables, or on the use of x-rays in medical diagnoses, the use of radioisotopes in cancer therapy, pacemakers, in determining whether materials have faults or are the correct thickness, or other applications. Group or individual oral reports should be made so all members of the class can learn about the variety of uses of nuclear energy.

IN THEIR INVESTIGATIONS, STUDENTS DO RESEARCH TO DEVELOP THE UNDERSTANDING THAT RECENT HUMAN DISTURBANCES OF NATURAL ECOSYSTEMS, SUCH AS POLLUTION AND NEW LAND USE, AFFECT THE ENVIRONMENT.

ACTIVITIES:

INVESTIGATING DISTURBANCES TO OUR ENVIRONMENT BY A VARIETY OF ENERGY SOURCES: The teacher provides magazine articles, books, or pictures which describe several major disturbances caused by people's need to use energy sources. Use examples such as the Three Mile Island accident, heat pollution caused by nuclear reactor's cooling systems; air pollution caused by burning fossil fuel to make electricity; strip mining of fossil fuel; and oil spills on the rivers, lakes, and seas through offshore drilling or in transporting fuel from place to place. Small groups of students investigate and summarize their findings in order to report back to the class. The teacher or students should chart the positive and negative aspects of each of the energy sources.

WRITING LETTERS TO SOLICIT INFORMATION: The teacher should provide students with the names and addresses of several environmental protection agencies and groups. Students should compose letters in order to request information regarding each group's viewpoint. Upon receipt and analysis of the information, groups should make a poster illustrating each group's viewpoint.

TEACHER DIRECTED LESSON PLAN

DESCRIBING VARIATIONS IN MATTER

TOPIC/SUBJECT AREA: Science (Matter) Grades K-2

MATERIALS/EQUIPMENT:

- classroom and materials therein
- orange
- lemon
- yellow marker
- pencil
- overhead projector
- attached picture sheets
- sorting box and attached captions
- magazines with many pictures

OVERALL CONTENT OBJECTIVE:

Students will demonstrate knowledge of scientific content relating to matter and how it exists in varying forms with specific properties.

SPECIFIC INSTRUCTIONAL/SKILL OBJECTIVES:

- Students will identify physical properties of various types of matter.
- Students will identify similar and different attributes of matter.
- Students will group matter according to similarity of attributes.

MOTIVATION/RATIONALE:

1. Students and teacher play a guessing game: "I'm thinking of two things in this room that are red....square....made of glass....rough...(etc)."
2. After children begin to get the idea that seemingly different things may have similar attributes, the teacher explains that different objects have similarities and differences.

DIRECTED LESSON SEQUENCE:

1. The teacher should show an orange and a lemon. Have children describe how they are alike and how they are different. Repeat the process with a lemon and a yellow marker.... a marker and a pencil,etc. Descriptions should include size, weight, shape, color, taste, smell. When children describe the objects, record their words on a chart or the blackboard with categories such as size, weight, and shape.

2. The many attributes which the children have described are all ways in which to describe matter. The teacher explains that everything is made of matter. Look around the room. List different types of matter. Is the chair made of matter? The lemon? Water? The chalkboard? The classroom pet? Air? How are these things alike? How do we know they are there?

GUIDED GROUP PRACTICE:

Using an overhead projector and a transparency of pictures of various objects, teacher should ask children to divide things into two groups at their seats. Teacher can then call upon individuals to bring their groupings up to the overhead and explain why they sorted the groups the way they did for example, big things and little things. Repeat the process with other students who have divided their objects in different ways. Later divide the objects into three groups and repeat the procedure.

INDEPENDENT PRACTICE:

(This could also be done as a center activity.) Students cut pictures from magazines and paste them to index cards. Then children can use an attribute sorting box to sort the cards. Captions for sorting box headings can be attached.

PROVISION FOR INDIVIDUAL DIFFERENCES:

1. Provide a set of tactile blocks which children can sort according to similarities in feel.

2. To demonstrate that all matter, including air, has weight and takes up space, place an inflated balloon on one side of a balance scale and a deflated balloon on the other. Observe the results, and discuss whether other types of matter also have weight and take up space.

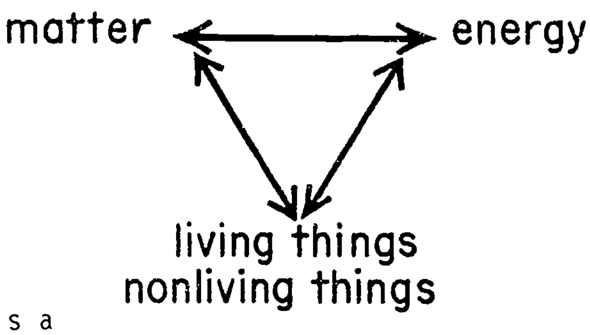
EVALUATION:

Students will be asked to circle the pictures of things which they think are made of matter. They then can cut the pictures and paste them into groups according to what they perceive as similarities in the attributes. Students should be able to explain why they are grouped in each "set."

TEACHER DIRECTED LESSON PLAN

ENERGY USERS AND ENERGY SOURCES

TOPIC/SUBJECT: Science (Energy) Grades K-2



MATERIAL/EQUIPMENT:

tag board
pictures representing energy users
data sheet

OVERALL CONTENT OBJECTIVE:

Students will demonstrate that a system is a group of related objects which have certain properties and functions and that there is continuous interaction between matter and energy in living and nonliving things.

SPECIFIC INSTRUCTIONAL/SKILL OBJECTIVES:

- Students will compare their own energy needs to those of other living and nonliving things.
- Students will match energy users to energy producers.
- Students will communicate an understanding that things need energy in one form or another in order to move or grow.

MOTIVATION/RATIONALE:

Initiate class discussion by asking children the following questions:

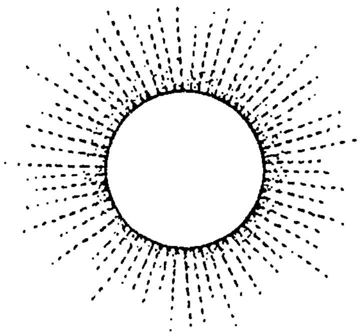
1. What do you think might happen if we were to stop eating? Would we be able to run and play? Would we be able to grow?
2. Why do we need food?
3. Do plants grow?
4. Do plants need to have energy too?
5. Why do you think animals and plants need energy?

Teacher should lead children to the understanding that energy enables things to move--to do work.

Ask children to identify all the things which they can think of that move--that do work. The teacher should list these things on one side of a large piece of butcher paper or tag board. Make sure to elicit responses which include nonliving things like boats, machines, airplanes, rockets, submarines, and cars.

DIRECTED LESSON SEQUENCE:

1. On the next day, teacher should review with the students the list of things which do work.
2. Add any new "things which work/move" to the list from the previous day.
3. Show the students a variety of pictures which might represent energy sources for the items which were listed. The pictures might include things such as a hamburger, hay, coal, sun, oil, wind, water, an atom, or a geyser. Show each picture and discuss what it represents and how it might produce energy. For example a hamburger gives people energy when they eat it. People use the energy to move and grow. Oil is used to enable cars and trucks to move. An atom can be used to create heat energy to turn a machine which makes electricity. Electricity makes many things move.



GUIDED GROUP PRACTICE:

The teacher lines up the pictures of the energy sources on the chalkboard tray. Children are divided into groups, each with a different set of energy user pictures. As each energy user is named, the teacher should ask children which source of energy matches the user. Each child can come up to the tray and tape the picture of the source next to the energy user. (Duplicate source pictures should be available in case more than one user uses the same source.) Discussion should precede each choice, and it should be made clear that in many cases there could be more than one source of energy.

INDEPENDENT PRACTICE:

Given a data sheet with pictures of energy users and energy sources, children should draw a line from the user to the appropriate energy source.

PROVISION FOR INDIVIDUAL DIFFERENCES:

1. Provide students with a variety of wind-up or battery-driven toys. Have them describe what they think is the energy source for each toy.
2. Children should be encouraged to experiment with plants in order to discover the need of the plant to have a source of light in order to grow.

EVALUATION:

Ask children to draw a picture of three things which need energy to move or to grow. Next to each picture, ask them to draw the source of the energy.

DIRECTED TEACHING LESSON

INVESTIGATING THE RELATIONSHIP BETWEEN ENERGY AND WORK

TOPIC/SUBJECT AREA: Science (Energy) Grades 3-4

MATERIALS/EQUIPMENT:

- rubber ball
- wind-up toys
- 6 sets of picture cards representing things which move or do work
- 1 set of picture cards representing a large variety of energy sources worksheets for independent practice

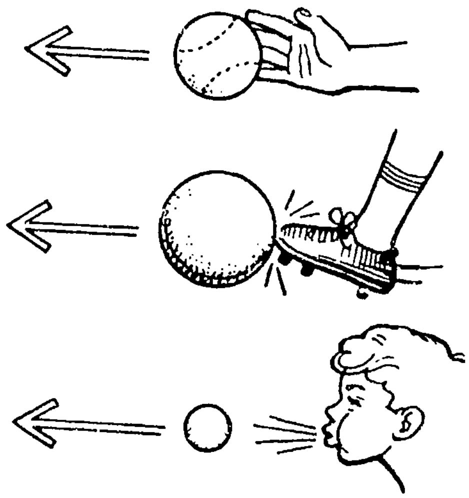
OVERALL CONTENT OBJECTIVE:

Students will demonstrate an understanding that energy must be applied to do work.

SPECIFIC INSTRUCTIONAL/SKILL OBJECTIVES:

- Students will apply force to do work or to move something.
- Students will identify energy sources necessary to do various types of work.
- Students will explain the scientific meaning of work and energy.

MOTIVATION/RATIONALE:



The teacher will ask students to form a circle in the center of the class around a small playground ball. Teacher will ask children to suggest different ways to make the ball move. Can the ball move all by itself? What must be done to make it move? As students make suggestions (for example, push, pull, blow, use a fan, throw something at it, use a wind-up toy to push it), they should carry out the action. Teacher records these suggestions.

DIRECTED LESSON SEQUENCE:

1. The teacher should explain that whenever something is moved, work is being done. In order to do work, there must be a source of energy (for example, food [chemical] energy, mechanical energy, kinetic energy).
2. The teacher should ask children to try to identify the energy source in each of the recorded suggestions given. The teacher records the responses next to the previous responses.

3. The teacher should ask the class to list other things that move or grow. Do these things require energy to do this? What do they use for energy? Can anything move or grow without using energy?

GUIDED GROUP PRACTICE:

The teacher can divide the class into small groups, providing each group with a set of cards depicting things which move or grow (things which do work). As the teacher holds up a picture of an energy source, each group should decide which of their set of pictures would use that energy source to do work. Discussion should follow. This is especially important when different groups select different sources of energy. Can a "worker" use more than one kind of energy? Can a "worker" use no energy?

INDEPENDENT PRACTICE:

A worksheet depicting a variety of things which may or may not do work (e.g., car, rock, submarine, ant, fan, water wheel, windmill, pencil, paper) as well as one illustrating energy sources such as bread, nuclear energy, running water, "Mr. Wind," oil, sun, or a geyser, should be provided for each child.

Students indicate those things which they believe do work by pasting a picture of an energy source next to the "worker." Cross out those pictures of things which don't normally do work.

PROVISION FOR INDIVIDUAL DIFFERENCES:

1. Students can look up pictures of types of energy and draw pictures for a display depicting energy sources.
2. Students can investigate and devise a model of one type of electrical energy generator.

EVALUATION: (WRITTEN OR ORAL)

1. Can this ball move by itself? (Why or why not?)

2. What is used to cause a push or a pull on the ball?

3. Draw or write three different ways that energy could be used to move the ball.

   a.

   b.

   c.

TEACHER DIRECTED LESSON PLAN

INVESTIGATING VARIOUS WAYS TO GENERATE ELECTRICAL ENERGY

TOPIC/SUBJECT AREA: Science (Energy) Grades 3-6

MATERIALS/EQUIPMENT:

hand operated electricity generator
diagram of a generator
pictures of various methods used to generate electricity
books, picture sets, magazines or rewritten material for a multilevel research lesson on the generation of electricity

OVERALL CONTENT OBJECTIVE:

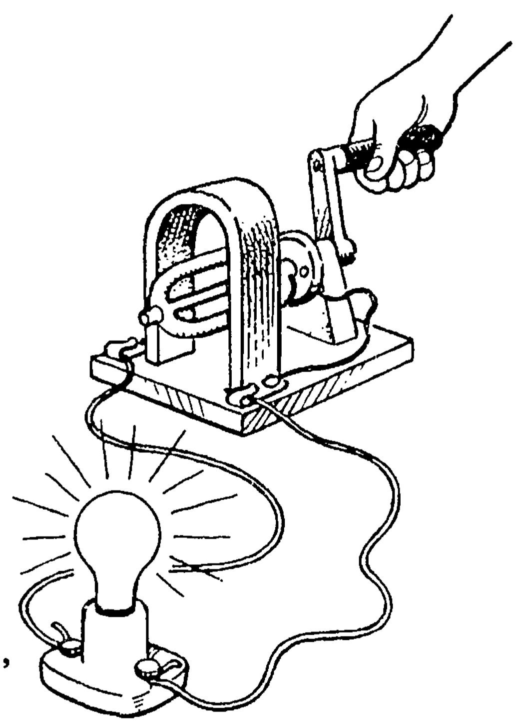
Students will demonstrate that energy can be changed from one form to another.

SPECIFIC INSTRUCTIONAL/SKILL OBJECTIVES:

- Students will demonstrate, observe, and infer various ways which can be used to produce electrical energy.
- Students will make a model of one method of producing electrical energy.
- Students will trace the sources of energy needed when creating electrical energy by hand.
- Students will evaluate various methods of electrical energy production.

MOTIVATION/RATIONAL:

The teacher will ask students to list as many items as they can which use electricity. The teacher will then ask students where they think the electricity comes from. How is it made? (A previous experience with static and current electricity is desirable.) The teacher may review with students the idea that electricity is an energy source created by the flow of electrons through a circuit. List the students' ideas about what causes the electrons to flow.



DIRECTED LESSON SEQUENCE:

1. The teacher will show the students a hand generator and tell them what it is. Invite several students to crank the generator to produce enough electrical energy to light up a small bulb.
2. The teacher will point out the various parts of the hand generator such as crank, coil, magnet, and wires.

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3. The teacher asks students what has to happen to make the bulb light up. What makes the crank turn? Explain that something turns the coil in a big hydroelectric generator too. What do the students think it might be? How do the students think that the hand generator is like the generator in a hydroelectric plant. Which makes more electricity? Which takes more energy to turn? What are some other forces which could be used to turn the crank in a generator?

GUIDED GROUP PRACTICE:

1. The teacher provides the students with a diagram of a generator, identifying the field and armature. Students should write a paragraph, developed either individually or as a group, which describes how turning a turbine or crank turns the wire coil (or the magnets) around the magnets (or coil), which moves the electrons through the wire, causing an electric current to flow.
2. The teacher should display a variety of pictures depicting ways which are currently used to turn turbines which generate electricity. The teacher should facilitate a discussion about the good and bad points children might suggest which relate to each of the generation methods depicted. Points should be charted.
3. The class should then be divided into study groups to write a brief research report and to draw pictures of the various methods used to generate electricity. Students will use magazines, books, or rewritten information about one method per group. As each group reports back to the whole class, a comparison between research and charted ideas should be made and the chart should be adjusted and corrected.

INDEPENDENT PRACTICE:

Students can be asked to draw or write a story (or both) about the method of electrical generation which they think is best, indicating why they think this method is the best.

PROVISION FOR INDIVIDUAL DIFFERENCES:

1. Children with reading difficulties should work with peers who are better able to read. The former can act as the group's recorder, artist, or the student who summarizes the research to the class.
2. Children may want to build models of nuclear, hydroelectric, or fossil fuel electrical generating plants.

EVALUATION:

Students should be asked to report the class's findings to parents or other adults at home and solicit their opinions. Students can draw or write a description of the generation method most favored by their parents.

Two classroom graphs should be developed. One would be a bar graph or pictograph representing the preferences of the students in the classroom. The other should be a similar type of graph representing the preferences of the adults at home. A comparison can be made and any differences discussed.

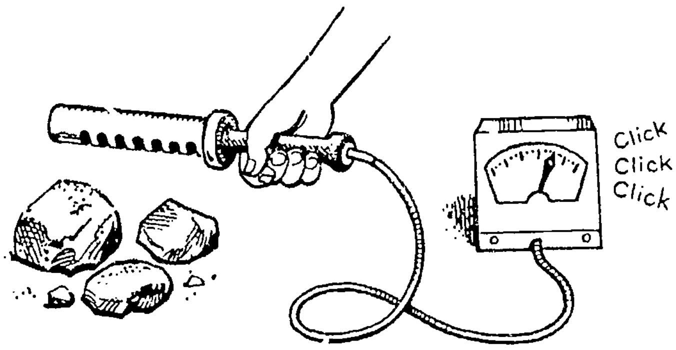
TEACHER DIRECTED LESSON PLAN

USING A GEIGER COUNTER TO DETECT MATTER WHICH EMITS RADIATION

TOPIC/SUBJECT: Science (Matter and Energy) Grades 3-6

MATERIALS/EQUIPMENT:

Geiger counter*
granite rocks
limestone
chalk
radioactive mineral sample*
watch with radium dial
variety of other items
1 meter stick per group



*available from Science Materials Center

OVERALL CONTENT OBJECTIVES:

Students will demonstrate that a system is a group of related objects which have certain properties and functions; that there is a continuous interaction between matter and energy throughout the universe; that interaction of matter and energy occurs in nonliving things. Students will use direct comparisons and simple measurement to generate data.

SPECIFIC INSTRUCTIONAL/SKILL OBJECTIVES:

- Students will observe, record, and evaluate data which demonstrate that background radiation is present everywhere, that some matter emits more radiation than other matter, and that some matter blocks radiation.
- Students will plan an experiment or an appropriate science investigation.

MOTIVATION/RATIONAL:

1. The teacher will show the class the Geiger counter and ask children what they think it is.
2. After discussing all the possibilities, the teacher turns on the Geiger counter to show the students how it works. If no one can guess what it is, explain to the class that it is a machine which detects the presence of radiation in the environment.
3. The machine is making noise. The teacher asks, the students why they think it is making noise? Explain that the noise they hear is the result of background radiation. Almost anywhere they are, they will find some background radiation because it is natural in the environment. However, larger amounts of radiation have proven to be harmful to living things.
4. Students should record the amount of background radiation.

DIRECTED LESSON SEQUENCE:

1. The teacher asks students to predict which of an assortment of items, such as granite rock, chalk, limestone, watches with radium dials, or certain dishes, will give off the most radiation.
2. Record what the predictions are so that comparisons can be made later.
3. Measure the level of radiation of a radioactive sample 10 cm, 1 meter, and 2 meters from the Geiger counter. Record the findings. Remind the students that the amount of background radiation must be subtracted from the measurement because it is always there and does not come directly from the sample.
4. The teacher should initiate discussion as follows:

   - What happens when the Geiger counter is moved farther away from the uranium sample?
   - Why do you think this happens?
   - When you do your own measurements, why is it important always to measure at the same distance?
   - Use what we have just done to identify one way to protect living things from too much radiation.

GUIDED GROUP PRACTICE:

1. Students use the Geiger counter to measure the amount of radiation given off by the various objects. They should record their observations and subtract the background radiation to keep accurate records. They should observe the results of moving the Geiger tube farther away from the sample. Since this is a variable, the distance should remain the same during each measurement.
2. Students should predict what effect a variety of materials, such as paper, glass, aluminum foil, or a sheet of wood would have on the radiation measurement if it were placed between the Geiger tube and the radiation source.
3. Investigate and record the results on a data sheet. Class discussion should follow regarding some of the best ways to protect oneself from radiation.

INDEPENDENT PRACTICE: Children can devise their own experiments to answer the following questions:

- How well does water shield radiation?
- Does a large piece of granite give off as much radiation as a small piece?

PROVISION FOR INDIVIDUAL DIFFERENCES:

1. A child can work with an aide or a peer tutor to complete and record observations of experiments.
2. A child can do research by reading articles which the teacher provides about ways in which workers who might be exposed to radiation can and do protect themselves. Students should be able to report back to the class either orally or by doing a picture display.

EVALUATION:

ANSWER THE FOLLOWING QUESTIONS:

1. A Geiger counter is an instrument which measures ______________.
2. Does all matter give off the same amount of radiation?_________
3. Why is it important to be able to shield people from too much radiation? ____
4. Do some materials shield radiation better than others? ________
5. What things did you discover were the best shields?______
____

TEACHER DIRECTED LESSON PLAN

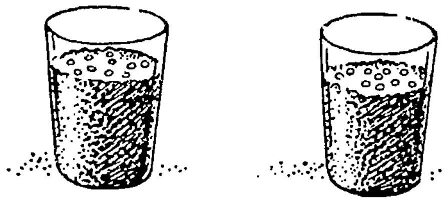
INVESTIGATING THE EFFECT OF RADIATION ON THE GERMINATION OF SEEDS

TOPIC/SUBJECT: Science (Effects of Energy on Living Things) Grades 3-6

MATERIALS/EQUIPMENT:

irradiated radish or tomato seeds*
normal radish or tomato seeds of the same type
2 pots per group
potting soil
1 ruler per group
data sheets for each group

*Available on loan from Science Materials Center



OVERALL CONTENT OBJECTIVE:

Students will demonstrate an understanding that there is a continuous interaction between matter and energy throughout the universe.

SPECIFIC INSTRUCTIONAL/SKILL OBJECTIVES:

- Students will compare growth patterns and rates of irradiated seeds with those of normal seeds.
- Students will observe, record, and evaluate events which demonstrate that radiation has a profound effect upon living things.

MOTIVATION/RATIONAL:

Upon completion of this lesson, students will begin to evaluate more wisely the effects of radioactivity upon living organisms.

DIRECTED LESSON SEQUENCE:

1. Discuss with students their ideas about how radiation affects living things. Ask about the many movies which depict giant ants or giant lizards, etc. being produced by radioactive fallout. Recall how Spider Man got his super powers.
2. Explain that while these science fiction stories are not based on scientific fact, there _is_ a relationship between excessive radiation and changes in living organisms.
3. Show children some seeds which have been irradiated and some of the same type which have not been irradiated. Ask children to observe and describe any differences.
4. Ask them to predict what would happen if the seeds were to be planted. Record their predictions for future reference.

GUIDED GROUP PRACTICE:

Each group should have a labeled packet of irradiated seeds and another labeled packet of normal seeds. Children should prepare two pots with soil and label the pots in the same way the packets are labeled. Carefully plant several irradiated seeds in the pot so labeled. Plant the normal seeds in the pot labeled "normal." Place both pots in well-lighted areas and provide them with the proper amount of water. Observe, measure, and use the data sheet to record what they see as the seeds begin to grow. After two weeks, class should compare results and summarize. Do irradiated seeds grow better than normal seeds? How are they different? Why do they think there is a difference? How might radiation affect animals or humans?

INDEPENDENT PRACTICE:

- Given several pictures of plants which are growing normally and plants which were irradiated, children should place them and paste them in the appropriate column.
- Ask children to predict what might happen to a baby chick if the egg in which it was developing was exposed to radiation.

PROVISION FOR INDIVIDUAL DIFFERENCES:

1. Show pictures of plants or animals which have mutations caused by radiation. Facilitate a discussion about the effects of radiation and possible ways to prevent accidental exposure to radiation.
2. Ask children to report back to the class about their investigations using information provided to them about the sterilization of various insects by irradiating them in order to control their populations.

EVALUATION:

- Either as a group, or independently, children should write a story about the effects of radiation on living organisms and how radiation can affect all of us both positively and negatively.
- Discuss or write a paragraph about why it is important to provide shielding around reactors in nuclear energy plants.

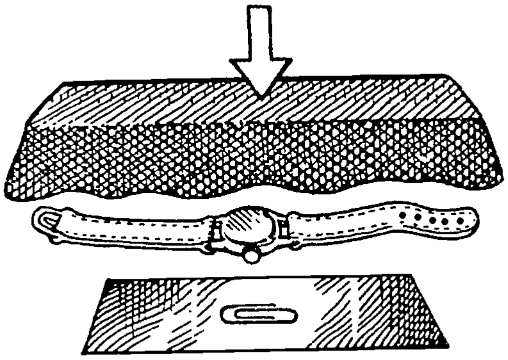
TEACHER DIRECTED LESSON PLAN

INVESTIGATIONS INTO RADIOACTIVE DECAY

TOPIC/SUBJECT AREA: Science (Energy and Matter) Grades 3-6

MATERIALS/EQUIPMENT:

photographic film
darkened room
paper clip
watch with radium dial
light-proof packet
magnifier
zinc sulfide
paper towel tube



OVERALL CONTENT OBJECTIVE:

Students will demonstrate an understanding that matter and energy can be changed from one form to another, but the total sum of matter and energy remains the same, and that matter consists of particles.

SPECIFIC INSTRUCTIONAL/SKILL OBJECTIVES:

- Students will observe and record the results of radioactive decay.
- Students will research the history of those who work with radioactive materials.
- Students will make inferences regarding the safety of radioactive materials and the necessity to take precautions when dealing with radioactivity.

MOTIVATION/RATIONAL:

Using photographic film in a darkened room while the class looks on, the teacher will place a paper clip over the film, then place a watch or clock with a luminous dial (an older one which was painted with radium) on top of that. Teacher will cover and seal the packet so that light cannot penetrate into it. Students should be asked to write down their predictions about what will happen to the paper clip or the film or the packet after a period of three to seven days. At that time, open the packet and develop the film. Observe what has happened to the film. Compare the results with the predictions.

DIRECTED LESSON SEQUENCE:

- Using the motivational activity, the teacher should promote a discussion of what the results of the demonstration were and what students suggest as the reasons for these results. The teacher should chart these suggestions.

- The teacher should explain that many years ago a very similar thing happened to a scientist by accident. The scientist had left a rock near some film in a dark drawer. The result was that the scientist became very curious about what caused a shadow that he later found on the unexposed film, and he investigated. Ask students to suggest ways to investigate what caused the film to change. Chart their responses.

GUIDED GROUP PRACTICE:

- The teacher should provide materials, either on tape or at a variety of reading levels, describing the incident in which Becquerel discovered the effects of and postulated the presence of alpha particles. After reading or listening to the material, students use a study guide to answer questions or, in a group, write a short summary of their findings. Discuss the findings as a class and, if necessary, revise the charted responses to correctly reflect Becquerel's inquiries.
- The teacher should provide pictures and read a story describing the problems encountered by early watcn face painters and early scientists who worked with or studied radioactive materials. Facilitate a discussion to elicit why the problems occurred and how they might have been avoided. What are some ways in which workers who must be near radioactive materials today can avoid serious problems such as these?

INDIVIDUAL PRACTICE:

- At a center, place a watch or clock face which has a radium dial and zinc sulfide at the end of a paper towel tube. Place a strong magnifier on the other end of the tube. Place the entire tube setup inside a box which is big enough for a student's head. The box should have a black "curtain" at one end to keep out light. Inside the box, the student can peer into the tube in order to observe the tiny flashes which occur each time a zinc sulfide atom is hit by an alpha particle. Keep a tally of the number of flashes seen in five minutes. Record the observation on a class data sheet. Graph the results.
- Students should write a short paragraph explaining how the photographic film could become exposed by the radium-faced watch, using the information gained in this demonstration.

PROVISION FOR INDIVIDUAL DIFFERENCES:

1. Students could tally the number of flashes seen in each of five, five-minute observations. The results could be graphed. An average number of flashes per minute could be calculated.
2. Students could write a letter to various hospitals and research facilities inquiring about safety methods taken by doctors, nurses, and scientists using radioactive isotopes to treat patients or to conduct research. Report findings to the class.

EVALUATION:

Either on tape or in writing, answer the following questions:

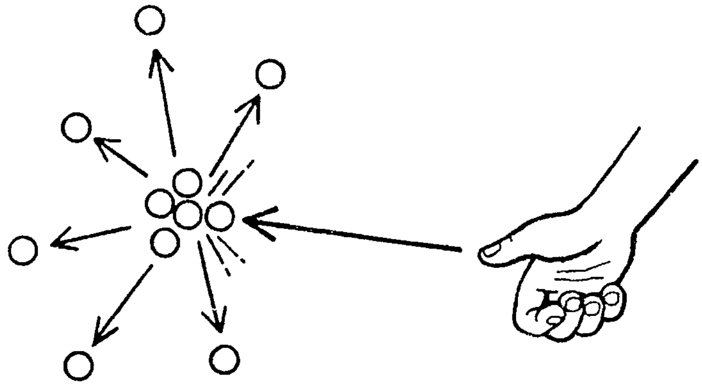
1. Why do you think the photographic film became developed?
2. How might radioactive materials affect people?

TEACHER DIRECTED LESSON PLAN

NUCLEAR ENERGY.....FISSION

TOPIC/SUBJECT AREA: Science (Energy) Grades 5-6

MATERIALS/EQUIPMENT:



- marbles
- rubber cement
- overhead
- Sharpie pens and transparency
- 10 mousetraps
- 10 ping pong balls

OVERALL CONTENT OBJECTIVE:

Students will demonstrate an understanding that mass-energy can neither be created nor destroyed, but it can be transferred from one object to another or changed from one form to another.

SPECIFIC INSTRUCTIONAL/SKILL OBJECTIVES:

- Using a model, students will demonstrate how a fission chain reaction takes place.
- Students will demonstrate the necessity of providing a material to absorb excess neutrons in a chain reaction in order to control the reaction.
- Students will infer what might happen if materials were not available to absorb excess neutrons in a chain reaction.

MOTIVATION/RATIONAL:

The teacher will group a handful of marbles together on the floor and ask the students to postulate ways to separate the marbles without touching them. Ask a student to demonstrate hitting the group with another marble and watch the results. Suggest to the class that the bunch of marbles represents the nucleus of an atom. Remind students that the protons and neutrons of an atomic nucleus are tightly bonded together. A small bond of rubber cement can be applied between the marbles to represent the bonding. Students should now speculate what they would need to do in order to break the marble apart. (The speed of the marble "bullet" needs to be greatly increased.) Try shooting the bullet marble with increased force.

DIRECTED LESSON SEQUENCE:

1. The teacher should refer to the example of the marbles as students view a diagram of the nucleus of uranium. Explain that in the fission process, a neutron is shot into the nucleus of an atom and that this is what splits the atom. When the nucleus of uranium is split, an atom of krypton and an atom of barium are produced. Two or three neutrons and a great deal of energy are also released.

2. After watching the teacher diagram the fission process on an overhead transparency, students should be encouraged to reproduce the diagram on their own papers. The number of protons (92 for uranium, 56 for barium, and 36 for krypton) should be indicated in their diagrams as well. Teachers should make sure children understand that the difference between a nuclear reaction and a chemical reaction is that the nucleus of the atom itself is altered in a nuclear reaction. In a chemical reaction, atoms are combined to produce different compounds, but the atoms themselves are not changed. When the number of protons changes in an atom, the element and therefore its properties also change.

GUIDED GROUP PRACTICE:

- Ask students to suggest what they think happens to the two or three neutrons which are released as a result of the nuclear fission of one uranium nucleus. The teacher could demonstrate another example of a chain reaction by setting about ten mousetraps and placing them into a box. Carefully place a cork or a ping-pong ball on top of each. Students should predict what will happen when a cork is dropped into the box. Teacher should carry out the action while students observe and record the results. Students should be asked to suggest what might happen if there were thousands of mousetraps in the box. Could the reaction be stopped? If so, how?
- The teacher should indicate that chain reactions in nuclear reactors also need to be controlled. Control rods of the metal cadmium are often used to absorb extra neutrons and slow down the reactions. Each time fission occurs in an atom, energy is released, and a burst of radiation is produced. This means that the reactor must be shielded so that neutrons and other radiation do not escape because they can be very dangerous to living things.

INDEPENDENT PRACTICE:

- Provide the students with the initial diagram of a neutron splitting a uranium atom, resulting in two new atoms, a great deal of energy, and two new neutrons.
- Ask students to continue the diagram of the chain reaction ten more times to calculate how many neutrons are set free at the tenth step.
- Why is a "sponge" needed to absorb neutrons? Use the mousetrap example to write a paragraph explaining what could happen if control rods were not present in a reactor. Research information describing what could happen in an uncontrolled chain reaction. Record findings in a short paragraph.

PROVISION FOR INDIVIDUAL DIFFERENCES:

1. Students construct a model of a reactor, using dominoes, straws, wire, pencils, and foam polystyrene. The straws represent fuel rods and the pencils, control rods. The dominoes represent the graphite blocks in Enrico Fermi's first atomic pile. The foam is used as a model of protective shielding. When the wire indicators indicate to controllers that the pile is becoming too hot, they move the pencil control rods in to control the reaction.

2. A reactor must have a cooling system to conduct away the great heat which is produced. The heat which can be put to useful work can also change the existing ecosystem. Students conduct research to find out what kinds of cooling systems are used in different reactors.
3. Discuss the Chernobyl nuclear power plant disaster. What do they think caused the problem? Are some nuclear power plants in the United States designed to be safer than the Chernobyl facility?

EVALUATION:

1. How is energy produced in uranium fission?
2. In a nuclear reactor, how is heat energy produced?
3. A chain reaction goes on and on because fission produces
   a. energy
   b. atoms
   c. electrons
   d. free neutrons
4. Why is it necessary to have cadmium rods in a nuclear reactor?

TEACHER DIRECTED LESSON PLAN

NUCLEAR FUSION: LOOKING BACK AND LOOKING FORWARD

TOPIC/SUBJECT AREA: Science (Energy and Matter) Grades 5-6

MATERIALS/EQUIPMENT:

pictures of Hiroshima/Nagaski after the A-bomb was dropped
pictures of European cities after heavy bombing
picture of the solar storms on the sun's corona
picture of mushroom-shaped cloud
1 set of 10 disks (4 one color, 4 another color, and 2 a third color) for each group of students

OVERALL CONTENT OBJECTIVE:

Students will demonstrate an understanding that energy cannot be created or destroyed. It can be transferred from one object to another or changed from one form to another. Matter and energy interact in living as well as nonliving things.

SPECIFIC INSTRUCTIONAL/SKILL OBJECTIVES:

- Students will use a simple model to demonstrate how a fusion reaction works.
- Students will compare the relative degrees of destruction which can be done to a city by nuclear bombs and conventional bombs.
- Students will create and compare graphs of types of energy created by a nuclear bomb and its effect on people and property compared to conventional bombs.

MOTIVATION/RATIONALE:

The teacher will display pictures of the sun and of a mushroom cloud created by an atomic blast. Teacher will ask the class to suggest similarities and differences. As students make suggestions, the teacher should chart their responses. When the class has finished making suggestions, the teacher should tell them that the energy produced by the sun and by a hydrogen bomb are made in the same way. Energy is produced when atoms of hydrogen fuse together to form helium.

DIRECTED LESSON SEQUENCE:

- Each student or small group should be provided with a set of disks. Four disks should be marked "+." The teacher should explain that these represent the protons in the nucleus. Four disks should be marked "-." The teacher indicates that these respresent the electrons which surround the nucleus of an atom. Two disks should not be marked. The teacher explains that these have no charge because they represent the neutrons of the atomic nucleus. Using a diagram on the board, the teacher can ask the students to "build" four models of hydrogen atoms with the disks on a piece of paper. (Hydrogen atoms have one proton in the nucleus and one electron which travels around the nucleus.)

- Use a pencil to circle each hydrogen atom model.
- Ask students to move to proton disks away from the hydrogen atoms to another spot.
- Take the other two proton disks and combine them with two of the charges which balance the negative charge of the electrons. Together they are neutral like the neutrons, so students may substitute two neutron disks with the first two proton disks to form the nucleus of a helium atom.
- The students should still have two electrons left in the hydrogen atom circles. These can be moved down to represent the two electrons of a helium atom.
- The teacher should explain that this reaction takes place only when there is a tremendous amount of heat which causes the hydrogen atoms to move at tremendous speeds and collide with one another. Each time hydrogen atoms are converted to helium atoms, some matter is changed into energy. On the sun, about four million metric tons of hydrogen atoms are changed into helium each SECOND! This releases a fantastic amount of nuclear energy each second in the form of light, heat, and other kinds of energy. We are very lucky the earth is so far away from the sun!
- The teacher should review the fusion process orally with the students and then ask them to summarize. Then teacher should ask these questions: "Where does the tremendous amount of energy come from?" "What happens to the hydrogen atoms?" "How many atoms of helium are created from four atoms of hydrogen?" "What is left over after the matter is fused?" "Has the TOTAL amount of matter and energy increased, decreased, or remained the same during fusion?"

GUIDED GROUP PRACTICE:

- Teacher should again display charted similarities and differences between the sun and a nuclear bomb. Ask students to modify or add to the chart, using their new knowledge.
- Discuss the ways in which the energy of explosions is released.
- Discuss the devastation caused by World War II bombings, including nuclear and conventional saturation bombing.
- Let students use the following information to create a bar or line graph using different colors to depict nuclear and conventional destructive capabilities. A class discussion should follow to clarify questions and express varying viewpoints.

NUCLEAR BOMB	CONVENTIONAL BOMBS
Explosive blast (Knocks down buildings and creates great destruction.)	
Total or moderate building destruction up to two miles away (e.g., one "Little Boy" Hiroshima bomb)	13,000 tons of TNT

NUCLEAR BOMB	CONVENTIONAL BOMB
Thermal radiation (Heat and fire caused by bombs)	
Temperatures as high as millions of degrees. Visible light causes flash-blindness between 13 and 53 miles away. First degree burns to 7 miles. Second degree burns to 6 miles. Third degree burns to 5 miles	Damage occurs only in immediate area of blast
Radiation (direct and fallout)	
Direct radiation causes death at about 1 mile. Fallout can cause radiation sickness and death many miles away and at a much later time depending upon when it is brought back to earth from the atmosphere.	No radiation is emitted.
Nuclear winter	
If enough bombs were dropped, dirt and debris would be spread around the earth's upper atmosphere in enough quantity to block out sunlight, possibly lowering the earth's temperature and interfering with the normal process of photosynthesis.	Conventional bombs would not generate such extraordinary amounts of debris.

INDIVIDUAL PRACTICE:

Students should be able to use the graph and information gathered during class discussions to write a paragraph expression feelings or opinions about nuclear bombs and conventional bombs.

PROVISION FOR INDIVIDUAL DIFFERENCES:

1. Ask students to create posters illustrating their viewpoints about the use of nuclear weapons. Why does the United States produce nuclear weapons?
2. Ask students to research fusion reactions and their use to produce electrical energy. Have students summarize potential uses and problems that will have to be overcome and present the findings to the class.

EVALUATION:

1. How are matter and energy related?
2. Explain how fission reactions compare with fusion reactions. (This assumes a previous lesson about fission.)

DIRECTED TEACHING LESSON

RADIOACTIVE MATERIALS WHICH HELP US

TOPIC/SUBJECT AREA: Science (Matter and Energy) Grades 5-6

MATERIALS/EQUIPMENT:

X-ray pictures or photos from magazines
articles from magazines
books describing various uses of radioactive materials.

OVERALL CONTENT OBJECTIVE:

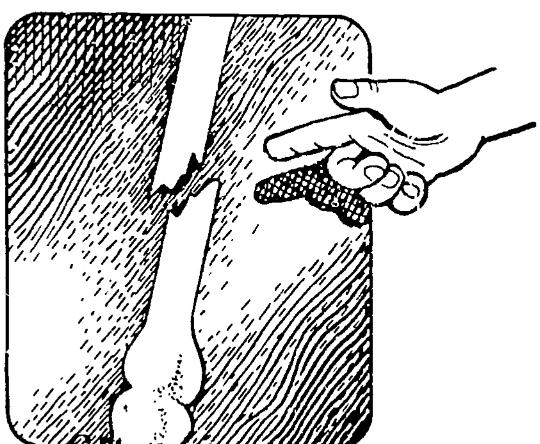
Students will demonstrate their understanding that interaction of matter and energy occurs in living and nonliving things.

SPECIFIC INSTRUCTIONAL/SKILL OBJECTIVES:

- Students will gather data and ideas, using reading skills.
- Students will explain orally or in writing data, methods, and procedures.
- Students will seek and evaluate explanatory ideas of others.
- Students will show appreciation of both the interdependence of living organisms in and with the natural environment and the implications of that interdependence for their continued survival.

MOTIVATION/RATIONAL:

The teacher will display X-ray pictures and photos from magazines. The teacher will ask students what they think these are. Could students take pictures like these with their own cameras? Why not? How are these photos different from photos taken with normal cameras using light to expose film? Ask students if they have ever had pictures like this taken of themselves. When? (Possibly when bones were broken or when they were at the dentist.) Ask those that have had the experience to relate what happened during the process. The teacher can explain that X rays and gamma rays are forms of energy like light, but that they are much more powerful. These rays can penetrate through living and nonliving things. When these types of rays pass through the objects being photographed, such as teeth or bones, they expose the film on the other side. The teacher can ask why students think lead aprons are used. The teacher can ask students in what other ways X rays can be used.



DIRECTED LESSON SEQUENCE:

1. The teacher divides the class into research groups. Provide each group with a study guide of questions to answer and books, magazine articles, pictures, and/or tapes which relate to such various beneficial uses of radioactive materials as:

    a. Radioisotopes used in medicine for research in animal and plant physiology as well as in detecting health problems.
    b. Radiocarbon dating.
    c. Use of gamma rays to detect flaws in machinery and variations of metal thickness.
    d. Use of radioactive materials to power submarines and space vehicles.
    e. Use of gamma radiation to sterilize medical equipment and prevent food spoilage.
    f. Use of gamma radiation to kill cancer cells and prevent the growth of tumors.
    g. Use of radioactive materials to sterilize insects in order to control their populations.

2. The teacher explains that each group is responsible for reading or listening to the material and using the study guide of questions to summarize what they have learned. Groups should record their findings.
3. Teacher circulates and assists groups as needed.

GUIDED GROUP PRACTICE:

Groups should report their findings to the class. The teacher can facilitate a discussion between the groups about similarities and differences of the different uses of radioactive materials. Teacher should chart the main points of each group's report.

INDEPENDENT PRACTICE:

Students can be asked to choose the two uses of radioactive materials which they think are the most beneficial to humankind. These should be illustrated in some manner and identified with a caption. Students should write a brief paragraph explaining why they think these two uses are more beneficial than the others which they learned about.

PROVISION FOR INDIVIDUAL DIFFERENCES:

1. In the use of research materials which are on tape, students should be assisted by a peer or by a paraprofessional.
2. Students can conduct a comparative study of the amount of time two sets of potatoes take to spoil. The first set should be fresh out of the ground, and the second set should have been processed with gamma radiation to prevent spoilage. A weekly record should be kept in order to make and graph observations.

EVALUATION:

Describe either orally or in written paragraph form three uses of radioactivity: one in industry, one in agriculture, and one in medicine.

DIRECTED TEACHING LESSON

INVESTIGATIONS INTO ENVIRONMENTAL PROBLEMS WHICH RELATE TO PEOPLE'S USE OF ENERGY

TOPIC/SUBJECT AREA: Science (Matter and Energy/Environment) Grades 5-6

MATERIAL/EQUIPMENT:

lists of addresses which include governmental agencies and public interest groups which deal with the environmental effects of energy use
butcher paper or tagboard
graph paper
markers
poster paint
yardsticks
rulers

OVERALL CONTENT OBJECTIVE:

Students will demonstrate skill in working independently or cooperatively to conduct simple surveys, to use monitoring equipment, and to seek information on environmental problems from appropriate agencies and individuals.

SPECIFIC INSTRUCTIONAL/SKILL OBJECTIVES:

- Students will identify several areas of environmental concern which relate to production of energy or use of energy sources.
- Students will interview or survey adults at home and at school about their views on these areas of environmental concern and summarize the survey in graph form.
- Students will write to environmental agencies and groups requesting information and will use this information to make posters illustrating the view points of the various groups.

MOTIVATION/RATIONALE:

The teacher asks students what they have learned about energy in this unit. Ask if they can recall any benefits concerning how we use or convert energy. (What are some of the benefits of electrical, nuclear, or other energy?) What do the students think are some of the problems involved with energy conversion or use? As students suggest positive and negative points about energy use and the effects on our environment, chart these ideas. Explain that in this lesson students are going to find out how other people and various interest groups feel about these same issues.

DIRECTED LESSON SEQUENCE:

1. The class should be divided into groups. Each group should be assigned the task of composing five questions which evaluate the positive and negative effects on people and the environment of a particular energy source. (For example two groups might do fossil fuel, two nuclear, one solar, one wind, etc.)
2. As each group presents the questions to the rest of the class, students should refine the questions with teacher assistance and create a summary of about 30 questions requiring yes, no, or very brief answers.
3. After the teacher types up and duplicates the questionnaire, students are expected to interview two adults in their family and one or two school staff members. (Teacher may wish to assign these. The teacher should request assistance from school staff members ahead of time. If the school is small, the teacher may wish to assign two students to one school staff person.

GUIDED GROUP PRACTICE:

1. Use the overhead projector to tally responses gathered by students. Discuss these responses as a class. Begin graphing the results in bar graph form, using the overhead projector to demonstrate. Students should complete the graph by themselves. Call students up to the projector to complete one question at a time of the graphed results to make sure that students understand the graphing process.
2. Summarize the survey in one paragraph. Students suggest a topic sentence, detail sentences, and a summary sentence. The teacher writes each sentence on the board after discussion and class consensus.
3. Review the business letter form. Ask the class to suggest a way which they could incorporate the summary of the survey in a letter to a private energy generating company about its industry and its problems. Write a sample letter as a class.

INDEPENDENT PRACTICE:

1. Each student or small group of students is given the name and address of an agency or group which may provide information which relates to the topic. The student should compose a letter telling about the summary of the survey and requesting information from the group's viewpoint.

2. When the letter has been reviewed and written correctly, it should be mailed. When students receive information in the return mail, they can create a poster which expresses the opinion of the agency or group to which they wrote.

PROVISION FOR INDIVIDUAL DIFFERENCES:

1. Students who have difficulty in writing can work with the aide or the teacher. The student can dictate a letter and the teacher or aide can record it. The student can then copy the letter. Assistance will also have to be given when information is returned. The teacher can discuss the information and ask the student to draw pictures depicting what he or she thinks about the viewpoint of the agency or group.

2. Students can create a debate panel to evaluate the benefits and harmful effects which can come from the various energy sources.

EVALUATION:

Have students write a summary of what they feel may be the benefits and possible harmful effects to people and the environment of using nuclear energy or fossil fuel to meet our energy demands.

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INSTRUCTIONAL UNITS:

ELEMENTARY HISTORY-SOCIAL SCIENCE

NUCLEAR AGE ISSUES IN HISTORY-SOCIAL SCIENCE

FOR KINDERGARTEN THROUGH GRADE THREE

STUDENTS DISCUSS AND EXCHANGE IDEAS ON A SPECIFIC TOPIC.

BACKGROUND INFORMATION AND ACTIVITIES: Pupils will read or listen to stories read to them dealing with cooperation, conflict, and conflict resolution. They will participate in discussions that encourage oral language development and social participation. Pupils will state their own opinions on a given topic by participating in a discussion on conflict and conflict resolution that may occur in school or at home. They should be given opportunities to express their own feelings and ideas. Teachers may want to use picture sets that show various forms of conflict between friends at home, schoolmates on the play yard, and other settings. Pupils will observe and explain the content of the pictures. They will be encouraged to find solutions or discover cooperative methods that could resolve the pictured conflicts. Pupils will answer questions related to the topics using complete sentences.

STUDENTS IDENTIFY OR STATE A PROBLEM ABOUT A GIVEN SITUATION.

BACKGROUND INFORMATION AND ACTIVITIES: Pupils will participate in the "Magic Circle" process to resolve classroom/playground conflict. They will become aware of the conflict resolution process of allowing everyone an opportunity to explain their ideas and state their own opinion on a given topic. Pupils will learn alternative methods of conflict resolution by being encouraged to formulate possible solutions to a problem.

STUDENTS COOPERATE WITH OTHER PERSONS.*

BACKGROUND INFORMATION AND ACTIVITIES: Pupils will discuss and experience the effect of cooperation by participating in cooperative games. They will cooperate with other class members in order to play the games.

- Two partners sit back to back, with bent knees and linked arms. Leaning on one another, they try to stand up.

- Two partners stand facing one another, palms touching, about three feet apart. They take turns falling toward each other and being supported by their partner's palms.

- Partners stand facing one another and stretch their arms straight out in front until palms are touching. Both partners then close their eyes, drop hands, and turn around in place three times. Keeping eyes closed, they then try to reconnect by touching the palm of either one of both hands.

- Make a tight, shoulder-to-shoulder circle with all of the children present. Everone turns in the same direction. At a signal, everyone tries to sit on the lap of the person behind. Great hilarity!

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*Adapted from Dialogue: A Teaching Guide to Nuclear Issues, Educators for Social Responsibility, 1982, page 65.

. A large group of children measure the length of time they can keep one or more large balls or balloons in the air. This can be done outdoors or sitting indoors in chairs or at desks.

STUDENTS SUMMARIZE INFORMATION IN VARIOUS FORMS.

BACKGROUND INFORMATION AND ACTIVITIES: Pupils, guided by the teacher, will research and identify different energy sources (such as animals, people, wind, oil, coal, electricity, water, steam, solar, nuclear) and make a list under the specific heading "Energy Helps Us Do Work." Pupils and teacher will prepare a chart from given information and individually research information on how people use different kinds of energy to do work or to improve the quality of life. The teacher and the class discuss energy sources that are recent developments, with an emphasis on nuclear energy. The class or individuals develop stories on ways pupils think nuclear energy can be used or on why it should not be used at all. What types of nuclear technology, including medicine, industrial, communication, and space exploration, would be unavailable to our lives if nuclear energy were not used. The teacher may display pictures that show nuclear energy being used in various ways. Class or individual stories will be developed by paraphrasing information orally or in written paragraphs. As a summary activity, using the information developed in the proceding activities, organize a panel discussion on the topic: "What would be the effects if the United States discontinued nuclear research and its applied technology?"

STUDENTS LOCATE PERTINENT INFORMATION FROM VARIOUS READING SOURCES.

BACKGROUND INFORMATION AND ACTIVITIES: The teacher will guide pupils into discovering current uses of nuclear energy. Pupils will locate information in books, newspapers, and periodicals. Pupils may cut out magazine and newspaper photographs or draw pictures of nuclear energy uses to make a collage or other kind of bulletin board display. Pupils will prepare written communications such as signs, captions, and labels to accompany their display. Pupils will classify pictures and words according to the categorv "Peacetime uses of nuclear energy/nuclear weapons."

STUDENTS LEARN TO ASSOCIATE EXPERIENCES WITH IDEAS PRESENTED.

BACKGROUND INFORMATION AND ACTIVITIES: After listening to a story about fear, pupils will be encouraged to discuss their own fears. They will explain their ideas and feelings about things of which they are frightened. Pupils will differentiate between fact and imagination in their discussion by identifying real things that may frighten them as opposed to fictional or imaginary things. The teacher should guide pupils into discovering ways to cope with fear by helping them to formulate possible solutions to situations that cause their fear.

NUCLEAR AGE ISSUES IN HISTORY-SOCIAL SCIENCE

FOR GRADES FOUR THROUGH SIX

STUDENTS LOCATE PERTINENT INFORMATION FROM VARIOUS READING SOURCES.

BACKGROUND INFORMATION AND ACTIVITIES: Pupils will research the question "What is nuclear energy?" They will collect facts on the topic and write an explanation using them. They will find information by using newspapers, periodicals, and the library card file. Pupils will learn to use parts of a book to find information, and they will develop a simple bibliography from given resources.

Pupils will participate in class discussions dealing with nuclear issues. The class may be divided into groups, with each group given the responsibility of researching and answering one question related to a nuclear issue. Pupils will interpret reading and graphic material, take notes, and cooperate with others by following through with group tasks. Each will present his or her information to the entire class, using correct terminology in explaining information. Pupils will participate in class discussions by making their own contributions.

STUDENTS IDENTIFY, DESCRIBE, AND USE MAJOR PARTS OF A MAP.

BACKGROUND INFORMATION AND ACTIVITIES: Pupils will learn about California and its land and environment. They will research, record, and report on the locations of nuclear power plants in California. Pupils will recognize and apply map and globe concepts to locate Los Angeles and other California cities. They will compute distances, using a mileage scale, between nuclear power plants near Los Angeles and other cities. Pupils will become aware of the possibilities of nuclear accidents and potential danger by analyzing causeand-effect relationships between nuclear facilities and population centers.

Pupils will prepare a list of the countries which have nuclear weapons and become aware of the defensive alliances between nations. They will construct a world map by adding the correct country names to a blank map. Pupils will become aware of the possibility of nuclear confrontation by identifying countries with nuclear capabilities and coloring them the same color, or they may identify global alliances by coloring the member countries the same color. Pupils will recognize the relationship of political boundaries to conflicts among nations.

STUDENTS ANALYZE AND COMPARE INFORMATION CONTAINED IN VARIOUS GRAPHIC MATERIALS.

BACKGROUND INFORMATION AND ACTIVITIES: Pupils will report on newspaper and magazine articles or radio and television broadcasts that support a variety of positions. They will compare ideas contained in various sources. Grade six pupils can learn to use the Reader's Guide to Periodical Literature for this activity. Pupils will become aware of the reasons for the positions taken by those who support the use of nuclear energy and of those who wish to ban it. They will identify similiarities and differences among ideas.

Pupils will prepare a time line from information provided or individually researched by creating a time line that describes the development and use of nuclear energy. The time line should include nuclear energy used both in weapons of war and peacetime applications.

STUDENTS USE LOGIC IN ADDRESSING CRITICAL ISSUES.

BACKGROUND INFORMATION AND ACTIVITIES: Pupils will participate in a team debate to explore the question "Should the use of nuclear energy be banned?" Pupils will (1) explain their ideas, (2) state generalizations based upon factual evidence, (3) express opinions based upon appropriate information, and (4) infer and give reasons for their inferences. The debate and the small and large group discussions will aid pupils in learning to judge the merits of an issue and make choices based on possible consequences to individuals and society. Pupils will learn to listen to and evaluate fairly the ideas and points of view of others.

STUDENTS COOPERATE WITH OTHER PERSONS.

BACKGROUND INFORMATION AND ACTIVITIES: Pupils will discuss how they think children in other cities/countries feel about the use of nuclear energy. They will apply information to new situations by writing group or individual letters to children of similar ages and grade levels in other cities or countries. Pupils should be encouraged to state their opinions on nuclear issues in their letters based upon information gathered in objective research and request the opinions of their correspondents by return mail. The teacher should encourage the pupils to look for evidence of objectivity in the letters they receive. Letter writing activities may be aided by contacting:

International Friendship
22 Batterymarch Street
Boston, MA 02190

OR

World Pen Pals
1690 Como Avenue
St. Paul, MN 55108

Teachers may want to begin this activity by having pupils write to other pupils in similar grade levels within their own school. Pupils will cooperate with others in writing individual and group letters.

STUDENTS INTERPRET CHARTS, TABLES, GRAPHS, DIAGRAMS, AND TIME LINES.

BACKGROUND INFORMATION AND ACTIVITES: Pupils will record their correspondents' opinions on nuclear issues and compare them with their class and individual opinions. Pupils will prepare, from given information or individually researched information, a chart or graph that reflects both pro-and anti-nuclear positions.

TEACHER DIRECTED LESSON PLAN

SUBJECT AREA: History Social Science, Grades K-3

TOPIC: Conflict Resolution

CONTENT OBJECTIVE: Valuing

SPECIFIC SKILL OBJECTIVES: Students identify a value conflict related to a school situation.

MATERIALS/ EQUIPMENT: Story material about a child prevented by peers from participating in a game.

MOTIVATION: The teacher presents an example of a fair rule that is applied during lunch time when people line up to await their turn for food. The teacher and the pupils discuss why the rule is a good one. Discuss other rules that are fair. The teacher guides pupils into dictating a group story describing fair rules. The teacher reads or tells a story about a child who wanted to play with other children but who was left out of the game. The class discusses reasons why the rules for participating in the game were unfair to the child.

DIRECTED LESSON: The teacher divides the class into two random groups of equal size and takes the pupils to the yard. The teacher explains that pupils in the first group will play their favorite game while members of the second group sit on the bench with their hands folded and watch. After 10 minutes, the pupils return to the classroom and discuss their feelings.

INDEPENDENT PRACTICE:

- Pupils draw pictures of children playing together using fair rules.
- Pupils dictate to the teacher a set of fair rules regarding school and classroom activities.

ALTERNATIVE ACTIVITY:

- The class is divided into small groups. Each group is asked to make up a fair or unfair rule. Members of each group are asked to pantomime their rule, discuss whether or not each rule is fair, and explain the reasons for their choice.
- Teacher reads Two Is a Line by Jon Madian and discusses why rules are needed.
- Pupils work in groups to develop a three-frame cartoon script demonstrating situations in which rules or interactions are needed to solve a conflict. (The teacher may suggest a conflict such as a group of older students not allowing a group of younger students the use of a playground slide.) The first frame can show a possible solution, and the third frame the outcome of the solution. Pupils share and discuss their cartoons.
- Show and discuss the following filmstrips: "You Got Mad: Are you Glad?" and "Guess Who's in a Group." See list of related materials below. The pupils articulate ways people resolve hostilities and conflicts.
- Pupils will discuss and participate in cooperative games.*

RELATED MATERIALS TO BE USED WITH ALTERNATIVE ACTIVITIES ABOVE

1. "Living with Me and Others." Character Education Curriculum. Level A. American Institute for Character Education. 1974. (A teaching kit with lessons in developing values for the primary student. Lessons explore generosity, kindness, helpfulness, honesty, truthfulness justice, and tolerance.)
2. "Fairness for Beginners." Color or b/w, 16 mm film. Coronet Films. Grades K-3. (This film discusses ways of being fair, taking turns, choosing, sharing, and respecting the rights of others.)
3. "You Got Mad: Are You Glad?" "Guess Who's In a Group?" "What Happens Between People?" Six sound filmstrips. Guidance Associates. Grades K-3. (These filmstrips provide positive behavioral choices to solve conflicts and reduce hostilities.)

EVALUATION: Teacher observation of pupil participation.

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*See list of suggested activities under Students Cooperate With Other Persons on p. 67 of this publication.

SUBJECT AREA: History-Social Science, Grades K-3

TOPIC: Fear*

CONTENT OBJECTIVE: Exchanges ideas on a specific topic.

SPECIFIC SKILL OBJECTIVE: Pupils listen to a story about fear and then discuss their own fears.

MATERIALS/ EQUIPMENT: Where the Wild Things Are by Maurice Sendak

MOTIVATION: Teacher reads Where the Wild Things Are

DIRECTED LESSON: Children should sit in a circle or other relaxed arrangement to make it easier to talk to each other and to the teacher. Teacher leads discussion of the story focusing on what was scary in the story. The teacher guides pupils into recognizing that the monsters in the story were imaginary (in the boy's dream). The teacher asks pupils to talk about a scary television program or movie that they may have seen.

The teacher helps children to discover what was good and comforting about the story's ending, relating it to the security and comfort they may have felt after awakening from the scary dream or when the television program or movie was over. The teacher then asks pupils to think of real things that they are afraid of now.

Pupils are encouraged to express their fears, but they should not be pressured to do so. The teacher asks pupils what they think they can say to themselves to reassure themselves about a particular fear. The teacher accepts whatever expressions of fear and reassuring solutions are given.) The teacher should make reassuring statements when and where appropriate during the discussion. Children should be assured that adults share their fears and concerns. The teacher identifies some useful coping mechanisms for handling fears, including the following:

- denial
- avoidance
- magical thinking
- learning more about the subject of the fear
- becoming involved in some action (e.g., installing or asking for a night light if afraid of the dark)

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*For a detailed discussion of the subject, refer to the section of this resource guide entitled "Dealing with Nuclear Issues: Behavioral Approaches."

INDEPENDENT PRACTICE:

- Pupils draw or paint pictures about things which they have heard that frighten them.
- In order to assist pupils to lower their fear threshold, have them draw or paint pictures about things which make them feel happy, glad, calm, or secure. (Discuss and compare the two sets of drawings.)

ALTERNATIVE ACTIVITIES:

- Pupils ask other adults--family members, friends or other teachers--how they reassure themselves about their fears.
- The teacher can read aloud What Mary Jo Shared, by Janice May Udry and discuss Mary Jo's "fear" and how she overcame it. Pupils can tell about times they were afraid to do something and how they overcame their own fear.
- The teacher can read aloud The Giggle and Cry Book, by Eileen Spinelli and discuss how this book is both similar to and different from Where the Wild Things Are. The teacher can ask which of these two books the pupils would select to read to a younger brother or sister.
- Pupils can locate library books ("picture books") which make them feel happy, glad, calm, or secure. The teacher can read some of these books orally and discuss how these books make a person feel.

EVALUATION: The teacher observes pupil participation.

SUBJECT AREA: History-Social Science, Grades 3-4

TOPIC: Nuclear Weapons

CONTENT OBJECTIVE: Students demonstrate conceptual understanding about the topic under study.

CONTENT OBJECTIVE: Pupils become aware of the consequences when nuclear energy is used as a weapon of war.

MATERIALS/ EQUIPMENT:
- Square of paper for each pupil. Use the short story Sadako and the Thousand Paper Cranes as reference.
- World Map/Globe
- Encyclopedias
- Magazines/Newspaper Articles/Textbooks

MOTIVATION: Teacher will explain that the story Sadako and the Thousand Paper Cranes comes from Japan. Pupils will locate Japan on a world map/globe. Teacher reads Sadako and the Thousand Paper Cranes by Eleanor Coerr to pupils.

DIRECTED LESSON:
- Teacher and pupils discuss the story with emphasis on these questions:
  - Why was Sadako ill?
  - How did nuclear energy in its most destructive form cause her illness?
  - Why do the children of Japan still honor Sadako by making paper cranes and sending them to Hiroshima for Children's Day each May 5?
- The teacher asks the pupils how nuclear energy can be used to cure illnesses or improve the quality of life as well as to destroy life.

GUIDED GROUP PRACTICE:
- The teacher elicits from pupils a list of sources of information to locate additional information on nuclear energy. (The list would include books, newspapers, periodicals, and encyclopedias.)
- While part of the class researches nuclear energy, the teacher demonstrates the folding of an origami crane (tsuru) to the remainder of the class. (See directions following this lesson.)

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INDEPENDENT PRACTICE: Pupils research information on the peaceful and nonpeaceful uses of nuclear energy and record their findings in a short paragraph.

ALTERNATIVE ACTIVITIES:

- The teacher or pupils can prepare a chart showing peaceful and nonpeaceful uses of nuclear energy. Pupils can cut out magazine pictures to use on this chart.
- The teacher can read The Doll's Day for Yoshiko by Momoko Ishii. Compare this book with Sadako and the Thousand Paper Cranes. Discuss how the stories are similar and how they are different.

EVALUATION:

- The teacher observes pupil effort and involvement.
- The class reads orally and discusses their reports. (Are the pupils now more aware of the peaceful and nonpeaceful uses of nuclear energy?)
- On the following day, ask the pupils to recall how nuclear energy can be used. (How can it be destructive? How can it be helpful?)

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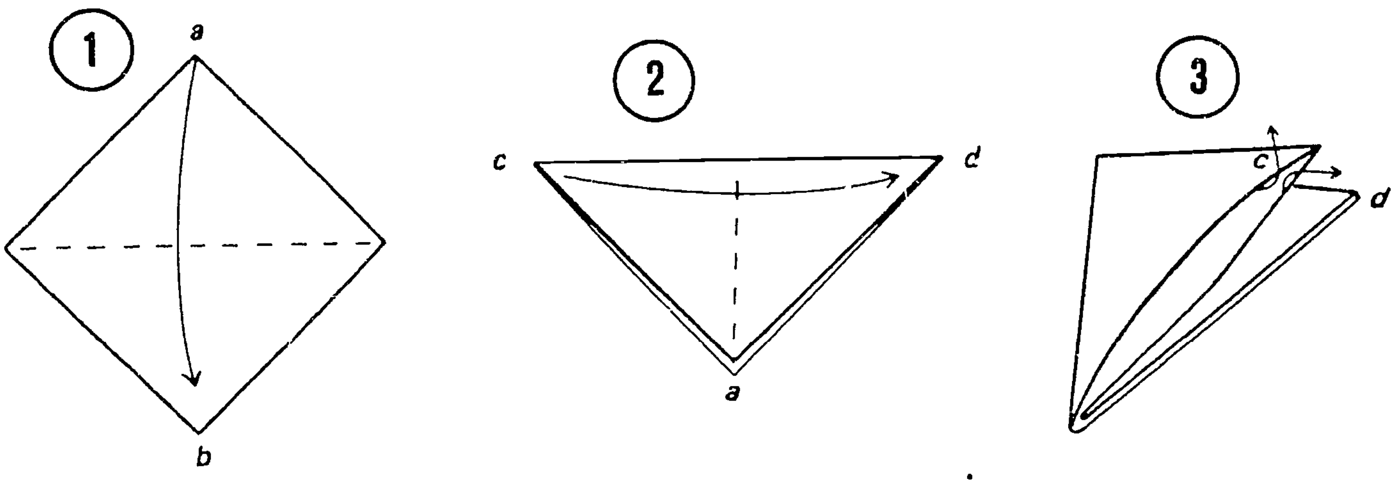
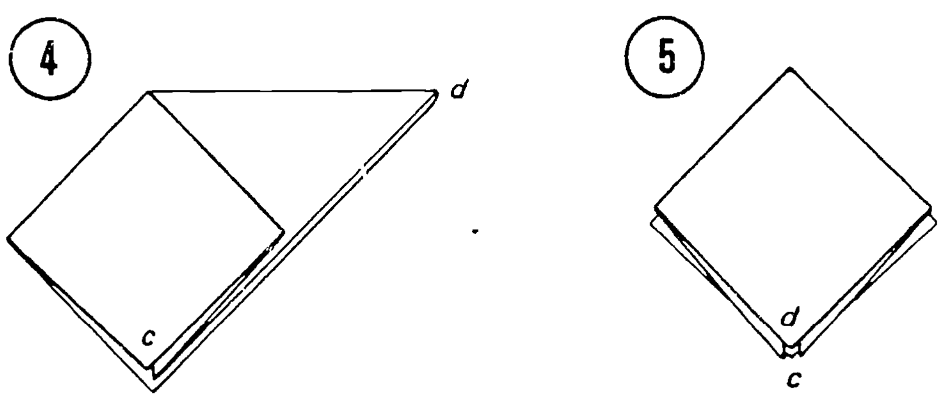
HOW TO FOLD A PAPER CRANE *



HOW TO FOLD A PAPER CRANE* (tsuru)

1. Fold a square piece of paper from a down to b and crease the fold c-d.
2. Fold c over to d and crease.
3. Lift flap c up and open the flap and then. . .



4. Squash flat. Turn over.
5. Repeat steps 3 and 4 with flap d.

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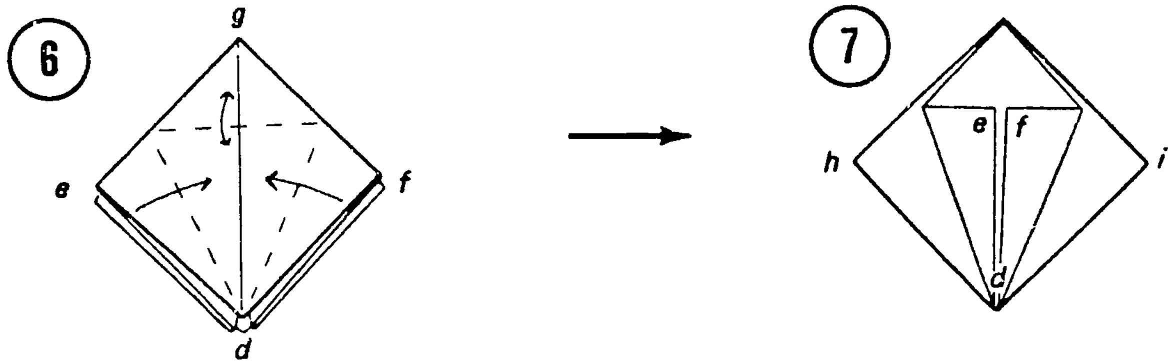
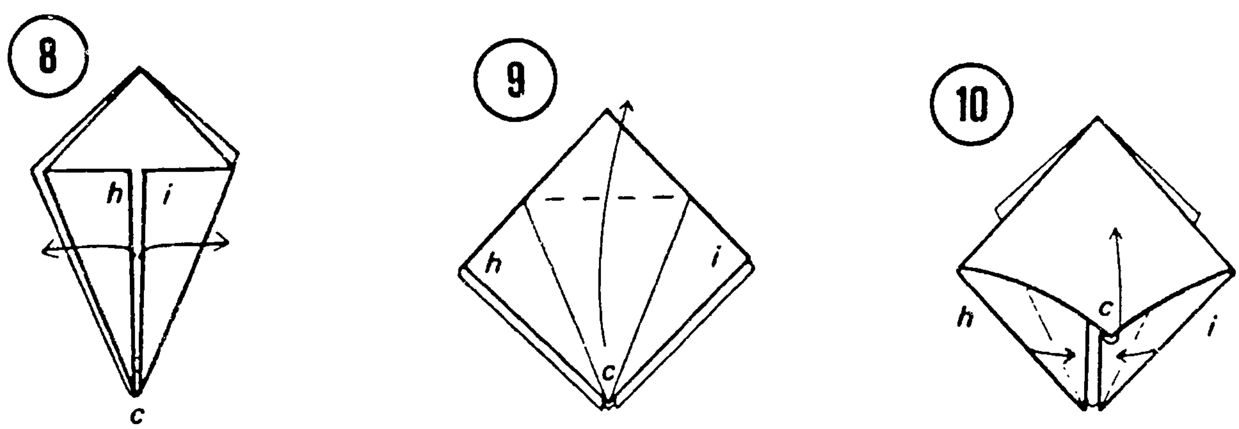
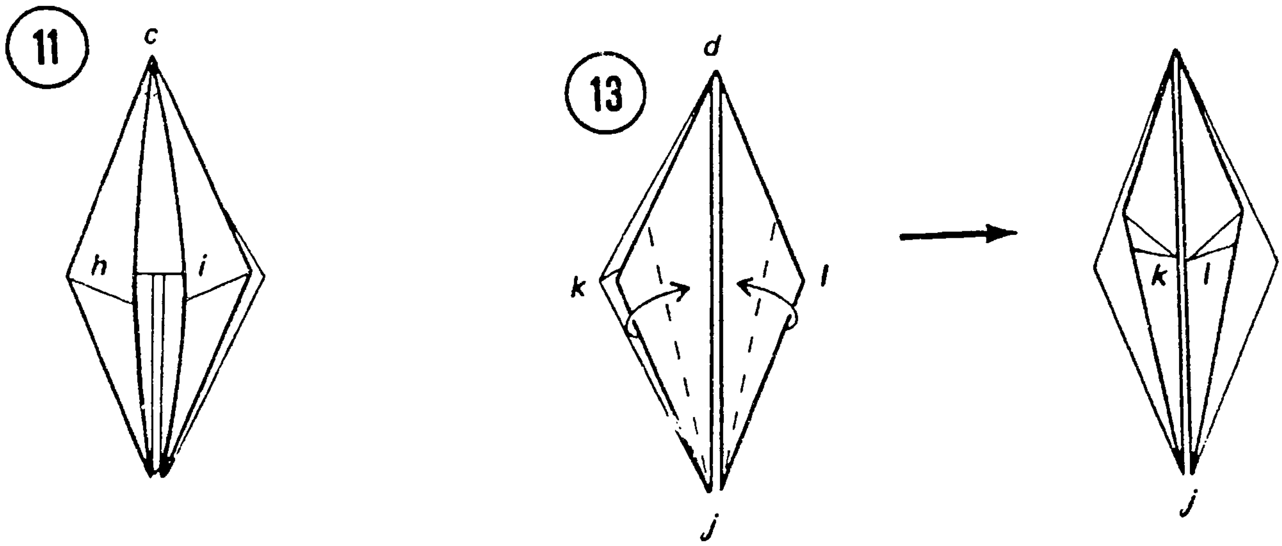
*Directions are from the book Matsuri: Festival by Nancy K. Araki and Jane M. Horii. Heian Publishing Co., 1978. Used with permission of the publisher.



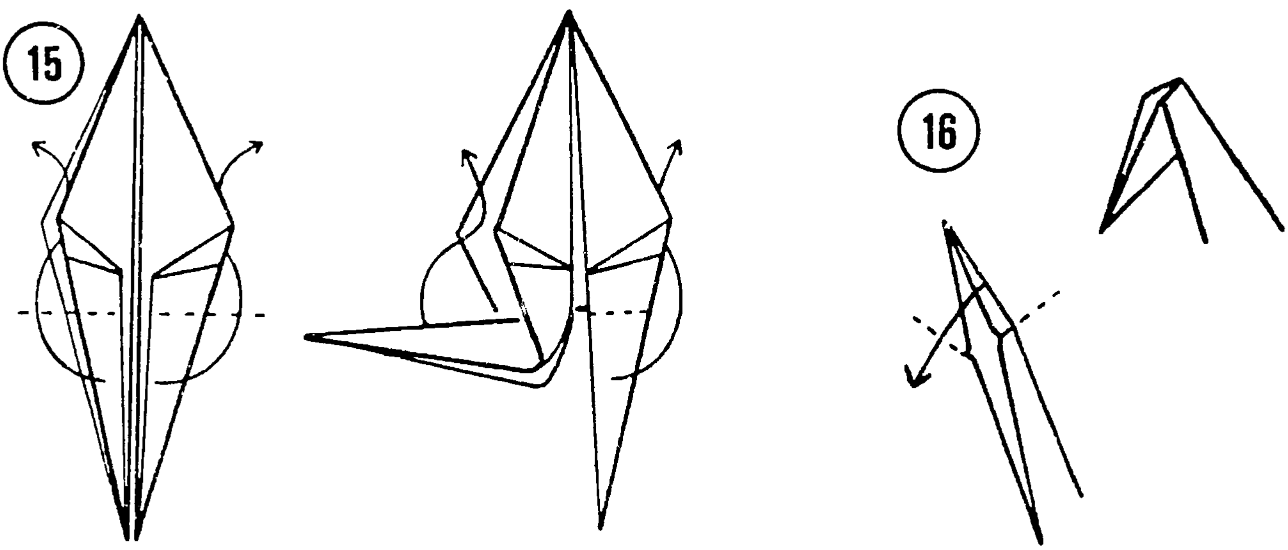
6. Fold side e-d to the center. Fold side f-d to the center. Fold g down, then unfold.
7. Turn over and repeat step 6 with sides h and i.



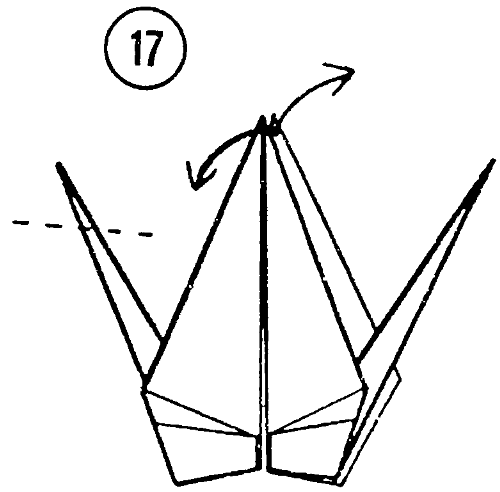
8. Open up flaps h and i outwards.
9. Lift c upward at the same time.
10. Fold h and i inward.



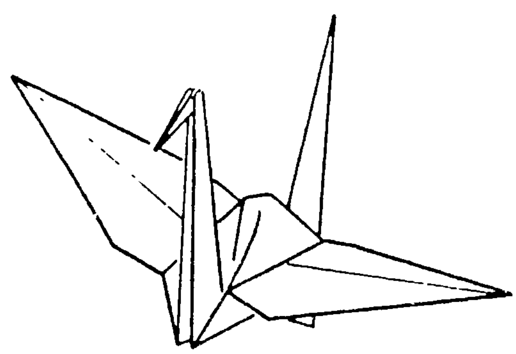
11. Press flat.
12. Turn over and repeat steps 8-11 with flap d.
13. Fold side k-j to center and l-j to center.
14. Turn over and repeat step 13 on the reverse side.



15. Fold tail and neck sections upward and inward on each side.
16. Fold head down.



17. Open wings outward. Blow into hole at bottom to inflate.



TSURU (PAPER CRANE)*

* Note: the teacher should practice making this crane before demonstrating it with a class.

SUBJECT AREA: History-Social Science, Grades 4-6

TOPIC: Living Together Peacefully.

CONTENT OBJECTIVE: Students relate pictorial content to main ideas, using supporting details in order to analyze and compare information contained in various graphic materials.

SPECIFIC SKILL OBJECTIVES: After viewing the film, Boom!*, pupils recall accurately what they have seen. Pupils explain in writing why it is important for children, grownups, and nations to live together peacefully.

MATERIAL/ EQUIPMENT:

- Film: Boom!
- Projector
- Materials for writing
- Chart paper
- Felt pen
- Materials for illustrating paragraphs

MOTIVATION: The teacher leads a discussion on what happens when aggression takes place (pupils should understand the meaning of aggression) on the playground, in the classroom, in the home, etc., relating it to the problems that arise between nations. Children discuss how they would feel if they were the recipients of aggression. Children should understand that sharing anger can be constructive, when frustration is expressed in a nonviolent way, or destructive, when anger results in physical harm.

DIRECTED LESSON: Pupils relate what they saw in the film. They relate why it is important for people to get along with each other. The teacher writes details on a chart as pupils relate them. The teacher demonstrates how to put details (phrases) into complete sentences, and the teacher and pupils review both. Discuss the differences between details and complete sentences.

GUIDED GROUP PRACTICE: Pupils make their own list of details and construct sentences using their details. The teacher demonstrates how to order sentences into a paragraph. Pupils order their sentences into a paragraph. Pupils determine titles for their paragraphs and illustrate them.

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*BOOM! 11-minute 16 mm color film animated by Bratislav Pojar for the United Nations, 1979. The history of aggression carried into the age of atomic weapons, using only music and sound effects. Available from Journal Films, 930 Pitner, Evanston, Illinois 60202; telephone (312) 328-6700. $20.00 rental fee.

INDEPENDENT PRACTICE: As a homework activity, pupils receive a group of details (phrases) related to friendship and are instructed to construct a paragraph about the value of friends.

ALTERNATIVE ACTIVITY: Pupils write rules for citizens of a peaceful world.

Arrange for pupils to write letters to other pupils at their grade level within the same school or at another school as explained in the directed lesson.

EVALUATION: The teacher evaluates pupils' sentences and paragraphs to determine if skills have been mastered.

The teacher observes the group's work habits.

SUBJECT AREA: History-Social Science, Grades 4-6

TOPIC: The Nuclear Arms Race

CONTENT OBJECTIVE: Students construct maps for a specific purpose.

SPECIFIC SKILL OBJECTIVE: Pupils identify the countries of the world which possess nuclear capabilities.

MATERIALS/ EQUIPMENT: Blank world maps
Pencils
Crayons

MOTIVATION: The teacher reads a variety of objective articles representing different points of view about the arms race.* Pupils and teacher discuss the articles relating them to the stockpiling of nuclear weapons by nations of the world.

DIRECTED LESSON: The teacher displays a world map. The teacher and pupils identify the nations of the world. From previous research, pupils identify the countries which possess nuclear capabilities. The teacher records the names of the countries on the chalkboard or a chart. The teacher and pupils select one color to be used for nations with nuclear capabilities and a different color for all other nations. The teacher demonstrates how to complete the map by adding the names of countries.

GUIDED GROUP PRACTICE: As pupils complete their maps, the teacher circulates and helps and helps pupils complete the task. The teacher encourages children to work independently by referring to the world map displayed and the list of country names on the chalkboard and chart.

INDEPENDENT PRACTICE: Pupils may complete a world map which reflects the military alliances of nations with nuclear capabilities, differentiating the members of the different alliances with different colors.

ALTERNATIVE ACTIVITY: Pupils bring in newspaper or magazine articles or report on news broadcasts which deal with the nuclear arms race.

EVALUATION: The teacher evaluates and grades student maps by the following criteria:

a. Were pupils able to construct a map?
b. Did pupils become aware of the nuclear arms race?

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*The teacher may wish to use the reading selection on pages 84 and 85 of this publication to illustrate some of the effects of stockpiling nuclear weapons.

THE ARMS RACE

Once upon a time there lived two friends who loved to build with the colored rocks both had collected for many, many years. They had them in all sizes and shapes -- red, green, oval, round, purple, yellow, large and small. They built castles and bridges, skyscrapers and boats. These two could play for hours together and never get tired.

One day Friend One said, "I know! Let build a wall between us. You cannot come on my side unless I say so. And I cannot come on your side unless you say so."

Friend Two agreed . . . although she wondered what they would do after they built the wall.

Slowly the wall went up as a friend on each side put up one rock after another. The last ones on top were the hardest to get up. They had to stand on tip-toe and push with all their might. When they finished, they sat down wearily on the ground.

"Phew, that was hard work," said Friend Two. Shouted Friend One, "You can only come over if I ask you over."

"Oh..." Friend Two looked around for something to do. She noticed a small pile of rocks left over from their wall. So she sat down next to them and began building a house.

After a while, Friend One heard her friend humming and the sound of rocks clicking together. She looked around for some rocks to play with herself, but all the stones had been left on her friend's side of the wall.

"Can I come over and build with you?" asked Friend One in a kind voice, hoping her friend would be generous.

"No, I haven't very many, and besides _I_ did not _ask_ you to come over," she replied.

Friend One put her face in her hands. Her mouth was bent in a frown. "I do not much like this game anymore," she thought to herself. "I will ask my friend to give it up."

But when she told her idea to Friend One, she was not interested.

"I like this game. I can do exactly what I want," she replied. "Go find some new rocks to play with."

Friend Two's response made Friend One so angry that she stomped off in search of her own rocks -- on her own side, of course. When she found a big, heavy rock, she carried back to the wall and threw it over.

"Hey, you almost hit me!" cried Friend Two.

"Good. That is what you get for not sharing your pile with me. Besides, those were once my rocks, too."

"Well, they are not yours any more." And having said that, Friend Two knocked her house down and began setting up the rocks in a tall pile next to the wall. "I have a lot more rocks than you do," she said in a threatening voice, "and if you have it in mind to throw over another stone, I will throw all thirty of mine back at you."

"Please, let's stop this game," pleaded Friend One. But she was only pretending to be sorry. She really wanted to collect forty rocks for herself without her friend knowing it. "That way," she thought, "I will be stronger than she is. Then she will be afraid of me."

Friend Two could hear her friend pacing around on the other side of the wall. As she drew closer, she discovered a small crack in the wall which she could spy through. When she looked, she saw her friend collecting rocks and piling them up next to the wall just as she had done. So Friend Two began collecting more rocks, too.

The two piled up more rocks next to their side of the wall, but no matter how many they each collected, they never felt they had quite enough to scare the other. So they went on piling up more and more rocks next to the wall.

Also, they no longer thought of each other as friends. They were enemies now.

Because they gathered up so many rocks, the ground around them was scarred with many holes. Sweat dripped from their foreheads and their muscles became very tired and sore.

"Playing with rocks is not a fun game at all anymore," mumbled Friend Two as she dragged her one hundredth rock to the wall. She was so hot and tired, she decided to lean against the cool stones of the wall to have a brief rest.

Suddenly a rock under her sholder skipped out of its place and crashed down on the other side of the wall. Her enemy, who had been resting too, jumped up and screamed, "So, you are ready to fight, are you?"

"No, no! It was a mistake. I did not throw that rock. Let's stop this whole affair?" she cried.

But her voice was drowned in a wave of stones falling over the wall. With regret she too began throwing her rocks in reply. But as she threw, she stepped away from the wall until she was so far, her rocks could hardly reach over the wall.

Finally, she made up her mind to run away. She would throw one last rock at the wall and then dash away over the hill.

She aimed at the space where the first rock had slipped out. She could see her enemy all red in the face like the sun setting behind her. She hoped her rock would make the wall tumble.

Just as she lifted the rock behind her shoulder . . . .

SUBJECT AREA: History-Social Science, Grade 6

TOPIC: Nuclear Energy

CONTENT OBJECTIVE: Students locate pertinent information from various reading sources.

SPECIFIC SKILL OBJECTIVE: Students research the topic and report the results of their findings.

MATERIALS/ EQUIPMENT: Encyclopedias; Textbooks; other books; Magazine and newspaper articles; Films; filmstrips; Bibliography; chart

MOTIVATION: The teacher initiates a discussion related to a bulletin board on nuclear energy. The bulletin board should show examples of nuclear energy used in weapons of war; treatment of diseases; production of electrical energy; transportation, etc. The discussion should provide opportunities for students to answer the following questions:

- What is nuclear energy?
- When and how was it first used?
- What are some of the uses of nuclear energy?
- Is the use of nuclear energy safe?

DIRECTED LESSON: The teacher records the class answers on a chart or chalkboard for later comparison. Students review the answers for clarity and objectivity. The teacher assigns groups to research the questions. The teacher and students review the general skills used in locating information and the standards for group discussion. The teacher and students review bibliography charts for resources to be used in research.

GUIDED GROUP PRACTICE: The teacher releases students to form research groups. Students read from assigned materials and discuss materials to formulate answers to their assigned question. As students work, the teacher (1) helps groups, as needed, in finding answers to their assigned question, and (2) reinforces location skills. The teacher provides guidance as to timing for reading and for discussion.

Members of each group select one student to present their information to the entire class, with added statements volunteered by other students in the group.

Statements, if questioned, should be supported by students' resource materials. Emphasis should be placed upon student-to-student interactions. The teacher records summary statements on the chalkboard to answer each of the questions used during motivation. The teacher and students compare original suggested answers with the factual statements made after research. They analyze both groups of information to determine if hypotheses were correct. The class determines whether the questions have been answered satisfactorily.

INDEPENDENT PRACTICE: Organize a timed debate to explore this question: "Should the production of nuclear energy be banned?"

ALTERNATIVE ACTIVITIES: Using the information researched, students participate in a class discussion of the last motivation question: "Is the use of nuclear energy safe?"

EVALUATION: The teacher awards grades according to the following criteria:

- Did the lesson achieve its stated objective?
- Did students apply the work-study skills in a satisfactory manner?

INSTRUCTIONAL UNITS:

SECONDARY SCIENCE

NUCLEAR AGE ISSUES IN SCIENCE
FOR GRADES SEVEN THROUGH TWELVE

IN THEIR INVESTIGATIONS, STUDENTS CLASSIFY, MEASURE, AND ANALYZE TO DEVELOP THE UNDERSTANDING THAT SUBSTANCES ARE COMPOSED OF MATTER. MATTER HAS MASS AND OCCUPIES SPACE.

BACKGROUND INFORMATION: Everything in the universe, living and nonliving, is matter. Matter is usually defined as anything that has mass or weight and takes up space. Mass and weight are quite different properties of matter. The mass of an object is the amount of force with which an object is pulled toward the center of the earth. The concept of weight depends on where you are. For example, on the moon, on the earth, and in orbit, the weight of an object is different, but its mass is the same. Scientists have learned that different types of matter have different properties, and they have devised many different approaches for classifying matter. For example, the periodic table of elements is a useful organizational system for classifying and understanding the chemical properties of elements.

ACTIVITIES:

MEASURING THE MASS OR WEIGHT OF AN OBJECT: Provide various substances for students to measure mass. They should learn how to use a beam balance and be able to differentiate between "the mass of an object" and "the weight of an object." If a suitable metric scale is available, have students weigh themselves using metric units. It is very important for students to use the metric system in this activity. The teacher should reinforce the use of this system, because the scientific community uses it exclusively on a worldwide basis and the units are more manageable.

CLASSIFYING MATTER BASED ON OBSERVATION: Provide various objects, including solids and liquids of various colors, and have students devise a system for organizing them into groups. Relate their systems to those (taxonomies) used by scientists to classify states of matter and/or living organisms. This activity can be carried one step further by introducing the concept of a taxonomic key. Have the students work in small groups to develop a key that can be used to classify objects.

IN THEIR INVESTIGATIONS, STUDENTS OBSERVE AND EXPERIMENT TO DEVELOP THE UNDERSTANDING THAT MATTER EXISTS IN FOUR STATES: SOLID, LIQUID, GAS OR VAPOR, AND PLASMA.

BACKGROUND INFORMATION: One method of classifying matter is by the physical state in which it exists. There are four such states: solid, liquid, gas, and plasma. In all states, the molecules are in constant motion. However, in the solid or crystal state, each molecule is associated with fixed neighbors, and its motion is limited to vibrations in the immediate neighborhood of its neighbors. In addition, solids tend to resist any force that would change one or more of ther surfaces. Finally, solids only exist at temperatures below the melting temperature of the substance of which they are composed. In a liquid, the motion is less restricted, and a molecule may more freely move from one location to another. Liquids also allow substances to penetrate through them. In the gas or vapor state, molecules are essentially independent and will tend to spread out and exert pressure on any containment vessel. Therefore, gases are said to have no definite volume. Most common gases are colorless. Plasma exists at high temperatures and low pressures and consists of highly energized atomic nuclei with electrons involved in the active transfer of energy. Molecules of materials which may exist in all four states, such as those of ice, water, and steam, have a different energy and corresponding velocity in each state. Ice has the least energy content while steam has the highest energy content. A substance may change state, for example, from ice to water, in response to the application of energy in the form of heat. Conversely, lowering the temperature of water, as in a refrigerator, will cause freezing, or a transition to ice. Ice, in turn, can lower the temperature of something else, for example, as in cooling a drink. Heating water to an adequate temperature will cause boiling and a transition to steam. Steam has a high temperature or energy content which can further be converted to mechanical energy, or work, as in driving a piston engine or a turbine generator. Note that in each of these cases, energy is being transferred in the form of heat or mechanical energy. Of course, mechanical energy may be converted to electrical energy if the turbine is used to turn an electrical generator. Energy in this example may change form, but in the transition the total energy is conserved. That is, there will always be the same total amount of energy if heat losses are accounted for.

ACTIVITIES:

OBSERVING A COMMON SUBSTANCE IN THREE COMMON STATES OF MATTER: Apply heat to a beaker containing ice. The ice, a solid, will melt to form a liquid, water. Applying more heat will result in the conversion of water to a gas, steam. As a follow-up, place some dry ice in a beaker and observe what occurs. The dry ice will change from a solid directly to a gas.

CONVERTING WATER INTO HYDROGEN AND OXYGEN GAS: Set up the necessary equipment to demonstrate the electrolysis of water. When an electrical current is passed through the water, hydrogen displaces the water in one tube while oxygen displaces the water in the other. The ratio of the two gases is 2:1, illustrating that water molecules consist of two atoms of hydrogen to one atom of oxygen.

IN THEIR INVESTIGATIONS, STUDENTS EXPERIMENT, DISCUSS, AND COMPARE TO DEVELOP THE UNDERSTANDING THAT MATTER CAN BE IDENTIFIED BY ITS PROPERTIES.

BACKGROUND INFORMATION: In addition to the four physical states of matter, there are other properties that are used to classify and identify matter. Volume is the property that is defined as the amount of space that matter takes up. Solid matter also has the property of impenetrability, i.e., no two pieces of matter can be in the same place at exactly the same time. Another property is called inertia. Inertia is the tendency of matter to resist any change in motion. If an object is at rest, it tends to stay at rest. If it is in motion, it tends to stay in motion, moving at the same speed and in the same direction. The object's inertia will change only if a force acts on it. The density of an object is defined as the mass per unit volume, i.e., density is a measure of how close the particles of matter are packed together. Other physical properties include: color, hardness, solubility (how rapidly an object will dissolve in a certain amount of a liquid), and boiling and freezing temperatures.

ACTIVITIES:

INVESTIGATING MASS AND WEIGHT: Fill a graduated cylinder approximately half full of water. Mark the position of the water on the cylinder with a grease pencil. Carefully drop a metal ball into the water. Mark the new position of the water with the grease pencil. Next, drop a marble into the water. Mark the new position of the water. Finally, drop a styrofoam ball into the water. What happens to the water? Which object was heaviest? Which object has the most mass? Discuss the concept of mass and weight with students.

COMPARING THE FREEZING AND BOILING POINTS OF ELEMENTS: In class, discuss the concept of boiling and freezing points with students. Next, have students look up the boiling and freezing points of elements in the library and construct a chart listing them. How does knowing the boiling and freezing points of substances help us to identify them? Which element has the highest boiling point? Highest freezing point? Lowest boiling point? Lowest freezing point?

<u>IN THEIR INVESTIGATIONS, STUDENTS OBSERVE AND INVESTIGATE TO DEVELOP THE UNDERSTANDING THAT MATTER CAN BE CHANGED BUT NOT DESTROYED</u>.

BACKGROUND INFORMATION: The Law of Conservation of Mass (or Matter) states that during chemical reactions, there is not a detectable loss or gain in total mass (weight). Matter can be changed from one form to another, but there is no gain in the total amount of matter. In a chemical change, the total mass of the reacting substances always equals the total mass of the products of the reaction. A chemical change can be defined as any change in matter that results in the disappearance of one or more substances, and the appearance of one of more new substances, each with its own unique properties.

ACTIVITIES:

OBSERVING THE INTERACTION OF TWO ELEMENTS: In a laboratory setting, students combine measured amounts of iron and sulfur. Heat the reactants to produce iron sulfide. Weigh the product. The mass of the product should be equal to the sum of the masses of the reactants.

MIXING TWO CLEAR, MEASURED LIQUIDS TO FORM A COLORED PRECIPITATE THAT HAS THE SAME MASS AS THE REACTANTS: Combine the contents of two premeasured beakers, one containing a solution of lead nitrate and the other, potassium iodide. The resulting solution is bright yellow with a thick precipitate. The mass of the product will be equal to the masses of the reactants.

<u>IN THEIR INVESTIGATIONS, STUDENTS IDENTIFY, MEASURE, AND INVESTIGATE TO DEVELOP THE UNDERSTANDING THAT ELEMENTS ARE THE FUNDAMENTAL BUILDING BLOCKS FOUND IN NATURE</u>.

BACKGROUND INFORMATION: Elements are substances that are composed of only one type of atom. An element cannot be broken down into any other substance by chemical means. Elements are considered the building blocks of all other substances. Molecules are the smallest divisions of matter which retain their initial properties. However, a material may change state, e.g., liquid to solid, without changing its molecular structure. This is a physical change, in constrast to a chemical change in which the molecule is changed, i.e., the elements in the molecule are rearranged. They can chemically combine to form compounds. Compounds are chemical combinations of two or more elements. The majority of elements are metals, and are located on the left side of the periodic chart. A few are nonmetals, and they are located on the right side of the chart. Examples of the metals are gold and silver. Nonmetals include many gases such as chlorine, oxygen, and hydrogen. Ninety-two elements occur naturally, the remaining being humanmade.

ACTIVITIES:

IDENTIFYING PROPERTIES OF ELEMENTS: Students use a nichrome wire loop and perform flame tests on various substances. The flame test involves dipping the wire loop into unknown substances and then immersing it in a flame. The color of the flame is one way of identifying the clinging substance. For example, a bright yellow flame is characteristic of sodium, orange-red indicates carbon, violet for potassium, emerald green for copper, and crimson for strontium. (After each test, the wire loop should be cleaned by dipping it into dilute hydrochloric acid.)

MEASURING THE PH OF VARIOUS SOLUTIONS: Ask students to bring in various liquids found at home, e.g., milk, vinegar, orange juice, pure water, salt water, and soft drinks, and measure the PH of each using commercially available PH Hydrion paper.

INVESTIGATING THE ELEMENTS: Students choose one element or one group of elements, i.e, inert gases, and write a comprehensive report based on library research. Include chemical characteristics, where the element(s) are found, commercial uses, research uses, famous scientists who discovered or synthesized the elements, etc.

IN THEIR INVESTIGATIONS STUDENTS RESEARCH AND IDENTIFY TO DEVELOP THE UNDERSTANDING THAT ATOMS ARE THE SMALLEST UNITS OF THE ELEMENTS.

BACKGROUND INFORMATION: Matter is made up of very small units called atoms. Atoms of the same element are chemically alike, while those of different elements are chemically different. The atoms of a given element have a characteristic average mass, although the mass of each atom may not be exactly the same. Atoms are not broken down in ordinary chemical reactions. Atoms are composed of many small particles. There are three basic particles: electrons, protons, and neutrons. Electrons are negatively charged particles, protons are positively charges, and neutrons are uncharged. In addition to these, over thirty other atomic particles have been identified. If matter is continually divided into smaller and smaller pieces, there will be some point at which the parts are too small to be seen. Even if a very powerful microscope were used to see these parts, they could be still further separated until they could not be seen even by the most powerful microscope. However, the material would still exist. In chemistry, we talk about molecules and atoms which we cannot see. Yet they are real, and we try to draw pictures and construct model molecules and atoms just to make it easier to talk about them. In reality, the models do not look like the atom or molecule at all, since we have never seen them. In nuclear physics, or when talking about nuclear particles, i.e, atoms, neutrons, protons, we still use models even though we cannot actually see them. The test of a model is to make sure that our conclusions, based on working with the model, agree with what is actually observed, for example, the energy or radiation emitted from a nuclear reaction can be observed or measured.

ACTIVITIES:

RESEARCHING SCIENTISTS WHO HAVE CONTRIBUTED TO ATOMIC THEORY: Using reference books in the library, gather information about the lives and work of famous scientists who have contributed to atomic theory. Include one or two of the following in the report: John Dalton, Robert Boyle, Amedeo Avogadro, Stanislao Cannizzaro, Lothar Meyer, William Crookes, Niels Bohr, Ernest Rutherford.

IDENTIFYING ELEMENTS BY THEIR ATOMIC NUMBER: Discuss the arrangement of elements in the periodic chart. Using the chart, students look up hydrogen, iron, copper, silver, gold, uranium, and lawrencium and prepare a table showing the symbol, atomic number, atomic mass, number of protons, number of electrons, and number of neutrons.

<u>IN THEIR INVESTIGATIONS, STUDENTS DESCRIBE, MEASURE, AND EXPERIMENT TO DEVELOP THE UNDERSTANDING THAT ATOMS ARE MADE UP OF SMALLER PARTS THAT ARE IN CONSTANT MOTION.</u>

BACKGROUND INFORMATION: The general arrangement of atomic particles was first suggested by Ernest Rutherford. He suggested that the protons were concentrated in a small volume, but contained the most mass. Protons are heavy particles having a mass of approximately one (1) relative to the oxygen atom, which has a mass of sixteen (16) atomic units and a positive charge. This small, positively charged mass of protons is called the nucleus. External to the nucleus is an electron field with a total negative charge equal to the number of protons with a positive charge, so that the net charge on the atom is zero.

James Chadwich identified the neutron after Rutherford conducted his experiments. Neutrons have no charge but have a mass nearly equal to the mass of a proton and are located in the nucleus with the protons. Today, scientists believe that the electrons do not spin in circular orbits or at a definite speed, and they use the term energy levels to describe where the electron fields occur. Electrons are often thought of as a cloud with regions of various electrical charges surrounding the nucleus. In addition, it now appears that atoms contain mostly empty space.

ACTIVITIES:

INVESTIGATING THE DIFFUSION OF ATOMS: In a closed room, place an open pan of dilute ammonia on a lab table. Measure the time it takes for students to smell the ammonia. Explain that the molecules of ammonia diffuse from the pan throughout the room because their atomic particles are in constant motion. Repeat with an open pan of perfume. Compare the time interval it takes for students to smell the substances.

DESCRIBING THE MOVEMENT OF MOLECULES OF SOLIDS IN LIQUIDS: Drop a small crystal of potassium permanganate into a tall, graduated cylinder filled with water. What happens? Cover the cylinder and set it aside for several days. Examine it at regular intervals and record all observations.

MEASURING REACTION TIME: Commercial microcomputer software (e.g., <u>Experiments in Science</u> by HRM Software) is available to help in conducting experiments in class and collecting data using a heat/light probe to measure reaction time. The data is then analyzed on the computer.

IN THEIR INVESTIGATIONS, STUDENTS CALCULATE, SOLVE PROBLEMS, AND EXPERIMENT TO DEVELOP THE UNDERSTANDING THAT ATOMS HAVE THEIR OWN ATOMIC NUMBER AND ATOMIC MASS.

BACKGROUND INFORMATION: The number of protons in the nucleus of an atom is called its atomic number. Since individual atoms are electrically neutral, the number of electrons is the same as the number of protons. The way in which atoms combine with other atoms depends mainly on the number of protons and electrons they contain. Therefore, the ways in which elements combine depends primarily on the atomic number of the elements. The mass of an atom is extremely small. For example, the smallest group of atoms that scientists can weigh contains about 250,000,000,000,000 atoms. Since the mass of an electron is negligible, its mass is considered zero. Therefore, the atomic mass of an atom is called its atomic mass number. Living tissue is made up primarily of small atoms, i.e., low-mass elements, particularly hydrogen, oxygen, carbon, sulphur, etc. There are traces of intermediate elements and a substantial amount of iron. However, most heavy atoms, especially those that compose the heavy metals, (e.g., lead and mercury), are toxic.

ACTIVITIES:

CALCULATING THE MOLECULAR MASS: Using the periodic chart, calculate the molecular mass of some common compounds, e.g., sodium chloride, iron oxide (rust), ammonium hydroxide, sodium bicarbonate, ethyl alcohol, acetic acid (vinegar), carbon monoxide, carbon dioxide, carbon tetrachloride, water, and hydrogen peroxide. Use the following procedure: First, find the number of atoms of each element. Second, look up the atomic mass of each element. Third, multiply the atomic mass of each element by the number of atoms present. Fourth, add the masses of all atoms present in the compounds. The resulting number is the molecular mass.

INVESTIGATING THE ELEMENTS FOUND IN THE HUMAN BODY: Using reference books in the library and classroom, find out which elements are found in the human body. Which elements are most abundant? Which elements occur only in trace amounts? Are there any radioactive elements in our bodies? If any radioactive elements are present, are they harmful? Why or why not? Are any valuable elements found in the body?

ATOMIC WEIGHTS: Commercial microcomputer software is available (e.g., Introduction to General Chemistry by Compress) which provides students with practice problems on the periodic chart. Atomic weights and gas law problems are presented.

IN THEIR INVESTIGATIONS, STUDENTS EXPERIMENT AND CONSTRUCT MODELS TO DEVELOP THE UNDERSTANDING THAT CHEMISTRY DEALS WITH CHANGING ARRANGEMENTS OF ATOMS IN THE MOLECULES.

BACKGROUND INFORMATION: Atoms of the same elements combine with each other to form molecules of that element. For example, two atoms of hydrogen combine to form one molecule of hydrogen. Two molecules of hydrogen combine with one molecule of oxygen in a definite pattern to form two molecules of water. The total weight of a group of combined atoms--relative to the carbon atom, which has a standard weight of 12,000--is called its molecular weight. Molecular weights have a range of from 2.016 for hydrogen to several hundred thousand for certain complex molecules, e.g., large proteins. In chemical reactions, the atoms are not changed but simply rearranged.

ACTIVITIES:

INVESTIGATING WATER MOLECULES: Use foam polystyrene models to illustrate the arrangement of atoms in a molecule of water. Follow up with a demonstration of the electrolysis of water. This will show that there are twice as many atoms of hydrogen present as atoms of oxygen.

CONSTRUCTING MODELS OF MOLECULES: Use reference books in the classroom and library to find out the structural formulas for at least five chemical compounds. Use different colored foam balls and toothpicks or a commercially available set of materials for constructing molecules to assemble models of these compounds. Use a different color foam ball to represent each different atom. Label each atom and compound. How are models such as these useful to chemists?

IN THEIR INVESTIGATIONS, STUDENTS CONSTRUCT MODELS AND EXPERIMENT TO DEVELOP THE UNDERSTANDING THAT THE PROPERTIES OF ELEMENTS ARE DUE TO THEIR ATOMIC STRUCTURE.

BACKGROUND INFORMATION: Each of the 103 elements in the periodic chart has a different atomic structure. The number of protons and neutrons that compose the atoms of an element determines the physical and chemical properties of that element. For example, hydrogen, the simplest atom, has one proton and one neutron and is a colorless, odorless gas, while iron, a metal, has 26 protons and neutrons.

ACTIVITIES:

CONSTRUCTING ATOMIC MODELS: Draw diagrams of the atomic structure of carbon, oxygen, nitrogen, magnesium, and phosphorus. Make a three-dimensional model of each of the atoms, using colored beads, foam balls, and wire, showing the correct number of protons, neutrons, and electrons. The models can be suspended from the ceiling, using string or wire, for display.

INVESTIGATING ELEMENTS IN THE PERIODIC CHART: Perform chemical tests to identify elements. For example, carefully pour some dilute hydrochloric acid into a test tube, add a piece of magnesium ribbon, and place a "glowing" wooden splint near the mouth of the test tube. Hydrogen is produced in the reaction, and the wooden splint will show the presence of the gas by igniting. Dissolve some magnesium oxide in water and touch the solution with litmus paper. Record whether the litmus turns red (acid) or blue (base). Place three test tubes in a rack. Add 30 ml sodium chloride solution to the first, 30 ml sodium bromide to the second, and 30 ml sodium iodide solution to the third. To each, add a few drops of silver nitrate solution. Observe and record any change in the test tubes.

IN THEIR INVESTIGATIONS, STUDENTS OBSERVE AND INVESTIGATE TO DEVELOP THE UNDERSTANDING THAT MATTER UNDERGOES TWO KINDS OF CHANGES--PHYSICAL AND CHEMICAL.

BACKGROUND INFORMATION: A physical change is a change in the appearance of a substance with no change in the chemical composition. A physical change affects the size, shape, color, or form without changing the atomic structure. An example of a physical change results from the addition of heat to ice, melting the ice to water and heating the water to steam. While the physical structure of the substances is changed, the chemical composition is still two atoms of hydrogen to one atom of oxygen, i.e., water. A chemical change is one in which new substances are formed. The new substances have different properties from the substances from which they were formed. The process by which a chemical change occurs is called a chemical reaction. There are different types of chemical reactions. A composition reaction is one in which elements are synthesized into a compound. An example would be the formation of water, a liquid, from hydrogen gas and oxygen gas. A decomposition reaction is one in which a substance is broken down into its component substances. The separation of water into hydrogen and oxygen is a good example. A single replacement reaction involves a reaction between a compound and an element. The reaction between hydrochloric acid and zinc results in the formation of zinc chloride and hydrogen gas. A fourth type of reaction is called a double replacement reaction in which two compounds react to form two different substances. Sodium chloride reacts with silver nitrate to form sodium nitrate and silver chloride.

ACTIVITIES:

OBSERVING PHYSICAL CHANGES: There are many ways to illustrate a physical change. For example, grind a piece of chalk with a mortar and pestle, tear up a piece of paper, melt an ice cube, or heat a platinum wire until it is red hot.

OBSERVING CHEMICAL CHANGES: Demonstrate such chemical changes as burning a piece of paper, burning a magnesium strip, or dropping a small piece of zinc into a dilute acid solution. Follow up each of these activities by asking students to identify both physical and chemical changes that take place in their daily lives, e.g., chewing food (physical), digesting food (chemical), melting ice (physical), running an automobile engine (physical and chemical).

INVESTIGATING CHEMICAL CHANGES: Fill two beakers one half full of cold water. In one, dissolve a few crystals of potassium iodide. In the other, dissolve a few crystals of mercuric chloride. Observe what happens when you stir both with a stirring rod. (Be sure to clean the rod with distilled water after stirring the solution in one of the beakers.) Pour the contents of one beaker into the other. Describe any changes that occur. This is an example of a double replacement reaction. The reactants are potassium iodide and mercuric chloride. The products are potassium chloride and mercuric iodide.

IN THEIR INVESTIGATIONS, STUDENTS MEASURE AND EXPERIMENT TO DEVELOP THE UNDERSTANDING THAT THE CAPACITY TO MOVE OR CHANGE MATTER IS CALLED ENERGY.

There are five basic classes of energy: mechanical, magnetic/electrical, chemical, nuclear, and radiant.

BACKGROUND INFORMATION: Energy can be defined as the ability to do work. The ability to move an object from one place to another, to stop a moving object, or to set a stationary object in motion requires energy. Energy can be classified into five classes: mechanical, magnetic/electrical, chemical, nuclear, and radiant. The energy that moving objects have is mechanical energy. Magnetic energy is the force exerted by certain substances that cause the substances to point toward the North Pole. Since objects with magnetic properties can move objects, magnetized objects perform work; i.e., they have energy. The energy that some substances have as a result of their chemical composition is called chemical energy. Heat is usually the chemical energy released when matter undergoes a chemical reaction. Nuclear energy results from the splitting, or fission, of atomic nuclei. If a nuclear reaction proceeds slowly, a tremendous amount of energy is released in the form of heat. If a nuclear reaction proceeds very fast and is not controlled, a nuclear explosion can result. Radiant energy is the energy released by the continuous nuclear reactions that take place in the sun. Energy may be transferred via radiation, for example, as light and heat waves (infra-red) from the sun. Nuclear and chemical energy are both dependent on the arrangement of atoms or molecules. Chemical energy is apparent in some reactions (called exothermic). For example, burning gives off heat. Energy is also given off in any radioactive decay or other nuclear reaction. Forms of energy can be changed from one to another. For example, radiation from the sun may heat water in a solar collector to make steam which turns a turbine, which turns an electric generator, which makes electricity, which charges a battery, which turns on a light bulb, which gives out radiation in the form of light. Actually, the light will be dim, compared to the original sunlight, but if all the losses are counted, energy would have been conserved.

ACTIVITIES:

MEASURING HEAT ENERGY: Place a bundle of nails that have been wired or tied together and a single nail into a pan of water. Heat the pan until the water boils. Fill each of two plastic cups half full of water. Measure the temperature of the water in the cups with a thermometer. Now place the bundle of nails in one cup and the single nail into the other cup. Measure the temperature in each cup every thirty seconds for five minutes. What conclusions can you draw?

INVESTIGATING RADIANT ENERGY: Use a magnifying glass to focus sunlight onto the bulb end of a thermometer. What happens to the temperature reading? Next, place a match on an asbestos square. Use the magnifying glass to focus sunlight on the head of the match. What change occurs? Bore a hole in the center of a large flashlight reflector so that it will hold a single holed cork. Place a meat thermometer in the hole of the cork and place the cork into the hole of the reflector. Point the reflector towards the sun. What happens to the temperature? Repeat the procedure substituting a wooden match for the thermometer. Do not look at the sun when carrying out this experiment. Also, be sure to put out the flame quickly to avoid damaging the reflector or burning yourself.

<u>IN THEIR INVESTIGATIONS, STUDENTS IDENTIFY AND MEASURE TO DEVELOP THE UNDERSTANDING THAT MECHANICAL ENERGY MAY EXIST AS A COMBINATION OF POTENTIAL AND KINETIC ENERGY.</u>

BACKGROUND AND INFORMATION: Any object that is in motion has kinetic energy. Molecules in motion are also said to have kinetic energy. For example, a moving automobile and a kettle of boiling water are both examples of substances with kinetic energy. Objects that are not moving but which have the ability to do work have energy that is stored or in reserve. This type of energy is called potential energy. Examples of potential energy include an automobile that is not moving, water stored behind a dam, or a wound spring in a watch. Potential energy is the energy which a mass has due to its position, i.e., its height. It requires work to raise the mass to some height, and the mass can do work by falling down. For example, a waterfall can drive a turbine. In addition, a body in motion will have energy due to its motion. In freefall, a body will give up potential energy as it accelerates and gains kinetic energy. A swinging pendulum weight will stop at its maximum height, then fall back down and attain its maximum speed or velocity at the bottom of its path. Similarly, an earth satellite in orbit will have its maximum velocity when it is closest to earth and its minimum velocity at its farthest point. The total of kinetic and potential energy will be constant during its orbit.

ACTIVITIES:

IDENTIFYING EXAMPLES OF KINETIC AND POTENTIAL ENERGY: Have students list as many examples as possible of kinetic and potential energy during a twenty-four hour period. Include examples at home, at school, and at work. Have students compile their lists and determine whether they observed more examples of kinetic or potential energy. Where did specific examples of each occur the most (at home, at school, or at work)?

MEASURING KINETIC AND POTENTIAL ENERGY: The formula for determining the kinetic energy of an object is: Kinetic energy = mass x velocity squared x 1/2. Have students solve some simple problems using this formula. For example, if two objects, one weighing five pounds and the other ten pounds, are rolled down a surface at the same speed, which will have the greatest kinetic energy? What happens to the kinetic energy if the speed is doubled? The gravitational potential energy can be measured with the following formula: Potential Energy = Height x Mass. The mass of the object is expressed in newtons, the vertical distance in meters, and the gravitational potential energy in joules. If an object with a mass of 3 newtons is 5 meters above the earth's surface, how much potential energy does it have? If an object of 6 newtons is 3 meters above the surface, how much potential energy does it have? If an object of 10 newtons is 1 meter above the surface, how much potential energy does it have? Does the heaviest object always have the greatest potential energy? Why or why not?

IN THEIR INVESTIGATIONS, STUDENTS DEMONSTRATE, INVESTIGATE, AND DESCRIBE IN ORDER TO DEVELOP THE UNDERSTANDING THAT THE LAW OF CONSERVATION STATES THAT ENERGY MAY BE CHANGED FROM ONE FORM TO ANOTHER, BUT THE SUM OF THE MATTER AND ENERGY REMAINS THE SAME.

BACKGROUND AND INFORMATION: Energy can be converted from one form to another. For example, the food you eat is converted by your body into heat energy and mechanical energy. Fossil fuel and nuclear materials are used in power plants to produce electrical energy. However, in all energy conversions, energy is neither created nor destroyed. Likewise, matter cannot be created or destroyed, but only converted from one form to another. These observations led to the formulation of the Law of Conservation of Mass-Energy by Albert Einstein. He concluded that matter and energy are interchangeable, but that neither can be created nor destroyed. The total amount of matter and energy is constant when energy is converted to matter and when matter is converted to energy. This is also true in chemical reactions. The total energy in a chemical reaction will be found in the heat and the chemical energy of the materials. Chemical energy depends on the energy of the chemical composition itself. For example, the energy in a storage battery is in the chemical composition of the battery materials (called electrolytes). Loading the battery, i.e., turning on the flashlight, will cause a chemical reaction which gives up its energy as electric current. In a nuclear reactor, a great amount of energy is given up by a change in atomic combination and a loss in mass of the fuel materials involved.

ACTIVITIES:

DEMONSTRATING THE CONSERVATION OF ENERGY: Hang a pendulum from a support bar. Hold or mount a meter stick behind the pendulum. Demonstrate that a pendulum starting its swing from a given height on one side of its resting position will swing to almost the same height on the other side. Use the meter stick to measure the height. Discuss the concepts of kinetic and potential energy as they relate to the experiment.

INVESTIGATING THE LAW OF CONSERVATION OF MASS-ENERGY: Place a glass bowl on a balance. Heat the bottom of a candle to soften it a little, and stand the candle in the center of the bowl. Pour about three centimeters of water into the bowl. Cover the candle with a jar, so that the mouth of the jar is in the water. Record the weight of the objects on the balance. Remove the jar and light the candle. Cover the burning candle with the jar. Allow the candle to burn out. Record the weight of the objects after the candle has burned out. Was any matter destroyed? Was there a loss of mass? Was there an energy change? Discuss the experiment in terms of the law of conservation of mass-energy.

DESCRIBING THE CONTRIBUTIONS OF ALBERT EINSTEIN: Show students a videotape or film depicting the life of Einstein and how his research has affected our society.

IN THEIR INVESTIGATIONS, STUDENTS EXPLORE, DISCUSS, AND EXPERIMENT IN ORDER TO DEVELOP THE UNDERSTANDING THAT NATURE FAVORS CERTAIN COMBINATIONS OF STABLE ISOTOPES.

BACKGROUND INFORMATION: Each element has a specific atomic number. However, some elements with the same atomic number may have different atomic weights, such as atoms with different numbers of neutrons. These will have the same atomic number and will behave identically chemically, but they will have differing atomic weights. These are called isotopes. Most elements are present in nature in more than one isotope. For example, the simplest atom of hydrogen has a single proton. However, a small fraction of hydrogen occurs as a heavy hydrogen with an atom containing one proton and one neutron. Both isotopes have an atomic number of one, but atomic weights of one and two. The next higher-numbered atom, helium, contains two protons and either one or two neutrons. The most abundant helium atoms contain two protons and two neutrons with an atomic number of two and an atomic weight of four. Heavier atoms will usually, but not always, have a larger number of stable isotopes. For example, iron, with an atomic number of 26, has stable isotopes containing 28, 30, 31, and 32 neutrons with atomic weights of 54, 56, 57, and 58 For the heavy atoms, the number of neutrons may be more typically one and one-half times that of protons. For example, lead, with an atomic number of 82, has stable isotopes with atomic numbers 204, 206, 207, and 208 and corresponding neutrons numbering 122, 125, and 126. One and one-half times 82 is 123, roughly similar to the actual number of neutrons. The explanation of why nature favors certain isotope combinations and not others is very complex, but it is not necessary for an appreciation of the more practical aspects of nuclear reactions. It is sufficient to observe that the stable isotopes may be considered to be in a form having a low energy state relative to other possible isotopes with somewhat different numbers of neutrons.

ACTIVITIES:

INVESTIGATING THE ISOTOPES USED IN THE NUCLEAR INDUSTRY: Consult reference books in the library and make a list of radioactive isotopes used in various nuclear related industries. Include the formula for each one, how it is produced, what it is used for, and any harmful effects exposure to it might cause.

EXPLORING RADIOACTIVITY IN THE COMMUNITY: Assign students the task of interviewing local business people to find out if and how they use radioactive substances in their fields. Students should prepare a written and/or oral report for the class.

INVESTIGATING RADIOACTIVITY IN NATURE: Students write a research paper on one of the following topics: radioactivity in the foods we eat; how X rays affect our lives; atmospheric radiation; radioactivity in the soil; natural radiation in our bodies.

DISCUSSION QUESTIONS: Would you buy products that have been exposed to radioactive substances for preserving them? Why or why not?

<u>IN THEIR INVESTIGATIONS, STUDENTS EXPLORE, EXPERIMENT, AND DISCUSS IN ORDER TO DEVELOP AN UNDERSTANDING OF NATURAL RADIOACTIVITY.</u>

BACKGROUND INFORMATION: There are several isotopes found in nature which are unstable, in particular the very heavy elements, polonium, thorium, radium, and uranium. These materials undergo spontaneous changes at definite rates by emitting small particles, called alpha, beta, and gamma particles. These will be discussed in more detail in the next concept. There are in all about 50 naturally occurring types of unstable isotopes. For the most part, these are the very heavy atoms, e.g., uranium.

The only fissionable isotope which occurs in nature in sufficient quantity to be significant is uranium with atomic mass 235 (U235) which comprises less than one percent of natural uranium, most of which is uranium 238 (U238). It is possible to make a chain reaction with natural uranium, using graphite or heavy water as a moderator. In practice, a more useful reactor using ordinary water as a moderator must have a U235 concentration (or enrichment) on the order of three to five percent. Typically the decay rates are so slow that part of a particular material will survive several thousands of years. In radioactive decay, a material is generally characterized by its half-life, that is, the time required for half of its original atoms to decay, and by the particular particles or radiation it emits. For a particular isotope these values, including the energy of the emitted particles or radiation, are constant. In many cases the product of a radioactive decay will itself be radioactive and will decay in its unique way. The process will continue until the final decay product is itself stable, frequently an isotope of lead. This process is referred to as a decay chain or decay series. The process is also referred to as transmutation. At each state the material will have its own chemical identify differing from its parent. Radiation is given off by many naturally occurring substances. For example, uranium occurs in some of our soils. Radioactive thorium is often found in many sands. The radioactive gas radon is given off by natural gas, water, and building materials such as concrete blocks and rocks. Even the foods we eat contain some radioactivity. Bananas contain radioactive potassium. Some commercial fertilizers also contain this substance. Many food products are exposed to radioactivity in order to kill harmful bacteria or retard their growth and to ensure a longer shelf life.

For example, milk products may not have to be refrigerated in the near future because of a new process utilizing irradiation after packaging. Background radiation is a type of radiation that occurs naturally, like the cosmic radiation that enters the earth's atmosphere from space. Cosmic radiation consists of many types of atomic particles and gamma rays. We are also exposed to many types of humanmade radiations on a regular basis. For example, X rays are used to diagnose medical problems such as tooth decay and broken bones. Nuclear plant workers and nearby residents may receive some exposure to radioactivity that may be released into the atmosphere by the nuclear plants. Many industries use radioactive substances for various purposes and some workers may receive amounts of radioactive exposure. In addition, the smoke and fire detectors that protect our homes and families give off a very small amount of radiation. They contain radioactive chips that electrically charge the air inside the device. When smoke enters the detector, it cuts the flow of electricity and triggers the alarm. Finally, luminescent watch dials are coated with radioactive substances to make them glow in the dark.

ACTIVITIES:

EXPLORING RADIOACTIVITY IN THE COMMUNITY: Assign students the task of interviewing local business people to find out if and how they use radioactive substances in their fields. Students should prepare a written and/or oral report for the class.

INVESTIGATING RADIOACTIVITY IN NATURE: Students write a research paper on one of the following topics: radioactivity in the foods we eat; how X rays affect our lives; atmospheric radiation in our bodies.

DISCUSSION QUESTIONS: Would you buy products that have been exposed to radioactive substances for preserving them? Why or why not?

IN THEIR INVESTIGATIONS, STUDENTS DEMONSTRATE, RESEARCH, AND DESCRIBE IN ORDER TO DEVELOP THE UNDERSTANDING THAT NUCLEAR ENERGY IS AN IMPORTANT SOURCE OF ENERGY.

BACKGROUND INFORMATION: The nucleus in most of the elements is very stable and undergoes little change during chemical reactions. However, the elements with more than 83 protons in the nucleus have unstable nuclei, that is, they release high energy particles. The release of this energy is called radioactivity. The radioactivity can take the form of alpha, beta, or gamma rays. Alpha rays consist of fast-moving, positively charged particles. Beta rays are fast-moving, negatively charged electrons. Gamma rays are pure energy with no particles. Natural radioactivity is limited to only a few elements with more than 83 protons. However, other, lighter elements can be made radioactive with special instruments called cyclotrons. Cyclotrons were first developed by researchers in the early 1930s. They found that nuclear transmutations could be caused in some atoms by striking them with high energy particles. An effort was made to develop high voltage machines to electrically accelerate particles that required energy and thereby study and better understand nuclear structure. These machines were dubbed "atom smashers." The first such machine was the Crockcroft-Walton machine developed in England around 1930. Shortly after the Crockcroft-Walton machine was introduced, the Van de Graff machine was developed at MIT, followed by the cyclotron, developed by E.O. Lawrence at the University of California. These and other researchers learned that the tremendous amount of energy released by small amounts of radioactive substances can be controlled and used to produce large quantities of electrical energy in nuclear power plants.

Typical particles used in the cyclotron are protons (ordinary hydrogen ions), deuterons (heavy hydrogen ions), or alpha particles (helium ions). The high energy particle penetrates a nucleus causing some other particles to be ejected, usually leaving an unstable particle different from the original target material, which would eventually decay. A large number of artificial radioactive materials have been produced in this manner.

ACTIVITIES:

DEMONSTRATING NUCLEAR ENERGY: Use a Geiger counter to measure the radiation from cosmic rays, samples of uranium ore, buildings, and luminescent watch and/or clock dials.

DESCRIBING THE USES OF NUCLEAR ENERGY: Show a film or videocassette about the uses of nuclear energy. Examples include: Learning About Nuclear Energy (EBEC), Exploring the Atomic Nucleus (Coronet), and Atomic Power Today (U.S. Atomic Energy Commission). Discuss the various uses of nuclear energy with students after viewing the film(s).

RESEARCHING THE SCIENTISTS WHO CONTRIBUTED TO NUCLEAR THEORY: Using reference books in the classroom or library, have students write a report in a science or social science class on one of the following: Henri Becquerel, Konrad Roentgen, Marie Curie, Ernest Lawrence, Albert Einstein, Edward Teller, Enrico Fermi, Lisa Meitner, Otto Hahn.

DESCRIBING CAREERS IN NUCLEAR ENERGY: Using reference books, career counselors, or guest speakers, have students write a report on one or more of the following occupations: X-ray technician, radiologist, electronic technician, radiological physicist, electromechanical technician, maintenance technician. Contact local hospitals and request a guest speaker on one of the related careers. Encourage students to ask specific questions about these types of careers.

IN THEIR INVESTIGATIONS, STUDENTS DEMONSTRATE, INVESTIGATE, AND DISCUSS IN ORDER TO DEVELOP THE UNDERSTANDING THAT THERE ARE TWO KINDS OF NUCLEAR REACTIONS: FISSION AND FUSION.

BACKGROUND INFORMATION: There are two basic kinds of nuclear reactions, fission and fusion. Fission reactions involve the splitting of certain heavy elements into smaller atoms. Specifically, a neutron combines with a uranium 235 atom, causing it to break into roughly equal fragments, in addition to emitting two or three neutrons. A considerable amount of the energy given off in the reaction is in the form of kinetic energy of the two fission fragments. The remaining energy is given up as kinetic energy of the neutrons, gamma radiation, and decay energy of the fragments. The uranium atom split will not be exactly even, and the particular isotopes formed will vary randomly over a wide range. In any event, the fission fragments will always contain a gross excess of neutrons so that the initial fragments will decay by beta emission with extremely short half-lives. Uranium has 92 protons in the nucleus. When uranium is bombarded in a nuclear reactor with neutrons, each atom splits into many smaller atoms and a tremendous amount of heat energy is released. This energy is millions of times greater than the energy released in chemical reactions. For example, the energy released from the fission of one pound of uranium gives off as much heat as 300,000 barrels of oil.

Energy from the fission process may be realized if a sustaining chain reaction can be established. In order to make a chain reaction, that is, a continual succession of fissions, it is necessary to assemble a large number of fissionable atoms (uranium isotopes of atomic number 235) close enough together and large enough so that the chance of one of the excess neutrons producing another fission by being captured in another uranium 235 atom is just equal to one. If the assembly is too small or too spread out, most of the neutrons will be lost to the outside and the reaction will die out. The condition in which each fission produces exactly one new fission is called "critical," and there is said to be a critical mass. Note that critical mass is not a single number or amount, but it will vary with the size, geometry, and concentration of other material in the assembly. However, in nuclear power plants, the chain reaction is carefully controlled by delayed neutrons. Roughly one percent of the fission neutrons are delayed up to a few seconds after the fission such that changing the neutron population or power of a critical assembly takes some time. This allows the level to be controlled by simply changing the geometry to allow a greater fraction of neutrons to leak out or by inserting some material (control rods) which will interact with neutrons, thus reducing the number of neutrons available to be absorbed in other uranium 235 atoms. Generally the fission process produces heat, which will raise the temperature of the assembly and cause it to expand. The expansion will increase the neutron leakage probability and make the assembly subcritical. An increase in power will thus tend to heat the system which will then shut itself down. This provides a built in self-regulation. In order to raise power it is necessary to provide pressurization or reduce leakage in some other way. This enables the nuclear fuel to be used to produce electricity for use in our homes and businesses. In order to produce a nuclear weapon, the fissionable material must be highly pressurized to prevent the material from expanding and shutting itself down. Usually this external pressure is provided by detonating a space charge of high explosives surrounding the nuclear assembly. This assembly must be well over critical to operate independent of the delayed neutrons and it also requires the nuclear fuel to be highly concentrated and enriched to a very high level, typically over 90 percent. These weapon design requirements are completely inconsistent with power reactor design, and it is clearly impossible to cause a power reactor to create such a nuclear explosion as occurs in a nuclear weapon.

In a fusion reaction, the neutron is a heavy hydrogen of mass number 2 and the tritium is a heavy hydrogen of mass number 3. Tritium is not a stable isotope and must be produced artificially. It has a half-life of about 12 years and decays by beta emission. Combining these two heavy hydrogen atoms will result in a complex nucleus, which breaks into an alpha (or helium nucleus), and a neutron. In this type of reaction, matter is converted into energy. The result is that fusion produces even more energy than fission. Fusion has some advantages and disadvantages over fission. The advantages include the fact that fusion produces more energy than fission and fusion is cleaner than fission, since there are no radioactive wastes. The disadvantages are that fusion produces so much heat that there is currently no suitable container in which to carry on fusion reactions and therefore, it is not practical at this time.

ACTIVITIES:

DEMONSTRATING A CHAIN REACTION: Place a block of modeling clay on a lab table. Stick matches into the clay in a triangular pattern. Be sure the heads of the matches are no more than one centimeter apart. Light the match at the tip of the triangle. Record your observations. How does this demonstration illustrate the principle of a chain reaction?

INVESTIGATING FISSION AND FUSION: Show students a film or other visual aid describing nuclear fission and fusion. Examples include: Nuclear Fission (Education Materials and Equipment); Nuclear Fission and Fusion (Eyegate); Uranium Fission (Universal Education and Visual Arts); Fusion (Document Associates Films). Discuss fission and fusion after viewing the films or visual aids.

DISCUSSION QUESTION: You are a city council member. The local power company is seeking council permission to build a nuclear generating plant nearby. What issues do you need to consider before making your decision? Students might also discuss this topic in their social science class.

IN THEIR INVESTIGATIONS, STUDENTS DESCRIBE, EXPERIMENT, AND EVALUATE TO DEVELOP THE UNDERSTANDING THAT NUCLEAR ENERGY HAS BOTH POSITIVE AND NEGATIVE ASPECTS.

BACKGROUND INFORMATION: Nuclear energy has both positive and negative aspects. The positive include the following: First, the heat produced in fission reactions has been harnessed to produce electricity. Nuclear reactors produce no particulate air pollution. Only a very small amount of nuclear fuel is needed to power a reactor. Second, the radiation from several elements has been used in various medical fields. Radium and cobalt, both radioactive elements, are widely used in the treatment of cancer. Heart patients use nuclear batteries in their pacemakers to ensure long-lasting and reliable service. Third, radioactive carbon that exists in all living things can be measured and used to calculate the age of ancient organisms, and uranium is used to measure the age of ancient rocks. Fourth, radiation is used to control pests. Scientists use radiation to sterilize male insects. When they mate with the females, no offspring are produced, and therefore the pest population is decreased or wiped out. Fifth, radioactive tracers that contain a very low level of radiation are injected into living organisms to trace the movement of substances through the body for locating the sources of illness. Specifically, an injection of a radioactive compound may be given to locate problems within the brain or within the circulatory system leading to and from the brain. A scanner or gamma camera is used to scan the brain and follow the movement of the radioactive compound. This process is called a brain scan. Physicians also use radioactive substances to study the thyroid gland and determine how well the thyroid gland is working. Lung scans, cardiac imaging, liver scans, and bone scans are other helpful tests used in the medical field. Sixth, manufacturing plants use radioactive materials to gauge the thickness of many materials, to test products, and to examine the inner structure of building materials. Seventh, city water departments and large oil companies use radioactive tracers to measure pipeline leaks and the flow of materials in the pipeline. Eighth, highway construction companies use these substances to measure the density and moisture in the soil used for road building. Finally, radiation is being used in agricultural research to develop seeds that produce greater quantities of food and that are resistant to disease and insects.

The negative aspects of nuclear energy include the following: First, nuclear energy can be harnessed into military weapons that have devastating potential. There is a growing concern that some governments will misuse nuclear fuels and produce bombs and other nuclear weapons instead of using the fuel for peaceful purposes. Second, radiation can be harmful to living organisms. Radiation sickness can result in anemia, loss of hair, internal bleeding, burns, and even cancer or death. Third, radioactive wastes have to be disposed when they are used up. This involves finding suitable containers and storage places for the wastes. The radioactive waste produced in nuclear medicine includes the needles, syringes, swabs, and gloves used while administering various radioactive compounds. The radioactive materials themselves must be stored in special containers until they are removed from the hospital or office. Fourth, the nuclear reactions that take place in power plants have to be carefully monitored by the employees. There have been some problems with the very sophisticated equipment necessary to maintain control over the fission reactions. The result has been that many nuclear power plants are operating at far less than maximum capacity and in some cases, have had to be closed down for extensive repairs. Accidents at nuclear power plants have the potential for long-term genetic and other damage. The accident at the Chernobyl (USSR) plant which was poorly designed and constructed has caused many deaths and injuries.

ACTIVITIES:

INVESTIGATING ENERGY ALTERNATIVES: There are commercially available microcomputer programs available that involve students in a simulation of energy resource management. Examples include: Three Mile Island (Muse) and Energy Search (McGraw-Hill).

DESCRIBING NUCLEAR POWER PLANTS: Construct a model of a nuclear reactor using boxes, cans, straws, and wire. Label and discuss each part. Explain the steps in the conversion of nuclear energy to electrical energy. Compare a nuclear power plant to a fossil-fuel power plant.

INVESTIGATING THE MEDICAL USES OF RADIOACTIVE SUBSTANCES: Present students with a list of medical uses of radioactive substances and assign them the task of researching and writing a report on one specific use of nuclear medicine in the library. In addition, a guest speaker from a local hospital who works with radioactive substances, e.g., an X-ray technician, physician, or nurse, may be invited to address the students.

EVALUATING THE PROS AND CONS OF RADIOACTIVE SUBSTANCES: Divide the class into two groups. Assign one group the task of researching the potential benefits of radioactive substances and the other group the potential harmful effects. Each group should prepare a presentation, oral and/or written, for the whole class.

INVESTIGATING BENEFICIAL USES OF NUCLEAR RADIATION: Use reference books in the library to prepare a report on one or more beneficial uses of nuclear radiation. Examples can be found in the fields of medicine, agriculture, environmental pollution, hydrology, and pest control. Another alternative would be to arrange for a guest speaker from a local hospital that has a nuclear medicine unit. Such speakers could include physicians, technicians, or researchers.

USING RADIATION TO CURE DISEASE: Make a list of diseases in which radiation is used as a treatment or cure (e.g., cancer), and have students research one or more of these diseases and the involvement of radiation in the treatment.

DISCUSSION QUESTIONS: You are a physician who recently discovered a small tumor in a patient undergoing a routine examination. The patient has not complained of any health problems. What are you going to tell your patient? You are one of a distinguished group of scientists who have been invited by the President of the United States to serve on a nuclear energy ethics panel. What issues should the panel consider concerning the potential benefits and harmful effects of a nuclear plant in which some defects have just recently been discovered in the nuclear cooling system? What steps are you going to take, if any? This activity can be used as a simulation game with the entire class. Discuss with the class how a decision is made when both positive and harmful effects are to be considered as in using radioactive substances or operating a nuclear energy facility.

IN THEIR INVESTIGATIONS, STUDENTS DESCRIBE, COMPARE, AND DISCUSS TO DEVELOP THE UNDERSTANDING THAT NUCLEAR WASTE IS A CRUCIAL ENERGY ISSUE.

BACKGROUND INFORMATION: The fission of uranium atoms creates the heat energy that is used to generate electricity in nuclear power plants. After three or four years, nuclear fuel is spent, and it is removed from the reactor and stored in an on-site cooling tank, eventually to be either reprocessed into more usable fuel or disposed of permanently. There are two broad categories of nuclear waste: defense-related and commercial. There are three kinds of waste connected with commercial uses of nuclear fuels. There is "spent fuel" which is highly radioactive; this is the fuel that is removed from a reactor after three or four years. Second, there are low-level wastes, such as filters, rags, tools, and clothing used in plant maintenance and in fuel fabrication. Third, there are the "uranium tailings" which are piles of radioactive residue left over after uranium is mined.

The greatest concern has been expressed over the "spent fuel" and its storage and disposal. Spent fuel is initially stored under water in on-site pools for a period of about six months. After that, the spent fuel is removed from the site to other storage pools for reprocessing or permanent disposal. The water in the cooling pools eventually must also be disposed of. Currently, the spent fuel that has been permanently disposed of is stored in lead containers in stable geologic formations 2000 to 3000 feet deep. It takes several thousand years for the radioactive material to drop to its naturally occurring level. The greatest concerns center around the location of the storage sites. Several states currently have these spent fuel burial sites, and public concern over the potential damage from radiation caused by leakage in the containers is considerable. The total amount of this waste material is less than a ton for a full year's operation of a major power plant -- typically one thousand megawatts capacity. In terms of long range poisoning capability, this will be far less than from a similar quantity of arsenic used for pesticides with an infinite life. Arsenic will not decay like nuclear waste, but retains its poison potential indefinitely. In the past several years there has been a curtailment of nuclear processing and the spent fuel elements have simply been retained in the reactor cooling tanks. Ironically, the United States has imported radioactive material to fill its needs for nuclear medicine, food processing, and other industrial processes. Realistically, however, the issue of nuclear waste in itself is a significant argument against the proliferation of nuclear power plants. This issue is relative to other combustion processes which produce thousands of tons of waste per day for a similar power output. Typically, the total amount of radioactivity from natural sources in a coal power plant are about the same as that produced in a nuclear power plant of the same total power output, providing no accident or other breakdown occurs in the latter.

ACTIVITIES:

DESCRIBING POTENTIAL HAZARDS OF NUCLEAR WASTE: Divide the class into two groups, one in favor of nuclear power plants, and the other against. Have each group research the pros and cons and debate the issues. If a speech or debate teacher is available, this could be a schoolwide activity. In addition to newspapers and other reference materials in the library, there are many organizations which publish a wide variety of publications on both sides of the issues.

COMPARING POWER TO OTHER ENERGY SOURCES: Compare the advantages and disadvantages of nuclear energy with the energy that is produced using fossil fuels such as coal, oil, and natural gas. Alternative energy resources, e.g., geothermal, solar, wind, and tidal, can also be included in this comparison. The comparison can be made in a written report by students or in class discussion.

INVESTIGATING ALTERNATIVE ENERGY SOURCES: Students write a research paper on one of the alternative energy sources, such as wind, solar, tidal, or geothermal. They should include a comparison of costs, environmental effects, and other variables between the alternative source and fossil and nuclear energy sources.

DISCUSSION QUESTIONS: The federal government wants to bury radioactive wastes near your city. What is your opinion on the issue? What steps should be taken before making the decision to allow or prohibit such a disposal site near your city?

IN THEIR INVESTIGATIONS, STUDENTS DISCUSS AND WRITE TO DEVELOP THE UNDERSTANDING THAT THE PROLIFERATION OF NUCLEAR WEAPONS IS A CRUCIAL ISSUE.

BACKGROUND INFORMATION: Scientists first learned to control fissionable nuclear reactions in 1942. The United States dropped the first atomic bombs in 1945, an act that ended the second World War. In two explosions, tremendous amounts of heat and radiation were spread over wide areas in two cities in Japan. The destruction and loss of life was tremendous. Currently, there are several nations in the world that have nuclear weapons. Fortunately, the two that were detonated in World War II by the United States have been the only nuclear bombs ever used for military purposes.

A nuclear weapon requires a highly enriched or concentrated amount of uranium 235 or plutonium 239 with adequate pressure containment to allow it to reach an extremely high power level in a very short time. Pressure is maintained for an adequate time, i.e., a few millionths of a second (micro-seconds), by surrounding the active region with a very heavy material such as lead. This is called the tamper and delays the expansion simply by its mass or inertia. The interior of the weapon reaches temperatures in the millions of degrees before a significant expansion occurs. This environment, like the surface of the sun, permits an effective fusion reaction. Today's weapon design usually incorporates this feature, and possibly half of the energy is from fusion in the so-called "hydrogen bomb." Initially the major fraction of the weapon's energy is emitted as X rays which in turn rapidly heats the surrounding air to incandescence. This heated air forms the fireball.

Most of the energy is subsequently retransmitted as heat and the shock wave which follows. Actually, a very small fraction of the energy is transmitted as nuclear radiation. The major portion of the energy and most of the damage are caused by heat and shock. If the detonation occurs on or very near the ground, much of the soil directly below is vaporized and carried up into the atmosphere along with the rising hot mass. Winds from around the edge move in to fill the void from the rising mass and further sweep up dirt and debris. Much of the very heavy material such as rocks fall back to the ground near the resulting crater. However, fine particles are carried to very high altitudes. The actual fission fragments adhere to those dirt particles which may either be washed down by rain or dispersed over very wide areas (over a long period of time--possibly months) and likely over the entire hemisphere. Of major concern is the fallout which, under certain atmospheric conditions, may cause high concentrations of radioactive materials to be deposited on the ground downwind from the detonation. The most severe and widespread damage would occur from a detonation well above the ground, where it could be seen from a great distance. In this case there would be little or no cratering or debris carried aloft, and fallout would not be an immediate problem. The detonation would use up much of its energy lifting up the crater debris, and effects (except for the fallout) would not be felt at as great a distance as those from the higher altitude detonation. An additional effect is severe radio and electrical interference resulting from a very high altitude detonation causing radiation disturbances in the upper atmosphere. The intensity of this electromagnetic pulse (EMP) may be comparable to lightning, and considerable damage could be inflicted on power lines and electrical equipment. At a very high altitude there would be no fireball or shock wave, and no immediate fallout would occur. The radioactive debris from a nuclear detonation is generally short lived compared to that from a power reactor since the longer lived activities simply would not have time to build up to a very high level during the detonation of less than a microsecond's duration.

ACTIVITIES:

DISCUSSING THE EFFECTS OF NUCLEAR ARMS PROLIFERATION: Discuss the effects of nuclear detonations on the environment and on living organisms.

DISCUSSING THE PROS AND CONS OF NUCLEAR WEAPONS PROLIFERATION: Obtain articles from recent magazines and newspapers and discuss both the pros and cons of nuclear weapons. Form three teams of students and have two teams debate the issue. The third team can ask questions and judge the presentations. (The same activity can be presented in social science classes.)

DISCUSSION QUESTIONS: A terrorist group has constructed a nuclear device and has threatened to detonate it. You have been selected to serve on an antiterrorist panel to decide what to do about the situation. What variables do you need to consider? Design an action plan.

IN THEIR INVESTIGATIONS, STUDENTS EVALUATE, COMPARE, AND DISCUSS TO DEVELOP THE UNDERSTANDING THAT RISK AND FEAR ARE VERY DIFFERENT.

BACKGROUND INFORMATION: Risk is the exposure to hazard or danger, while fear is an unpleasant often strong emotion caused by anticipation or awareness of danger.

The actual risk from a nuclear reactor is very low relative to other occurrences around it. However, in our society, the fear of a nuclear reactor or anything having to do with radiation is very great. The actual risk that a large number of people or even a few people will be killed as a result of using nuclear power is extremely small relative to many other activities. From the earliest studies of the potential of using nuclear reactors, safety studies have received a great amount of attention. The net result has been that the nuclear designers have tried to be very much aware of every possible thing that could fail and have taken measures to try to make certain that, even in the most unlikely sequence of events, people would not be threatened. This was effectively demonstrated in the Three Mile Island incident in which, despite a series of failures and a possible misinterpretation of the situation, no one was killed, no one was injured, and no one was subjected even to an abnormally high dose of radioactivity. However, at Chernobyl, in the USSR, there was greater overall damage due in part to the design of the reactor which was not adequately shielded. Experience has shown that in all of the power reactor operations and the use of reactors for submarine and ship propulsion by the United States Navy for over thirty years, there has never been a single person injured as a direct result of operating the power reactors. By contrast, in other power industries, such as oil, coal, and hydroelectric, there have been a number of fatalities. For example, several hundred people have been killed in offshore oil rig accidents since the Three Mile Island accident. There are many deaths associated with coal each year, and occasionally a broken hydroelectric dam kills a large number of people. Yet none of these are feared as much as nuclear reactors. There are tens of thousands of people killed in automobile accidents each year, and many thousands contract lung cancer due to smoking. Yet these do not appear to be feared to the same degree as reactors and radiation.

This paradox is understandable in the light of a number of factors which create fear. People tend to fear the unknown, and to most people nuclear reactor principles are unknown. There is a widespread misconception that reactors and nuclear weapons are similar and hence a reactor might some day blow up! But this is obviously not possible. There is also great fear associated with something over which people do not have any control. An additional factor is the number killed in a single incident, such as the accident at Chernobyl. While a nuclear reactor accident involving fatalities has never occurred in the United States, popular opinion holds that a reactor accident could involve very large numbers of fatalities in a single accident. While it cannot be proven to a certainty that this is impossible, our experience indicates it is unlikely. People will generally be far less upset by our usual annual rate of tens of thousands of automobile fatalities than by one airline accident causing fatalities, even though the chance of an airline fatality per passenger mile traveled is far less than for automobile travel. Fear of death and dying does not have to be rational to be strongly felt.

Nuclear experts have studied and restudied all aspects of the nuclear industry, including waste dispersal, licensing procedures, and nuclear plant operations. Many of these areas studied are understood to a depth greater than in many other industries where there is less intense public scrutiny and concern.

ACTIVITIES:

DISTINGUISHING FACT FROM FICTION: Gather as many pamphlets, brochures, etc., as possible from groups who are both pro and con nuclear energy. Using this information, do some research and determine which data are fact and which are fiction.

DEBATING THE NUCLEAR ENERGY ISSUE: Divide the class into two groups, one pro and one con, to research nuclear energy issues, and to debate the issues. This can be done by the whole school, in a group of classes, or in the individual classroom. Why did the nuclear reactor accident in Chernobyl provide a great problem for the surrounding population? How did the lack of communication and immediate action also affect the population of the USSR and nearby countries?

COMPARING VIEWPOINTS ON NUCLEAR ISSUES: Have one or more guest speakers, with differing points of view, make presentations to the class. Afterwards, have a class discussion and/or debate. Before the presentations, research the particular opinion of the group that the speaker represents and have students prepare a list of questions for the speaker.

DISCUSSION QUESTIONS: Do you have any fears about nuclear energy? Are you pro or con nuclear power plants? How do other members of your family feel?

IN THEIR INVESTIGATIONS, STUDENTS EVALUATE, DEBATE, AND DISCUSS TO DEVELOP AN UNDERSTANDING ABOUT THE FUTURE OF NUCLEAR ENERGY.

BACKGROUND INFORMATION: There are several critical and controversial issues that humans will face concerning nuclear energy in the future. First, with the amount of fossil fuel available decreasing, alternative energy sources will be required. Nuclear power plants produce a tremendous amount of energy with no particulate pollution. However, the problems of nuclear waste disposal and radiation warrant concern. Second, the proliferation of nuclear weapons among the nations of the world is a serious concern to all people. The possibility of a terrorist group's acquisition and use of a nuclear weapon poses a formidable threat to the security of all nations. Third, the beneficial uses of nuclear energy in medicine, pest control, agriculture, and other fields are significant. However, students have to be aware of the fact that the same nuclear materials used for peaceful purposes can be abused and end up being utilized to make weapons.

Nuclear energy is a controversial topic and only by learning how to arrive at the facts will students be able to make right decisions about nuclear energy or any other controversial issue. The first step is to evaluate the sources of data on which decisions are made. The second step is to examine the students' current attitudes about nuclear energy and how those attitudes were formed. Third, consider the information sources upon which student attitudes and opinions were based. Examine the information carefully for bias, validity, and reliability in discussions of environmental effects, hazards, costs, and time considerations. Finally, consider the communication techniques which partisans of one view or another use to emphasize a particular point of view.

ACTIVITIES:

EVALUATING CONTROVERSIAL ISSUES: Students keep an annotated log of controversial issues involving nuclear energy by reading articles in newspapers and magazines, e.g., Science 85, Scientific American, Omni, Newsweek, Time, U.S. News and World Report. Students should also include their feelings about each of the issues involved. Cla s sessions can be held to discuss their research and their opinions concerning the issues. There should be a fair and accurate representation of beneficial and harmful uses of nuclear energy.

DEBATING THE ISSUES: Students read several pro and con articles concerning nuclear energy and write a position paper. When determining the validity of an article or book, students should consider all of the variables previously described. This type of activity can also be done after guest speakers present the pros and cons of a controversial issue.

DISCUSSION QUESTIONS: Debate the Strategic Defense Initiative (SDI) proposed by President Reagan and his administration. Research both sides of the issue and pre ent your findings. Do you support the use of nuclear power generating plants? Why or why not?

LOS ANGELES UNIFIED SCHOOL DISTRICT

Teacher-Directed Instructional Sequence

Subject or Course: Introductory Physical and Earth Science 8AB

Representative Objective: Students will be able to identify different substances by their properties.

Sending and Receiving Skill(s) Emphasized: Speaking _X_ Writing _X_ Reading _X_ Listening _X_ Thinking _X_

1. Specific Objective and How Presented to Students:

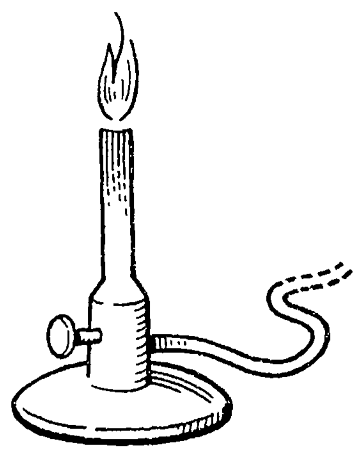
Students will identify different substances by their properties. The objective will be presented orally and written on the chalkboard.

2. Value to Students in Achieving the Objective:

Students will learn that everything that exists has certain characteristic properties that can be used for identification.

3. Initial Instructional Activity to Teach the Objective to Students:

The teacher introduces the lesson with overhead transparencies or on the chalkboard. Students record the definitions of each property. Next, the teacher performs various demonstrations: flame test for salt; flame test for copper; smell test for alcohol; taste test for salt and sugar; lime water test for carbon dioxide; and solubility tests for sulfur, iron filings, salt, and sugar.



4. Guided Group Practice:

Students record observations of the experimental demonstrations. Students identify substances from their properties.

5. Independent Practice or Activity:

Students are given a written homework assignment in which they describe as many properties as possible of ten common substances found at home.

6. Provision for Individual Differences in Ways of Learning:

   a. Remediation or Alternative Activities:

   Students view flashcards with two different substances and describe the similarities and differences in the properties of both.

   b. Enrichment or Supplemental Activities:

   Students name common substances found at school and list the properties of each.

7. Evaluation:

The teacher evaluates independent activity and the results of a teacher-prepared quiz based on demonstrations and class discussion.

NUCLEAR ISSUES
Observation Record
Identifying Substances by Their Properties

DIRECTIONS: Record your observations and results of the following:

1. Flame test for salt:

2. Flame test for copper:

3. Smell test for alcohol:

4. Taste test for salt and sugar:

5. Lime water test for carbon dioxide.

6. Solubility tests:

   Sulfur:

   Iron filings:

   Salt:

   Sugar:

LOS ANGELES UNIFIED SCHOOL DISTRICT

Teacher-Directed Instructional Sequence

Subject or Course: Introductory Physical and Earth Science 8AB

Representative Objective: Students will be able to recognize the differences between potential energy and kinetic energy.

Sending and Receiving Skill(s) Emphasized: Speaking __X__ Writing __X__ Reading __X__ Listening __X__

Thinking Level or Cognitive Level: Knowledge _____ Comprehension _____ Application _____ Analysis __X__ Synthesis _____ Evaluation _____

1. Specific Objective and How Presented to Students:

   Students will recognize the difference between potential energy and kinetic energy and will show the difference on a graph. The objective will be presented orally and written on the chalkboard.

2. Value to Students in Achieving the Objective:

   Students will recognize two scientific processes that take place around them all the time and affect their lives.

3. Initial Instruction:

   Using overhead transparencies, the chalkboard, or other commercial visual aids, the teacher describes potential energy and kinetic energy and asks students to list examples of each. The teacher can also set up a pendulum demonstration (a weight suspended by a string from a ring stand) to illustrate potential energy and kinetic energy and the law of conservation of energy.

4. Guided Group Practice:

   Students, working in small groups, drop a rubber ball from different heights and, using a meter stick, measure the heights of the return bounce. The teacher instructs students in how to graph their results.

5. Independent Practice or Activity:

   Students graph the results of the rubber ball experiment.

6. Provision for Individual Differences:

   a. Remediation or Alternative Activities

      Students who do not understand the difference between potential energy and kinetic energy are tutored by the students who do. Students can also list common examples of each type of energy and explain the reasons for the classification as potential or kinetic.

b. Enrichment or Supplemental Activities:

Students solve vocabulary puzzle or word-search puzzles related to the subject matter in order to reinforce the vocabulary.

7. Evaluation

The teacher evaluates the graphs assigned for homework and the teacher-prepared quiz based on the material. The teacher observes students performing the rubber ball experiment.

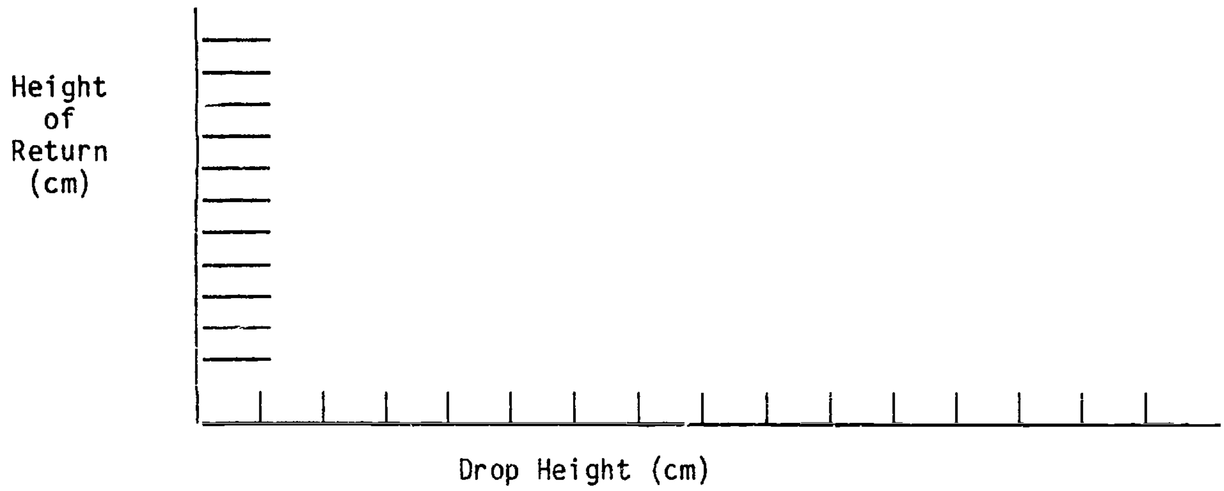
NUCLEAR ISSUES

MEASUREMENT RECORD
POTENTIAL ENERGY AND KINETIC ENERGY

DIRECTIONS: Record the drop heights and heights of return (in centimeters) from your investigation.

HEIGHT (cm)	DISTANCE OF RETURN (cm)

POTENTIAL ENERGY AND KINETIC ENERGY
Graph



DIRECTIONS: Label the two axes of the graph and record your experimental data.

LOS ANGELES UNIFIED SCHOOL DISTRICT

Teacher-Directed Instructional Sequence

Subject or Course: Introductory Physical and Earth Science 8AB

Representative Objective: Students will be able to describe interaction and reorganization of units of matter and their association with changes of energy.

Sending and Receiving Skill(s) Emphasized: Speaking X Writing X Reading X Listening X

Thinking Level or Cognitive Level: Knowledge ___ Comprehension ___ Application ___ Analysis X Synthesis ___ Evaluation ___

1. Specific Objective and How Presented to Students:

   Students will describe the characteristics of mixtures. The objective will be presented orally and written on the chalkboard.

2. Value to Students in Achieving the Objective:

   Humans regularly use various mixtures that affect their lives. Students will appreciate the role mixtures play in their lives.

3. Initial Instruction:

   The teacher defines the term mixture and asks students to list as many mixtures as they can. The list is put on the chalkboard or overhead transparency. The teacher also lists some nonmixtures and asks students why they are not mixtures. Students can also read about mixtures in their texts.

4. Guided Group Practice:

   Students work in small groups and perform the following experiment:

   1. On a piece of paper, mix equal portions of sulfur and salt.
   2. Add the mixture to a beaker half filled with water. Stir the solution for at least one minute.
   3. Set up a ringstand with a funnel lined with a filter paper cone. Place an empty beaker beneath the funnel.
   4. Pour the solution through the funnel into the beaker.
   5. The liquid that is collected in the beaker is called a filtrate. Place the filtrate in the beaker on a hot plate and evaporate the filtrate completely. Record all observations.

5. Independent Practice or Activity:

   Students answer the following questions:

   1. What was the color of each substance before they were mixed?
   2. What was the color of the mixture?
   3. What is the chemical symbol of each substance?

4. How was the mixture separated?
5. Can you define filtrate and filtration?
6. Can you define soluble? Which substance was soluble?
7. What conclusions can you draw about the experiment?
8. Can you list 10 examples of mixtures?

6. Provision for Individual Differences:

a. Remediation or Alternative Activities:

Show students flashcards describing substances and mixtures and have them identify the mixtures.

b. Enrichment of Supplemental Activities:

Provide students with a list of mixtures and instruct them to use reference books to identify the elements and/or substances in the mixtures.

7. Evaluation:

The teacher observes students performing the experiment and evaluates students' answers to questions. The teacher prepares a quiz on the subject matter.

MATTER AND ENERGY
QUESTIONS

DIRECTIONS: Prepare five questions with true or false answers related to mixtures.

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LOS ANGELES UNIFIED SCHOOL DISTRICT

Teacher-Directed Instructional Sequence

Subject or Course: Introductory Physical and Earth Science 8AB

Representative Objective: Students will be able to identify changes in properties and rates of change.

Sending and Receiving Skill(s) Emphasized: Speaking __X__ Writing __X__ Reading __X__ Listening __X__

Thinking Level or Cognitive Level: Knowledge ____ Comprehension __X__ Application ____ Analysis ____ Synthesis ____ Evaluation ____

1. Specific Objective and How Presented to Students:

   Students will be able to identify crystals and their uses. The objective will be presented orally and written on the chalkboard.

2. Value to Students in Achieving the Objective:

   Many common substances that we use are crystals (e.g., salt). Students will learn that matter takes on many forms that play a role in their lives.

3. Initial Instruction:

   The teacher shows slides or pictures of crystals, defines crystal, and explains how crystals are formed. The teacher demonstrates crystal formation by preparing a hot concentrated solution of copper sulfate. Allow the solution to cool to room temperature. When the solution is poured into another container, copper sulfate crystals remain. Allow the cool solution to evaporate for one to two weeks. Large copper sulfate crystals will be present. Have students record changes in the copper sulfate solution as it evaporates.

4. Guided Group Practice:

   Divide the class into teams of two. Each pair of students will need the following: microscope, slide, coverslip. Place a drop of a concentrated salt solution on a slide. Place the coverslip over the drop. Students observe the drop under the microscope. As the water evaporates, salt crystals will form. Students should record all observations.

5. Independent Practice or Activity:

   Using reference books in the library or classroom, write a report on crystals that we use daily. Find out the uses of as many as you can.

6. Provision for Individual Differences:

a. Remediation or Alternative Activities:

Students who do not understand the concept are tutored by those who do.

b. Enrichment or Supplemental Activities:

Word search or crossword puzzle on related vocabulary.

7. Evaluation:

The teacher observes the crystal-growing investigation and evaluates students' observation records and reports.

PROPERTIES AND RATES OF CHANGE
OBSERVATION RECORD

DIRECTIONS: Record all observations in the formation of the salt crystals:

LOS ANGELES UNIFIED SCHOOL DISTRICT

Teacher-Directed Instructional Sequence

Subject or Course: Introductory Physical and Earth Science 8AB

Representative Objective: Students will be able to understand that matter is composed of particles which are in constant motion.

Sending and Receiving Skill(s) Emphasized: Speaking X Writing X Reading X Listening X

Thinking Level or Cognitive Level: Knowledge ____ Comprehension X Application ____ Analysis ____ Synthesis ____ Evaluation ____

1. Specific Objective and How Presented to Students:

Students will determine the rate at which radioactive atoms decay. The objective will be presented orally and written on the chalkboard.

2. Value to Students in Achieving the Objective:

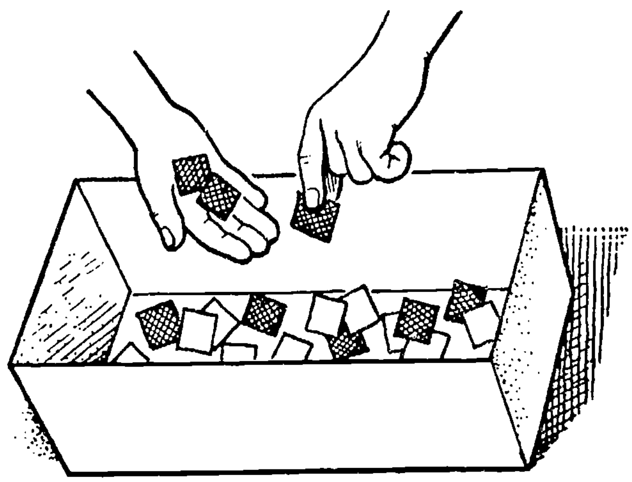
Radioactivity has both beneficial and harmful consequences. Understanding radioactivity will help students to make important decisions about future uses of radioactive materials.

3. Initial Instruction:

Show students a film or other visual aid describing the decay of unstable atoms into more stable elements. Discuss both the positive and negative consequences of radioactivity. Explain the concept of half-life as the time needed for one-half of the atoms of an element to decay. If a Geiger counter is available, demonstrate how it is used to measure radioactivity.

4. Guided Group Practice:

Divide students into teams. Give each team 50 cardboard squares which are marked on one side only, a large shoe box with a cover, and graph paper for each student. Instruct students to pretend that the squares are radioactive atoms. Place the cardboard squares in the box, cover it, and shake for 30 seconds. Uncover the box and remove all squares which are lying with the marked side up. Each square, or radioactive atom has a 50 percent chance of decaying. Record the number of squares remaining in the box. Repeat the procedure until all of the squares are removed. On the graph paper, label the horizontal axis "Number of Trials."



Label the vertical axis "Number of Remaining Squares." Graph the data from the experiment. The resulting curve is called a decay curve. Discuss the results with the class.

5. Independent Practice or Activity:

   Answer the following questions:

   1. How many trials did it take to remove all of the squares?
   2. What percentage of squares was removed on the first trial? What percentage did you expect?
   3. What conclusions can you draw about the decay of atoms in a radioactive element?

6. Provision for Individual Differences:

   a. Remediation or Alternative Activities:

      Students who do not grasp the concept should be on a team with students who do.

   b. Enrichment or Supplemental Activities:

      Using reference books in the classroom and/or library, write a comprehensive report on a radioactive element.

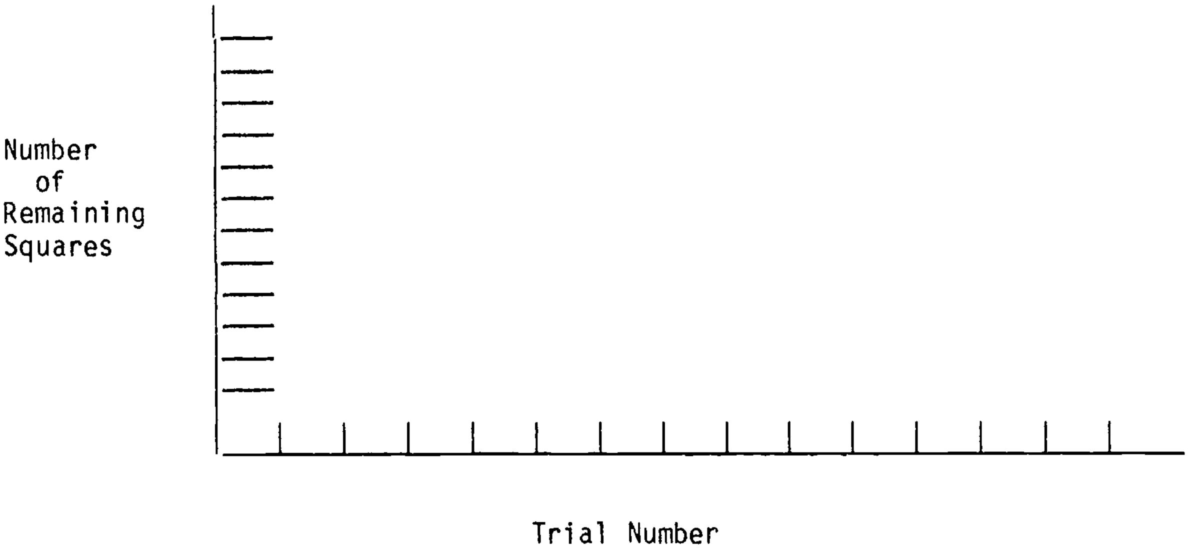
7. Evaluation:

   The teacher evaluates student graphs, presents a teacher-prepared quiz on the subject matter, and evaluates students' reports.

PARTICLES IN MOTION
DATA TABLE

Number of Trials	Number of Remaining Squares

PARTICLES IN MOTION
Decay Curve



LOS ANGELES UNIFIED SCHOOL DISTRICT

Teacher-Directed Instructional Sequence

Subject or Course: Biology AB

Representative Objective: Students will be able to identify types of data which are valuable in planning environmental changes.

Sending and Receiving Skill(s) Emphasized: Speaking __X__ Writing __X__ Reading __X__ Listening __X__

Thinking Level or Cognitive Level: Knowledge ____ Comprehension ____ Application ____ Analysis ____ Synthesis ____ Evaluation __X__

1. Specific Objective and How Presented to Students:

Students will gather information and state their opinions, based on relevant information, about a social issue. The objective will be presented orally and written on the chalkboard.

2. Value to Students in Achieving the Objective:

Students will be faced with many controversial issues during their lifetimes and need to develop the skills of evaluating data and forming opinions based on valid and reliable data.

3. Initial Instruction:

Present the following problem to students: The people of an area of western Washington are concerned about the tremendous number of fish that are dying in the nearby river. The number has significantly increased since last year. What has caused this to happen? Many of the local citizens believe that the new nuclear power plant, which went into operation recently, is the cause. However, engineers at the plant say there is absolutely no radiation leaking from the plant and they have data to support that claim. Yet the mysterious increase in fish mortality began only a few weeks after the plant began operating. The citizens of the town have decided to have a public forum in which both sides will present their arguments.

4. Guided Group Practice:

Divide the class into three groups. One group will assume the role of concerned local citizens. The second group will be the nuclear power plant representatives. Have each group choose a leader and a recording secretary. Assign each group the task of gathering as much information as possible from library reference books, newspapers, magazines, etc., to support their arguments. Discuss strategies that each might take and give them a time limit in which to prepare an argument to support their stance. Members of the third group will serve as an unbiased panel of judges to decide which presentation is best.

5. Independent Practice or Activity:

Students in each group decide the responsibilities for each of their members and research the topic. Allow class time for the groups to organize their research into a formal presentation. Provide the groups with any materials (e.g., large paper, markers, or tape) which they may need to make visual aids for their talk.

6. Provision for Individual Differences:

a. Remediation or Alternative Activities:

Have less able students perform simple tasks or work with those students who have a firm grasp of the subject matter.

b. Enrichment or Supplemental Activities:

The better students can provide the leadership that the groups need. Those who are better public speakers can be responsible for making the formal presentation. They might also make the same presentation in their social science class and compare reactions to the topic by students in both classes.

7. Evaluation:

The unbiased panel will evaluate the presentation of each group. The panel should be given planning time to develop a list of criteria that will be used as a basis for their decision. The teacher should observe the interaction in each group to make sure that every student is fulfilling his or her responsibility.

LOS ANGELES UNIFIED SCHOOL DISTRICT

Teacher-Directed Instructional Sequence

Subject or Course: Physics AB

Representative Objective: Students will be able to record observations accurately and organize data and ideas in ways that improve their usefulness.

Sending and Receiving Skill(s) Emphasized: Speaking X Writing X Reading X Listening X

Thinking Level or Cognitive Level: Knowledge ____ Comprehension ____ Application ____ Analysis ____ Synthesis ____ Evaluation X

1. Specific Objective and How Presented to Students:

   Students will describe the factors that affect the motion of a pendulum.

2. Value to Students in Achieving the Objective:

   The concepts gained from this experiment are important in understanding the principles of physical events, and they are prerequisites for further study.

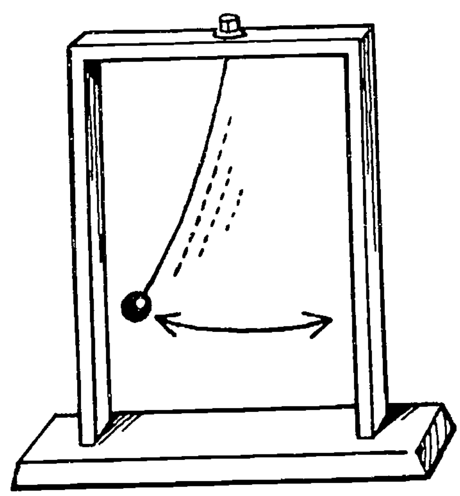
3. Initial Instruction:

   Students should read about the laws of motion in their text. The teacher can reinforce their knowledge with the aid of visual aids, class discussion, and/or lecture. Relevant terminology (e.g., pendulum, period, motion, momentum, arc) should be discussed.

4. Guided Group Practice:

   Divide students into laboratory teams. Set up a pendulum using a ring stand, a string, and a metal weight of known mass. The length of string should be 60 cm. Using a stopwatch, determine the period of the pendulum. This can be accomplished by measuring the time it takes for the pendulum to swing ten times and dividing the time by ten. Design and carry out experiments to answer the following questions:

   1. How does a longer or shorter length of string affect the period?
   2. Does the arc of the swing affect the period? Explain.
   3. How does the mass of the pendulum affect the period?



4. What conclusions can you draw about the relationship among mass, arc, length of string, and period of a pendulum? What is the relationship of pendulum motion to kinetic and potential energy? How does nuclear energy have kinetic and potential energy?

5. Independent Practice or Activity:

Students should write a formal laboratory report describing in detail the procedures for their experiments.

6. Provision for Individual Differences:

a. Remediation or Alternative Activities:

The teacher can perform the experiment as a demonstration, if materials are not available or if the class is a Physical and Earth Science AB class.

b. Enrichment or Supplemental Activities:

Students can use a meter stick to measure the height of the arc of the pendulum in order to illustrate the law of conservation of energy and the concepts of potential and kinetic energy.

7. Evaluation:

The teacher observes students working together, designing and performing experiments, and evaluates their laboratory reports.

LAB REPORT

I. Problem

II. Hypothesis

III. Procedure

IV. Data

V. Results

VI. Conclusions

VII. Verifying Conclusions

LOS ANGELES UNIFIED SCHOOL DISTRICT

Teacher-Directed Instructional Sequence

Subject or Course: Physical and Earth Science AB

Representative Objective: Students will be able to describe the interaction and reorganization of units of matter and their association with changes of energy.

Sending and Receiving Skill(s) Emphasized: Speaking __X__ Writing __X__ Reading __X__ Listening __X__

Thinking Level or Cognitive Level: Knowledge _____ Comprehension _____ Application __X__ Analysis _____ Synthesis _____ Evaluation _____

1. Specific Objective and How Presented to Students:

   Students will explain that the motion of molecules is relative to the amount of energy present.

2. Value to Students in Achieving the Objective:

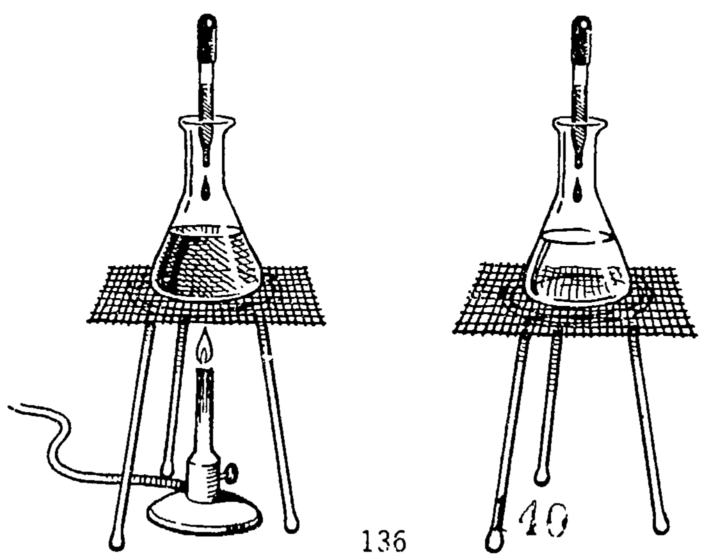
   Understanding the behavior of matter will help students to understand the behavior of solids, liquids, and gases, the forces between particles, and the energy of the particles.

3. Initial Instructional Activity to Teach the Objective to Students:

   Explain the kinetic theory of matter to students. There are many excellent visual aids available to reinforce the presentation. Students will perform an experiment to illustrate the theory.

4. Guided Group Practice:

   Divide the class into teams. Each team will need the following materials: two flasks, one of cold water and one of hot water, and a container of food coloring. Let the water in both flasks stand for two minutes, and then add a drop of food coloring to each flask. Do not stir the water. Observe and record what occurs in each flask.



5. Independent Practice or Activity:

Answer the following questions after the investigation is completed.

1. What happened in each flask?
2. In which flask did the food coloring dissolve quicker?
3. What effect did the heat have on the food coloring?
4. What effect did the cold have on the food coloring?
5. Why didn't you stir the water?
6. How can you explain difference in behavior of the food coloring in the two flasks?

6. Provision for Individual Differences in Ways of Learning:

a. Remediation or Alternative Activities:

This investigation can be performed as a demonstration by the teacher. Peer tutoring can be utilized so that students can help each other and share ideas.

b. Enrichment or Supplemental Activities:

Open a bottle of perfume in a closed room and discuss the diffusion of molecules throughout the room. Measure and compare how long it takes for students near the perfume bottle to smell it and how long it takes students far away from the bottle to smell it. Repeat the procedure with a container of ammonia. Compare the amount of time it takes for the perfume and ammonia to diffuse in the room.

7. Evaluation:

The teacher evaluates answers to students' questions and observes students as they conduct the experiment.

MOLECULAR MOTION
OBSERVATION RECORD

DIRECTIONS: Record your observations of what happened in each flask.

Flask of cold water:

Flask of hot water:

INSTRUCTIONAL UNITS:

SECONDARY HISTORY-SOCIAL SCIENCE

STUDENTS SHOULD KNOW ABOUT AND BE ABLE TO USE MANY SOURCES OF INFORMATION AND IDEAS AVAILABLE TO THEM. THESE WOULD INCLUDE VARIOUS MEDIA ENCOUNTERED BY THEM IN AND OUT OF SCHOOL.

BACKGROUND INFORMATION AND ACTIVITIES: Students will write research papers on the various types of missiles used by both the United States and the Soviet Union. They will find information by using a card catalog. They will find information by using the Reader's Guide to Periodical Literature. Their reports might deal with aspects of nuclear weaponry, such as destructive power, missile types, warheads, reentry vehicles, strategic stability, tactical nuclear weapons, intercontinental ballistic missiles, heavy or strategic bombers, MX missiles, or other related topics. Their papers should reflect the ability to locate the best sources of information on specific topics.

Students might research the history of the development of weapons. The first weapons were stones, clubs, and spears, all of which were directly powered by the human arm. The "extended arm" delivery systems were next, like catapults, slings, longbows, and crossbows. These extended the range of more primitive weapons. The discovery of gunpowder led to the development of more accurate long-range weapons. These weapons included machine guns, artillery, cannons, and all types of bombs. Nuclear weapons have completely altered the nature of warfare because of their enormous, unprecedented destructive capabilities. In destructive power, the first atomic bomb was 5000 times more powerful than a conventional contemporary bomb of the same weight. The first hydrogen bomb was 60 times more powerful than that atomic bomb. In addition to the immediate damage, the effect of radioactivity on human beings and their environment is far reaching and enduring.*

Students will be able to identify books and other sources appropriate for finding certain types of information. Students, in doing their research, should be able to find information in a book by using the table of contents and find material by using an index. Students may want to research modern delivery systems that have given nuclear weapons the ability to strike from great distances. Airplanes make it possible to transport bombs to an opponent's homeland (strategic warfare), and missiles can be launched from great distances and deliver nuclear weapons quickly and accurately. It takes only 30 minutes for missiles to travel between the USA and the USSR. Today's advanced delivery systems greatly reduce the amount of time permitted to reverse an initial attack decision.

Students can research the history of public concern about the arms race and the threat of nuclear war. They should focus on the two decades between the Korean War and the Vietnam War, 1955-75. Students should conduct two types of research--library and oral history. Students will be able to locate information in an encyclopedia, magazine, atlas, and/or almanac.

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*Refer to pages 106-110 of this resource guide for additional information relating to the topic of positive and negative aspects of nuclear energy.

Students should be encouraged to use the library to look through old newspapers and magazines. Students will be asked to use primary as well as secondary sources. Students will be able to distinguish between and evaluate primary and secondary sources of information. Many primary sources are on microfilm, but photocopies can be made and brought back to the classroom for a file. Students should be able to summarize the information given in a newspaper article.

Students should focus on these questions: What were the concerns of the people of the time? What were some of the terms or phrases used? Who were the key people of the time? Students may come across terms like strontium 90, radioactive fallout, Rosenberg trial, expansionism, cold war, subversion, McCarthyism, and Cuban missile crisis. Students should be able to define the meaning of an unknown word by using a glossary of appropriate social science terms. For their oral history research, students may talk with their parents or other adults who grew up during the 1950s. Students will be able to identify resource persons most likely to have useful information about a given problem. Oral history interviews should focus on the feelings and opinions of growing up in the 1950s and 60s and what interviewees remember of nuclear threats.

MATERIALS SUCH AS CHARTS, CARTOONS, GRAPHS, POSTERS, AND TIME LINES SHOULD BE RECOGNIZED AS WAYS OF GROUPING INFORMATION AND UNDERSTOOD AS MEANS OF SIMPLIFYING COMPLEX IDEAS AND STATISTICS.

BACKGROUND INFORMATION AND ACTIVITIES: Students will complete a time line given a time span and key events with their dates. Students will make a time line of significant events of the atomic age that changed the course of world history between 1910 and the present.

The following outline will be helpful in making this time line.

1910-1934	Scientists in Europe and the United States study the nature of the atom.
1934	Physicist Enrico Fermi demonstrates that the atom can be split.
1938	Fermi emigrates to the United States.
1939	Niels Bohr of Denmark reports that the weight of two halves of an atom weigh less than the original mass. The scientific conclusion: The missing mass was transformed into energy.
1939	Fermi and Einstein warn President Roosevelt that German scientists are working on an atomic weapon. F.D.R. forms an Advisory Committee on Uranium.
1941	The "Manhattan Project" is set up to build an atomic bomb as quickly as possible. J. Robert Oppenheimer is the head of the project.
1945	An atomic device is exploded in a steel tower in New Mexico, the dawn of the age of nuclear weapons.

1945 Henry Stinson, United States Secretary of War, estimates that over one million United States servicemen will be killed in the war against Japan if the "island hopping" nature of the Pacific War continues. Some scientists recommend that the bomb not be used. After weighing pros and cons, President Truman orders that the bomb be used. On August 6 at 8:15 a.m. an American B-29 bomber, the Enola Gay, drops the first atom bomb on Hiroshima, Japan. Over 100,000 people died immediately. On August ninth, the United States drops a second bomb on Nagasaki, Japan. Recently, there has been some speculation that it was unnecessary to use a second atomic bomb against Japan, because they might have surrendered after the bomb was dropped on Hiroshima if they had been given more time to react.

1946-1950 The United Nations sets up the International Atomic Energy Agency. The United States proposes the Baruch Plan (calls for the international control of nuclear weapons); the USSR rejects it. United States begins nuclear weapons testing in the Pacific. The Soviet Union attempts to match United States military might by mobilizing vast armies and exploding its first nuclear bomb. The United States and most western European countries join together to form NATO, the North Atlantic Treaty Organization (1949).

1951-1955 The United States develops the hydrogen bomb and tests it in the Pacific. The USSR develops its first intercontinental long range bomber, the Bison. The first Soviet H-bomb is tested. The USSR and most eastern European countries join together to form the Warsaw Treaty (Warsaw Pact) in 1955.

1956-1960 The USSR successfully tests the first intercontinental ballistic missile and launches Sputnik, the first artificial earth satellite, beginning the space race. The United States spurs civil defense programs, launches its first satellite, Explorer I, and, despite its clear lead in missiles and weapons, the so called "missile gap" becomes a presidential election issue. The United States increases its ICBM development program and designates large funding for engineering, mathematics, and science.

1961-1965 The Soviets deploy the first ICBM and explode a 50 megaton hydrogen bomb 3000 times more powerful than the bomb used in Hiroshima. In the United States, President Kennedy pushes for more funding for missiles and lauches the first ballistic missile submarine. The first ICBMs capable of reaching the Soviet Union are developed. The Cuban missile crisis occurs and the 1963 Limited Test Ban Treaty prohibits all weapons testing in the atmosphere, under water, and in space. This is the first treaty of its type between the United States and the USSR.

1966-1970 The United States develops MIRVs, and the USSR engages in a massive build up of ICBMs and deploys its first SLBM. The 1968 Nuclear Non-Proliferation Treaty represents the first attempt to control the spread of nuclear weapons beyond the five countries which already have them: United States of America, Soviet Union, France, Britain, and China.

1969 The first Strategic Arms Limitation Talks (SALT I) begin.

1971-1975 The SALT I Treaty is signed and ratified by the United States and Soviet Union. The Soviet Union continues modernizing and expanding its missiles and warheads.

1976-1980 In response to the Soviet build up, the United States begins to look for ways to protect its missiles from possible Soviet attack. The MX missile is developed. The Soviet Union continues to modernize its nuclear forces, and its submarines are equipped with MIRVs. Arms control efforts between the superpowers result in the SALT II treaty, but the treaty is not ratified in the United States Senate. The Soviet invasion of Afghanistan interferes in United States-Soviet relations and dooms the treaty ratification.

1981-present Strategic Arms Reduction Talks (START) are proposed by President Reagan, with a focus on the long range or strategic weapons of the two countries. Reagan's Strategic Defense Initiative (SDI) becomes an issue of debate in the United States.

(A different time line construction showing political views on nuclear issues through different presidential administrations appears in detail in the sample lesson format for grade 8AB.)

Students will be able to identify and read information presented in a given graph and compare and interpret information given in the graph. Students will interpret the meaning of the two graphs from Time magazine of 3-29-82 showing mushroom clouds representing megatonnage with stem shapes representing the numbers of United States and Soviet nuclear warheads. The cloud in the graph representing the Soviet Union appears wider and taller and it appears more powerful, whereas according to the graph, the reality lies in the numbers that indicate that the United States has more weapons. Students will be able to identify and read information and data presented in a table; compare and interpret information and data given in a table; and develop graphs, tables, and timelines as part of a presentation of information.

Students will present a research report on the state of the arms race. They will create graphs by using the table of information presented in the 1985 Almanac on Strategic Nuclear Armaments, U.S. and U.S.S.R. Students will also look at the total and projected budget of the United States (also presented in table form in the 1985 Almanac) and create pie or bar graphs to show major categories of expenditures. A report or breakdown of the defense budget should also be presented in the report. Students will be able to interpret the content of charts, cartoons, or posters. Editorial cartoons are one popular way of expressing an opinion. The teacher should guide students through editorial cartoons by asking questions such as: What issue does this address? Who do the people or objects represent? What is the cartoonist's opinion about this issue?

MAPS AND GLOBES ARE IMPORTANT TOOLS IN HELPING STUDENTS TO UNDERSTAND GEOGRAPHICAL, HISTORICAL, POLITICAL, AND CULTURAL RELATIONSHIPS.

BACKGROUND INFORMATION AND ACTIVITIES: Students will identify or state a definition of the term map. They will recognize and apply the following basic map and globe terms: sphere, globe, equator, poles, universe, solar system, planet, natural satellite, artificial satellite, orbit, axis, rotate, degree, Tropic of Capricorn, international date line, time zone, great circle. Students will be given a world map. They will be able to identify, describe, and interpret the major parts of a map: title, legend, compass direction, map scale, geographic grid. They will design a map with appropriate symbols, map scale, and key, given a paragraph description of location.

Students should be given the following information and asked to color their map and make an appropriate key that shows countries that have nuclear weapons: United States, Great Britain, China, Soviet Union, France, and India. Countries that are believed capable of building nuclear weapons now include Canada, West Germany, Pakistan, Switzerland, Sweden, Israel, South Africa, and Japan. Countries that could have nuclear weapons within the next six years include Brazil, Spain, Netherlands, Finland, Austria, Taiwan, Australia, Argentina, Belgium, Denmark, Italy, Iraq, and South Korea. Countries that could have nuclear weapons in 7 to 10 years include Libya, Norway, Egypt, and Yugoslavia.

Students can use a piece of tracing paper over their map to make a new map to show NATO and Warsaw Pact countries. Another piece of tracing paper can show the types of weapons placed in NATO countries and in the Soviet bloc. Students can be given a map of the United States and, by doing research, can make a key indicating where nuclear plants and waste facilities are located.

Students will be able to compute distances between points using a mileage scale. Students can be given a street map of Los Angeles and a compass. They will chart what would happen if a one-megaton bomb was dropped on the center of downtown Los Angeles. (Most of the nuclear bombs that the United States and the Soviet Union now have are in the one to 20 megaton range; hence this exercise will assume the use of a one-megaton bomb.) A one-megaton bomb has approximately 100 times the force of the atom bombs dropped on Hiroshima and Nagasaki. Many of our missiles today contain multiple warheads that contain two 25 one-megaton bombs.

Using the following information, chart on the map of Los Angeles the effects of a one-megaton bomb. Using your compass, draw circumferences and label them as follows: 0-2 miles--total destruction, 400 mile-per-hour winds, 99 percent of the people dead; a crater 1/4 mile in diameter and 20 stories deep. 2-3 miles--most buildings flattened, winds of 180 miles per hour, 50 percent dead, and 25 percent dead later from burns or injuries, an additional 20 percent injured or victims of second and third degree burns. 3-5 miles--fifty percent of the people dead, some commercial structures left standing, most homes flattened or burned out, gasoline storage tanks explode, wind 150 miles per hour. 5-10 miles--twenty-five percent dead from injuries or burns, most survivors receive second -or third-degree burns from thermal radiation or are blinded by the flash, winds 100 miles per hour, most buildings damaged. Anywhere in the 1-10 mile radius firestorms could start. These are more likely to occur during certain weather conditions. In a firestorm, the fire consumes the oxygen and people suffocate, even in shelters.

The immediate effects of a nuclear explosion can be separated into three categories relating to the three forms of energy released: blast, heat, and radiation. At the time of explosion, the bomb creates a blast wave of compressed air that travels at approximately the speed of sound. The pressure created is 100 times that of atmospheric pressure, so extremely high winds follow the blast. At the center of the explosion is the hottest area, called a fireball. Temperatures reach millions of degrees, causing extreme heat felt at great distances from the explosion center. Radiation has many effects: Fragments and dust caught up in the mushroom cloud become radioactive and when this material settles, it is called fallout. Persons exposed to radiation suffer intense sweating, fever, and injury to their stomachs, intestines, nerves, and muscles. They become dehydrated. In persons who inhale plutonium, the air sacs of the lungs become permeable to blood and tissue fluids causing the sensation of drowning. Hypoxia, heart failure, kidney disease, thyroid cancer, and leukemia may result later. Depending on weather conditions, an area 10 to 100 miles from the explosion would be lethally contaminated. People would suffer second- and third-degree burns in their eyes as well as over all their bodies. If they inhale, ingest, or absorb radioactive particles through their skin, they will experience radiation sickness. Cells that normally divide are damaged. Radiation penetrates the bone marrow where blood cells are made. Radiation sickness causes nausea, headaches, vomiting, diarrhea, anemia, loss of hair, loss of reproductive capacity, skin sores, and increased susceptability to infection. Radioactivity cannot be seen, smelled, tasted, or felt. It remains in the air, food, and water for a considerable time as fallout.

Students may want to attach to their map a description of what might happen to structures and places with which they are familiar. Using the scale on their map and the information given above, let them write what might happen to Disneyland, Dodger Stadium, their school, their homes, etc.

THERE IS LITTLE VALUE IN GATHERING INFORMATION UNLESS IT CAN BE ORGANIZED IN MEANINGFUL WAYS. ORGANIZED INFORMATION CAN TAKE THE FORM OF A WRITTEN OR ORAL ACTIVITY.

BACKGROUND INFORMATION AND ACTIVITIES: Students will be able to classify items which have characteristics in common and explain why an item does not fit in a given classification.

Teacher will write the words "nuclear issues" on the chalkboard. Students will brainstorm both negative and positive words and images they associate with it. Have the class examine the list for common themes. Have the class group these words under subtopics of their choice. Discussion should follow as to why certain words were grouped together and why certain words were not. This activity should help students to explore their own ideas about nuclear issues and help them to compare those ideas with others.

Each student will be able to prepare an outline of major points, using reference materials and taking notes while listening to a lecture or observing an audiovisual presentation. The teacher will present a lecture on the nuclear freeze issue, presenting both sides of the argument. Students will take notes and develop outlines of major events. They will research the freeze issue in newspapers and magazines to add to their outline. They will also be able to identify the chronological order of events and ideas which show the stages in a developmental process.

THE FOLLOWING INFORMATION IS PROVIDED TO HELP THE TEACHER MAKE THE PRESENTATION: The nuclear freeze movement from the beginning has been a "grassroots" movement, started by individuals who felt the arms race was getting out of control. The idea of a freeze reflects the impatience of some people with the arms race. Arms control advocates in nations in the arms race say they want restraint, but they have been unable to stop the race. Advocates of a nuclear defense buildup say their goal is to reduce the risk and preserve security.

Freeze proponents believe we are in a paradoxical position in which the more we spend on the military, the less secure we really become. By spending more and more on weapons we are speeding up the arms race and increasing the risk of nuclear war. Freeze advocates believe that the United States and the Soviet Union should stop where they are now; neither side should build more weapons. They feel the arms race has become uncontrollable. Even if the race were stopped today, the sheer number of nuclear explosives that exist today could destroy all of humanity. Freeze advocates are greatly concerned with the peril of accidental war, and they firmly believe this is a good time to stop. They feel both sides already have enough weapons to survive a first strikeretaliatory situation, and the greater the arsenal the greater the risk of its being used, even if accidentally. The biggest question raised is that if there is a mutual freeze, how will it be verified? It will require negotiating and compromise, but freeze advocates feel it can be accomplished, while those opposed feel verification is difficult to achieve especially in light of the fact that the USSR has refused on-site verification.*

In 1982, the nuclear freeze issue was discussed in communities around the country. In California, hundreds of thousands of people signed petitions calling for a referendum on whether the president should be advised to seek a nuclear freeze. In New York City, large numbers of people assembled in Central Park to demonstrate their concern and support for the freeze. Many citizens all over the United States, in both rural and metropolitan areas, felt strongly about the issue. Students should be encouraged to research what has happened to the freeze movement of 1982. They should demonstrate the ability to organize information by writing a bibliography on one topic, when given various references. Students can write a

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*Two interesting articles with views opposite those of the freeze advocates are to be found in Charles Krauthammer, "On Nuclear Morality," Commentary (October 1983), pp. 48-52, and Albert Wohlstetter, "Is There a Strategic Arms Race?" Foreign Policy (Fall 1974), pp. 48-81.

bibliography on the nuclear freeze using the Reader's Guide to Periodical Literature and the card catalog of the library. The bibliography should be balanced.

A MAJOR OBJECTIVE IN HISTORY AND SOCIAL SCIENCE INSTRUCTION IS TO HELP THE STUDENT LEARN TO THINK CRITICALLY.

BACKGROUND INFORMATION AND ACTIVITIES: Students will be able to identify similarities and differences and summarize these findings. Students will research the differences and similarities between the United States and the Soviet Union concerning the issue of nuclear arms. When dealing with nuclear arms discussions, the students must become familiar with Soviet political and strategic goals as well as our own. Teachers might first discuss with the class the images, thoughts, or ideas that come to mind when we think of the Soviet Union. Brainstorming might be used to stimulate discussion or clarify ideas. Sources of information should be looked at, such as magazines, newspapers, novels, and history books. Students should ask, "How does the Soviet government see us?" Groups could be assigned to research the topic of the influence of political opinion on the policies of the Soviet government. Faculty experts from local universities and colleges could be invited to talk with students on the role of political opinion on the government of the Soviet Union.

Students will be able to formulate a concept by obtaining data and organizing the information into meaningful clusters. The class might research basic characteristics of the government of the Soviet Union, such as the role of the party, relationship of the individual to the state, the role of the media, and the opportunity for political dissent. They might compare the information with the government of the United States.

Students will be able to state thoughts and feelings that are not explicit in a given data source, state reasons for these inferences, and distinguish between facts and opinions. There are many statements by many persons in many sources on nuclear issues. Students should read these statements and research the person being quoted. Students will be able to evaluate sources, ideas, facts, and opinions. They should read the statements, realize the source, and infer the meaning. Students can work with the following sample quotations, but teachers will have no trouble in finding hundreds more.

President Dwight Eisenhower, 1956--"The era of armaments has ended, and the human race must conform its actions to this truth or die."

Admiral Noel Gayler, U.S.N., Ret.--"The idea of strategic nuclear superiority and inferiority has no meaning. The important thing to remember is that we both have thousands of nuclear weapons. There is nothing realistic about being ahead or behind, when he has 6000 and you have 9000, and it only takes 400 megatons to destroy a country."

Caspar Weinberger, Secretary of Defense, April 29, 1982--"I would not for a moment exchange anything (with the Soviets) because we have an immense edge in technology."

General Omar Bradley, 1957--"Missiles will bring anti-missiles, and anti-missiles will bring anti-anti-missiles. But inevitably, this whole electronic house of cards will reach a point where it can be constructed no higher."

Prof. Robert Jay Lifton, specialist on nuclear psychology, Los Angeles Times August 4, 1985--"The pattern of psyche-numbing was very widespread in the early postwar years, and even decades, and numbing is very close to denial. People waver back and forth between numbing, resignation, and taking a stand or withdrawing from it. Nobody can maintain an awareness of an extreme threat 24 hours a day."

Henry A. Kissinger, former Secretary of State--"We added the atom bomb to our arsenal without integrating its implications into our thinking."

Quotations can also be used to help students identify cause and effect relationships, analyze cause and effect relationships, and interpret information from a broad source of data to make a general statement (generalization) which includes the main idea. The teacher might use some of the following statements to teach these skills or find others on their own. The FAS Public Interest Report, Vol. 34, No. 2, February 1981, Federation of American Scientists, contains the following statement:

> Now appears the time to say it again: the entire industrialized world could could be destroyed in 24 hours through nuclear war. Everyone in his fifties or older saw this grim situation of opposing deterrents emerge during his adult life. Those in their forties or older remember real life nuclear war scenarios: the Berlin crisis and the open threats of nuclear use in the Cuban missile crisis. But those in their twenties have largely escaped confrontation with this reality, and some of their elders may have forgotten it. The situation in brief, is this: one bomb can destroy one city. A large warhead with the equivalent of 25,000,000 tons of TNT (25 megatons) will level homes 13 miles in all directions from its ground zero. The Soviet Union is ready to deliver 100-200 bombs of this size. One such bomb would level the largest city, e.g., New York. A five megaton bomb will do the same for cities in a radius of 7.5 miles. The Soviet Union is ready to deliver 400 such weapons. Warheads of about one megaton could level cities that are four miles in radius. The Soviet Union has 6000 warheads in that range. The United States has only 2,000 cities over the minimal size of 10,000 persons. All of those could easily be destroyed. The official estimates are that between 70 million and 160 million Americans would die and 20 to 30 million more if the Soviet targeters really tried to kill people per se. America's population stands today at 226 million. Thus, 30% to 70% of the population would die promptly. Tens of millions more would die from non-existent medical care, from unchecked disease, from low temperatures when the winter arrived, and from agriculture failures.

The teacher might introduce Carl Sagan's study of the nuclear winter. More statements that are useful to stimulate critical thinking include the following:

Omar Bradley, General of the Army--"We have grasped the mystery of the atom and rejected the sermon on the Mount. Ours is a world of nuclear giants and ethical infants. We know more about war than we do about peace. We know more of killing than we do of living."

President Dwight Eisenhower--"Controlled, universal disarmament is the imperative of our time. The demand for it by the hundreds of millions whose chief concern is the long future of themselves and their children will, I hope, become so universal and so insistent that no man, no government anywhere, can withstand it . . . . People in the long run are going to do more to promote peace than are governments. Indeed, I think people want peace so much that one of these days, governments had better get out of the way and let them have it."

Richard Nixon, in The Real War--"It may seem melodramatic to treat twin poles of human experience represented by the United States and the Soviet Union as the equivalent of Good and Evil, Light and Darkness, God and the Devil; yet if we allow ourselves to think hypothetically, it can help clarify our perspective on the world struggle." (Students might be encouraged to explore the logical consequences of a view of this kind.)

Students will be able to predict, forecast, or anticipate what might happen in a given situation, combine main ideas to form an original product (report, dramatization, project), as well as formulate questions relevant to a given topic. Students can write position papers on nuclear issues after posing a question. The paper should try to answer the question posed. Suggested topics might include The Triad, the concept on which the United States defense against nuclear weapons is based; the Window of Vulnerability, the argument that the United States over the next few years may be so far behind the Soviet Union in numbers and types of nuclear weapons that it will be vulnerable to a "first strike" attack; the nuclear freeze, the concept that all nations shall stop production of nuclear weapons; the concept of Limited Nuclear War, the reliance on tactical nuclear weapons; The Pre-emptive Strike, a nuclear attack by one nation, designed to head off an expected strike by another. Many other topics could be developed such as the issue of unilateral nuclear disarmament.

PROBLEM SOLVING IS A DAILY ACTIVITY. MANY OPPORTUNITIES TO DEVELOP THE PROCESS OF PROBLEM SOLVING SHOULD BE PART OF THE STUDENT'S EXPERIENCE IN HISTORY-SOCIAL SCIENCE.

BACKGROUND INFORMATION AND ACTIVITIES: Students will be able to identify and describe the steps in the problem-solving method, state a problem developed from a given situation and determine the data needed to solve the problem. As students learn about nuclear issues, the question of how to prevent a nuclear war will arise. Students will want to translate their thoughts into action and learn how to have an impact on the system of which they are a part. They can promote the education of citizens about nuclear weapons and national defense issues. They can discuss with their friends and parents how nuclear weapons have changed war and international relations. Students will be able to identify and state one or more reasons why a particular hypothesis is tentative and identify or state one or more ways to validate a hypothesis. They will be aware of the wide variety of policies necessary to prevent a nuclear war but still maintain sufficient defense posture. These policies include Mutual Assured Destruction (MAD) which argues that nuclear war can be avoided if both sides realize that neither side can win a nuclear war. This can be analyzed as a policy of national security. Other ideas to be explored include nuclear arms control, improved relations between the superpowers, realistic national defense policies, improved conflict-resolution techniques, nuclear nonproliferation treaties, and improved crisis communications between the superpowers. Each possible use of nuclear weapons requires a different combination of methods of prevention.

Students may role-play different scenarios based on current events that may lead to nuclear war and then see if they can be resolved in a peaceful manner using some of the suggested techniques. Students will be able to state a proposal to solve a problem when given data about the problem. They will be able to apply inductive reasoning. Students can learn about the issues through many methods, such as by reading books, periodicals, and pamphlets, as well as seeing films on the subject. They can keep a classroom clipping file and an index of articles to share with others. They can start a discussion group at school. They must learn to pay close attention to developing issues in daily newspapers or news programs. They must learn to examine specific points concerning nuclear issues by pursuing further research.

Students wi'l be able to select or give a solution to a problem which considers as many different points of view as possible. Students will share what they have learned with others by writing position papers and organizing debates on the issue. The teacher might organize a guest-speaker program in which people with expertise in various subjects holding diverse opinions about nuclear issues would speak to to the class.

Students will be able to evaluate reasons for accepting one plan over the alternatives in order to solve a specific problem.

Students may write letters to a school or city newspaper expressing opinions about what our country can do to prevent nuclear war without compromising essential national defense considerations. They can communicate with federal, state, and local officials about their opinions. They can register to vote when they are old enough and be aware of the candidates' stands on nuclear war, the military budget, and defense, making these an informed factor in their voting decisions.

Students will be able to identify or suggest more than one approach to the solution of a school problem, and they may also apply this technique to a community problem. By bringing what they have learned about nuclear issues in school to the attention of others, students can help educate the community. They can also apply their problem-solving skills to work in the community.

Students will be able to describe how a given generalization may apply to a new situation. Students will realize that there are several steps they can take in solving problems. On an individual level, letter writing, phone calls, and volunteer work will have an impact on public officials and the press. At the community level, education, reaching out to family, friends, and neighbors, using the media, and localizing the issues may be effective. On the national level, practicing democracy, learning about the issues, and working through the democratic process may be the answer. On the international level, students may practice thinking globally and working on suggested approaches to improving American-Soviet relations.

ALTHOUGH THE PRACTICE OF VALUING IS INHERENT IN SOCIAL STUDIES EDUCATION, SPECIFIC OPPORTUNITIES SHOULD BE AFFORDED TO THE STUDENT TO CLARIFY AND DEVELOP HIS OR HER VALUES.

BACKGROUND INFORMATION AND ACTIVITIES: Students will be able to identify values from actions and words which express them. Students will look at the language that surrounds nuclear issues, and they will understand the terms propaganda, euphemism, and pejorative. Propaganda means the deliberate efforts, usually by appeal to the emotions, by an individual or group to create, change, or control the attitudes of others. Euphemisms are pleasant words which are substituted for unpleasant or offensive ones. Pejoratives are words which tend to disparage the subject and inflame the reader or listener. People often use pejorative words and euphemisms in nuclear arms debates. Have students make three lists. One list of words describing people who support the increase of nuclear weapons for national security and another list of those people who support decreasing nuclear weapons. Words that might be included on these lists are: peacenik, hawk, alarmist, realist, idealist, dove, warmonger, rightwinger, leftwinger, reactionary, anti-American, commie, fascist, utopian, liberal, conservative, or triggerhappy. Students should distinguish words which are neutral from those which are pejoratives or euphemisms. Another activity is to look at the naming of missiles. Have students look up the actual meaning of Cruise, Titan, Minuteman, Lance, Stealth, Polaris, and Trident. Class should discuss why these names have been used and the inherent value of using these names. They also should look at the terms "star wars" and nuclear freeze. Students should learn to recognize certain propaganda devices, including appeals to the emotions, distractions, pointing towards one thing to hide another, logical fallacy, misleading associations, oversimplification, selective perception, taking things out of context, euphemisms, repetition.

Students will be able to develop an awareness that values are based on such foundations as family and social traditions, religious beliefs, peer associations, and other factors, and identify one or more types of experiences that may instill values in a person. Students will research and compare growing up in the Soviet Union with growing up in the United States. They may want to role-play a scene as an adviser to the President of the United States or an adviser to the leader of the Soviet Union on nuclear arms and defense. Research into the values and history of both nations will be important.

Writing is often the best way to understand one's own values and ideas. E.M. Forster has been quoted as saying, "I don't know what I think until I see what I've said." Students might write their interpretations of this statement. Students can then identify ways in which values may change or state one or more examples of a value conflict and identify opposing values reflected in a situation of value conflict. There are several writing techniques that will help students reach these objectives. As Bill Honig, California Superintendent of Public Instruction, has said about writing, "As people who value the lessons of history, we must realize that our very survival depends primarily on our collective abilities to speak and write clearly and precisely and to be understood as we strive to understand others." Verse too has many forms that lend themselves to exploring ideas and values with words. Students can create "found" poems from words, phrases, or sentences they find in public communications like advertisements, signs, or newspaper or magazine articles. These can be arranged into lines and stanzas that form fresh commentaries on or insights into life. An example of this is the Word Cinquain, composed as follows: First line--one word that names the subject. Second line--two words that define or describe the subject.

Fourth line--words that express a personal attitude toward the subject. Fifth line--one word that sums up, restates, or supplies a synonym for the subject. Student examples of these as well as many other styles of verse may be found in the booklet RX FOR INSTANT POETS, Los Angeles Unified School District, Office of Instruction, Publication No. GC-22.

EACH INDIVIDUAL SHOULD BE RESPECTED AND ACCORDED EQUAL JUSTICE AND OPPORTUNITY. MUTUAL RESPECT SHOULD BE EMPHASIZED IN GROUP ACTIVITIES. IN THE PROCESS OF INQUIRY, FREEDOM OF THOUGHT, SPEECH, AND BELIEF SHOULD BE RESPECTED. STUDENTS SHOULD BE HELPED TO UNDERSTAND THAT DIVERSITY EXISTS AND SHOULD BE TOLERATED AND RESPECTED WITHIN THE CLASSROOM, THE COMMUNITY, THE UNITED STATES, AND THE WORLD.

BACKGROUND INFORMATION AND ACTIVITIES: Students will be able to demonstrate the ability to interact cooperatively with representatives of various cultures, and they will be able to give evidence to support the conclusion that all cultures have made contributions to civilization. Students will read the statement which President John F. Kennedy made at American University on June 10, 1963:

> Every thoughtful citizen who despairs of war and wishes to bring peace should begin by looking inward, by examining his own attitude toward the possibilities of peace, toward the Soviet Union, toward the cold war, and toward freedom and peace here and at home. First let us examine our attitude toward peace itself. Too many of us think it is impossible. Too many of us think it is unreal. But that is a dangerous, defeatist belief. It leads to the conclusion that war is inevitable, that mankind is doomed, that we are gripped by forces we cannot control. We need not accept that view. Our problems are man made. Therefore, they can be solved by man. And man can be as big as he wants. No problem of human destiny is beyond human beings. Man's reason and spirit have often solved the seemingly unsolvable, and we believe they can do it again."

Discuss this quotation with the class and ask why President Kennedy felt Americans should examine their feelings towards the Soviet Union.

Students will demonstrate the ability to make relevant contributions in large and small group discussions. Students will break up into groups to discuss what they already know about the Soviet people and their culture. They will assign and identify roles and procedures for group work. They will state clearly to the class their own opinion on a given topic. Students will challenge each others' points of view on the Soviet Union and make up a list of relevant topics to research. They will focus on the historical events that have led the Soviet Union and the United States to distrust each other as well as on the problems the Soviets face in defending large, geographically complex borders. They will review the history of war in the Soviet Union and learn about the number of deaths and the damage and other losses inflicted during World War II upon the land and its people. Students can review contemporary Soviet activities in the world as well, focusing on Afghanistan and other areas of Soviet activity beyond their borders such as Africa and the Middle East. These groups should also discuss other problems faced in nuclear issues. Students should recognize the advantages of working in a group. They will also be able to identify one or more advantages of the ability to interact cooperatively with others in large or small groups.

Other questions these groups might grapple with are these: What is "mutually assured destruction" (MAD)? Do you think it is an effective way to prevent nuclear war? Can you suggest other methods of deterrence? In what categories is the United States ahead of the USSR in terms of nuclear weapons and delivery systems? In what categories are the USSR ahead? What are some ways in which a nuclear war could start?

What is the reason for having a "strategic triad?" Students will be able to identify and analyze qualities necessary for effective participation in society. Students will discuss and define the role of possible peacemakers in our society. The teacher will give the following list of possible roles to the students with the explanations given below. Peacekeepers: Those individuals who maintain and enforce the rules we live by. Negotiators: Individuals or organizations who bring people together to hear each other and resolve their differences. Social-Activists: They are individuals or organizations that speak out for a cause. They are involved in creating political and social change. Visionaries: They are individuals or organizations that see the possibilities for a better world and communicate those visions to others in inspiring ways.

Students should understand these different categories and then make a list of peacemakers in their community and country. They should categorize these peacemakers and be sure to include government agencies. They should then examine a conflict in the school, community, or world, and decide who would be the best peacemaker for this conflict. Class discussion could evolve toward nuclear issues. Who might the peacemakers be? (This activity is adapted from Perspectives: A Teaching Guide to Concepts of Peace, a publication of Educators for Social Responsibility.) Can those who advocate a strong muclear defense also be considered peacemakers?

Students will be able to give examples of one or more ways in which rights may be altered as a result of failure to exercise civic responsibility and examples of people respecting individual minority rights. Students should trace the history of the United States civil rights movement. They should look at the issues involved and the rights guaranteed by the Constitution of the United States. They should become familiar with the federal Civil Rights Commission and the types of cases it handles and has handled. A discussion of civil disobedience should take place. Students should raise and deal with these questions: What forms did these actions take? What risks did the participants take? Is breaking the law ever justified? What are the personal consequences for the participants? Some examples and their consequences which might be researched include: the Boston Tea Party, Susan B. Anthony's illegal vote, Martin Luther King's activities, sit-ins in the South.

Students can discuss the advantages and disadvantages of these minority actions and compare them with the majority process of expressing views through the voting process and legislative activity. Students should role-play the President of the United States and other officers of the government who have to make decisions that are often unpopular. What are the problems people in leadership positions face? Might they be right? How should citizens respond if they disagree?

Students will evaluate ways available to a citizen of the United States to make maximum use of citizenship potential. Students will identify or explain the practical importance of participation in the political process in a democracy. Students will write a sample newspaper editorial about their opinion on a current nuclear issue. Students can play an important role in providing factual information to the public by writing letters to the editor concerning any topic and on either side of an issue. A letter has a better chance of being published if it is timely; is about a subject of interest; refers to a recent item in the news; is legible, double spaced, and written on only one side of the paper; and deals with only one issue.

TEACHER-DIRECTED LESSON PLAN

Subject or Course: Other Lands, Other Peoples (Grade 7AB)

Representative Objective: Students will develop an understanding based on generalizations and interdisciplinary concepts drawn from the various social sciences.

Sending and Receiving Skill(s) Emphasized:
Speaking _____ Writing __X__ Reading _____ Listening _____

Thinking Level or Cognitive Level: Knowledge _____ Comprehension _____
Application _____ Analysis _____ Synthesis _____ Evaluation __X__

1. Specific Objective and How Presented to Students:

Students will understand the concepts of conflict, escalation, and resolution. Students will explore various possibilities of conflict resolution. Teacher will present these concepts visually and orally.

2. Value to Students in Achieving the Objective:

In order to understand war, students must understand conflict, how it starts, and how it escalates. In order to understand peace, students must find ways of resolving conflict.

3. Initial Instruction:

The teacher writes the words conflict, escalation, and resolution on the board and asks students to define these terms in their own words. Definitions should come to agreement: CONFLICT--a basic disagreement; ESCALATION-enlarging or intensifying that conflict; RESOLUTION--a solution to conflict.

4. Guided Group Practice:

The teacher writes the word conflict on one side of the chalkboard and the word resolution on the other. The teacher asks students to "brainstorm," identifying conflicts they have at home, at school, or in the community, and the teacher lists them on the chalkboard under conflict. The same process is followed for the word resolution. The class discusses the resolutions they have come up with and puts them into two categories, "productive" and "unproductive."

5. Independent Practice or Activity:

The student, working alone or with a partner, chooses a new conflict that he or she is personally involved in and lists its possible resolutions. If students work alone, they will group their own list into "productive" and "unproductive" resolutions. If students are working with partners, they will group each other's lists.

6. Provision for Individual Differences:

a. Remediation or Alternative Activities:

The teacher assigns a conflict to a student and asks the student to list ways of resolving it. The teacher or a peer assists in grouping lists under "productive" and "unproductive" headings.

b. Enrichment or Supplemental Activities:

Students choose a current newspaper article that deals with city, state, national, or international conflicts. Students list resolutions, then group them into productive and unproductive categories.

7. Evaluation:

Teacher will list all productive resolutions on one side of the board (or on chart paper). Students will be asked to draw conclusions as to why they are productive. The same process will be done with the list of unproductive resolutions.

WORKSHEET FOR GRADE 7

DEFINITIONS:

CONFLICT:

ESCALATION:

RESOLUTION:

TYPE OF CONFLICT	POSSIBLE RESOLUTIONS

PRODUCTIVE RESOLUTIONS	UNPRODUCTIVE RESOLUTIONS

TEACHER-DIRECTED LESSON PLAN

Subject or Course: United States History and Geography AB (Grade 8)

Representative Objective: Students will analyze the merits of various United States Presidents and their policies regarding nuclear issues.

Sending and Receiving Skill(s) Emphasized:
Speaking _____ Writing _____ Reading __X__ Listening _____

Thinking Level or Cognitive Level: Knowledge _____ Comprehension _____
Application __X__ Analysis _____ Synthesis _____ Evaluation _____

1. Specific Objective and How Presented to Students:

Students will apply information to create a historical time line that represents American political attitudes towards nuclear issues. The teacher will present the objective visually and repeat it orally.

2. Value to Students in Achieving the Objective:

Since the beginning of the nuclear age, there has been a debate about the use of nuclear weapons and the type of nuclear policy the United States should follow.

3. Initial Instruction:

The teacher writes the following names and years on the chalkboard: Truman: 1945-1952; Eisenhower: 1953-1960; Kennedy-Johnson: 1961-1968; Nixon-Ford: 1969-1976; Carter: 1977-1980; Reagan: 1981-present. The teacher then lists the following terms on the chalkboard: atomic bomb, cold war, Cuban missile crisis, SALT talks, Comprehensive Test Ban Treaty, Strategic Defense Initiative (SDI.) The teacher matches terms with the President with whom they are associated.

4. Guided Group Practice:

The teacher provides information for the students, using the following summary about presidential policy concerning nuclear issues. Students may use lesson worksheet for recording notes.

(INFORMATION SHEET)

TRUMAN--He authorized the dropping of the atomic bomb on Hiroshima and Nagasaki in 1945. The United States had a monopoly on atomic bombs in the years 1945-1949. The hydrogen or thermonuclear bomb (immensely more powerful than the original atomic bomb) was developed. The Baruch Plan was proposed by the United States in 1946. This plan called for an international agency to oversee peaceful uses of atomic energy.

EISENHOWER--The Cold War created tremendous political tensions and military escalation between the United States and the Soviet Union. John Foster Dulles as Secretary of State announced a policy of massive retaliation by which the United States would respond with nuclear weapons to any Soviet challenge anywhere in the world. There was a call for nuclear superiority over the

Soviet Union, resulting in the creation of tactical nuclear weapons and short range missiles with nuclear warheads. In 1957 the Soviets launched Sputnik and there were reports that the Soviets had successfully tested Intercontinental Ballistic Missiles (ICBMs). The United States feared a missile gap and increased its production of ICBMs. Negotiations began in 1958 to ban nuclear testing, but there was little progress.

KENNEDY-JOHNSON--In 1960 satellite pictures showed that the United States was clearly ahead in the missile race, and the strategy of massive retaliation made little sense. Kennedy built up the nation's conventional weapons and developed what became known as a "flexible response." This led to the formation of our present triad of nuclear weapons: ICBMs, strategic bombers, and Polaris submarines. The Cuban missile crisis occurred when Soviet leader Khrushchev attempted to place intermediate range missiles in Cuba. President Kennedy responded by placing a naval blockade around Cuba, which resulted in the withdrawal of the Soviet nuclear missiles. Johnson re-established "deterrence" as the United States nuclear policy. These years also saw the first major successes in nuclear arms control: In 1963, the Limited Test Ban Treaty; in 1967, the Outer Space Treaty; in 1968, the Nonproliferation Treaty; in 1968, SALT talks were announced and then delayed. At the same time, United States technology developed Multiple Independently-Targeted Reentry Vehicles (MIRVs), a single missile with two or more warheads that can strike separate targets many miles from one another. The nuclear arms race accelerated during this period.

NIXON-FORD--In the mid-1970s the Soviets achieved their own MIRV technology. President Nixon and his security adviser, Henry Kissinger, recognized that "nuclear superiority" was no longer possible, and "parity" became official administration policy. The concept of "detente" was developed and pursued. It did not mean friendship but referred to a moderation of Soviet-United States rivalry. As Nixon led a massive build-up of arms with one hand, he also took several initiatives in arms control with the other. In 1972 two agreements were signed: The ABM Treaty which limited the number of sites each side could use from which to deploy missiles, and SALT I. Progress was also made during these years toward SALT II.

CARTER--In 1977 Carter presented the Soviets with what was called a Comprehensive Package calling for large cuts in land-based missiles. The USSR rejected this and proposed an alternative. There were several others arms initiatives proposed, the most important being a Comprehensive Test Ban (CTB). Meanwhile, opposition to the SALT II treaty was growing in the United States Senate, where ratification required a two-thirds vote of approval. Carter pushed for approval, but in 1979, United States intelligence revealed a Soviet military brigade in Cuba and later that year, the Soviet Union invaded Afghanistan. SALT II was put on hold. In these years, opponents of a strategic nuclear policy based on "mutually assured destruction" (MAD) continued to exert influence. Carter responded with Presidential Directive that set forth a policy of flexible use of nuclear weapons based on the United States being prepared to respond with "selective strikes" against certain Soviet military and industrial targets.

REAGAN--During his campaign, President Reagan suggested that arms control might be facilitated by negotiating from a position of strength.

This became known as the "margin of safety." He also proposed a huge buildup of new weapons. The SALT II treaty remained unratified, though both sides continued to observe its terms unofficially, and the CTB negotiations were suspended. European officials began to question (as did many Americans) the feasibility of "limited nuclear war." A new series of talks was conducted with NATO members about the development of Intermediate Nuclear Forces (INF). In 1983 these talks reached an end when deployments began and the Soviets walked out. Reagan altered the acronym SALT to START by substituting the word "reduction" for the word "limitation." In 1983 Reagan offered the Soviets a "build down" proposal. The Soviets rejected this and, as with the INF, talks about both issues were deadlocked. SALT I had officially expired, SALT II had not been ratified, and the President said it was "dead." Reagan subsequently called for the development and deployment of strategic defensive weapons, the so-called Strategic Defense Initiative (SDI). Technology grew faster than arms control, and the risk of nuclear war seemed to increase each day.

5. Independent Practice or Activity:

Students will construct a timeline based on major events presented in the guided group practice information sheet.

5. Provision for Individual Differences:

a. Remediation or Alternative Activities:

Each student will focus on one time period and outline a series of events that occurred in preparation for creating a more detailed time line.

b. Enrichment or Supplemental Activities:

Each student will research in detail one of the areas presented in the guided group practice.

7. Evaluation:

The teacher will grade and correct the completed timelines to see that they reflect the information presented.

CLASS NOTES

TRUMAN:

EISENHOWER:

KENNEDY-JOHNSON:

NIXON-FORD:

CARTER:

REAGAN:

TIME LINE OF EVENTS AND CONCEPTS:

TEACHER-DIRECTED LESSON PLAN

Subject or Course: World History AB (Grade 9)

Representative Objectives: Students will discuss the role of the United States in contemporary world affairs.

Sending and Receiving Skill(s) Emphasized: Speaking ____ Writing X
Reading X Listening ____ Thinking ____

Thinking Level or Cognitive Level: Knowledge ____ Comprehension ____
Application ____ Analysis ____ Synthesis ____ Evaluation X

1. Specific Objective and How Presented to Students:

   Students will study the historic decision to use the atomic bomb against Japan in World War II. They will learn about the tenacity of the Japanese army, the reaction of the American public to Pearl Harbor, and the dilemmas that faced President Truman. They will review the consequences of Hiroshima in order to evaluate the merits of the decision to use the atomic bomb.

2. Value to Students in Achieving the Objective:

   Students will understand how the decision to drop the atomic bomb was made. Students should be encouraged to discuss how and why a similar decision might or might not be made today.

3. Initial Instruction:

   The teacher and students will review the events leading up to the bombing of Hiroshima and Nagasaki. They review the details of the war in the Pacific and the climate of feeling in America towards Japan. Students will be given information as to the advice Truman received from scientists, political advisors, historians, and military advisors. They will discuss the effects upon world public opinion at the time of dropping the bomb on the people of Hiroshima and Nagasaki.

4. Guided Group Practice:

   Students will work together in groups discussing the objectives, alternatives, and consequences of the bombing. Students will review together the information and advice that Truman received. They will determine which advice suggests the use of the bomb and which suggests not using the new weapon. Issues should be debated within the groups and further research into issues should be encouraged.

5. Independent Practice or Activity:

   Students will write a report based on their group discussion and research supporting or opposing the use of atomic bombs on Hiroshima and Nagasaki.

6. Provision for Individual Differences

   a. Remediation or Alternative Activities:

      Students will work with a partner on the report. The teacher will assign a position to a student and suggest certain views from the earlier discussion that could be used to support the paper.

   b. Enrichment or Supplemental Activities:

      Students will write two papers, one on each side of the issue. Further research will be done by the student into additional aspects of the issue. Students might try to evaluate the effects of the bombing of Hiroshima on today's arms race.

7. Evaluation

   The teacher and the students will go over reports and see if they are supported by facts. An attempt should be made by the teacher to keep evaluations in a historical perspective to determine whether the dropping of the bombs on Japan was necessary in saving American lives and ending the war.

Note: Student worksheets may be developed relating to the representative lesson plan objectives in this and subsequent lessons.

TEACHER-DIRECTED LESSON PLAN

Subject or Course: Future Studies (Grade 10)

Representative Objective: Students will be helped to develop an awareness of changing technologies and their impact on future generations.

Sending and Receiving Skill(s) Emphasized: Speaking ____ Writing ____ Reading _X_ Listening ____ Thinking ____

Thinking Level or Cognitive Level: Knowledge ____ Comprehension ____ Application _____ Analysis _X_ Synthesis ____ Evaluation ____

1. Specific Objective and How Presented to Students:

   Students will become informed about the controversies surrounding nuclear waste. They will be given information about various types of nuclear waste. Students will improve notetaking skills and write an opinion paragraph evaluating the information given.

2. Value to Students in Achieving the Objective:

   Students will be able to analyze a large number of facts to form an opinion.

3. Initial Instruction:

   The teacher will put the term "nuclear waste" on the board and ask students what it means. Together they will explore where their ideas came from. The teacher will explain there are four types of nuclear waste: uranium mining, uranium milling, transuranic high level, transuranic low level. Have students do research to determine the meaning of these terms. Explain these terms

4. Guided Group Practice:

   The teacher will lecture on types of waste and the controversies surrounding them. (The teacher information on these issues is included in pages 102 - 105 of this resource guide.) The teacher reminds students they are to take notes in outline form and helps them by putting new headings on the board and clarifying questions as they arise.

5. Independent Practice or Activity:

   Students, using their lecture notes, will write an opinion paragraph supported by facts from their notes about the problem of nuclear waste.

6. Provision for Individual Differences:

   a. Remediation or Alternative Activities:

      The teacher will give students a previously prepared lecture outline from which to write a paragraph. Students will work in pairs to create a paragraph that is supported by facts.

   b. Enrichment or Supplemental Activities:

      Students will propose alternate solutions to the problems presented by nuclear waste, using the accident at Chernobyl and Three Mile Island as a starting point.

7. Evaluation:

   The teacher reads students' paragraphs and grades them; grading is based on whether the opinion is clearly stated and effectively supported by the facts presented.

TEACHER-DIRECTED LESSON PLAN

Subject or Course: United States History AB (Grade 11)

Representative Objective: Students will assess the responsibilities of the United States in the nuclear age.

Sending and Receiving Skill(s) Emphasized: Speaking ____ Writing X
Reading ____ Listening ____ Thinking ____

Thinking Level or Cognitive Level: Knowledge ____ Comprehension ____
Application ____ Analysis X Synthesis ____ Evaluation ____

1. Specific Objective and How Presented to Students:

   Students will create a "mandala" (a visual representation of a problem, using a circle and symbols to represent its positive and negative sides) that represents both sides of the armament-disarmament issue. The teacher presents it visually to show what a completed mandala might look like. (The teacher needs to model the procedure and its outcome before the presentation.)

2. Value to Students in Achieving the Objective:

   The use of mandalas stimulates the flow of ideas, encourages the use of figurative language in writing, acts as a concrete tool to aid in the understanding of abstract ideas, and serves as an aid in organizing ideas.

3. Initial Instruction:

   The teacher leads the class in a discussion of the topics of armament and disarmament. The discussion should include national security and defense posture. Both sides of the argument should be presented by the teacher. Teacher-developed fact sheets could be distributed to the class in preparation for this activity.

4. Guided Group Practice:

   The teacher begins a clustering technique with the class, using words and concepts like national security, nuclear missiles, and unilateral disarmament. Words that students suggest around the cluster should suggest visual images. The teacher should model a class mandala on the board using one concept, drawing the image on either the positive or negative side of the mandala (as the class suggests).

5. Independent Practice or Activity:

   Students will choose a concept or word, cluster their own words around it, list clustered words, create visual images for those words, and assign them to the positive or negative hemisphere of their mandala.

6. Provision for Individual Differences:

a. Remediation or Alternative Activities:

Students will work with clustering one concept and then list words associated with it. Instead of creating visual images, words will be placed in the mandala on appropriate sides.

b. Enrichment or Supplemental Activities:

Students will write an essay describing both sides of the mandala and explaining the visual images created.

7. Evaluation

Students will share and explain their mandalas to the class and answer questions as to how words evoked certain images.

WORKSHEET GRADE 11

MANDALAS

DEFINITION: A visual representation of a problem, using a circle and symbols to represent the positive and negative sides of a problem.

OBJECTIVES: To stimulate the flow of ideas.
To encourage the use of figurative language in writing.
To act as a concrete tool to promote the understanding of abstract ideas.
To act as an aid in organizing ideas.

MATERIALS NEEDED: Unlined white paper
Circle form, compass, or dish
Worksheet
Colored pencils or pens (Optional)

STEPS:

1. Put the term nuclear arms on the chalkboard.
2. Cluster words around it given by students.
3. Put the terms armaments-disarmament on the board.
4. Students brainstorm or list words under each of these that they feel are associated with the concept on their worksheet.
5. Students draw a circle on the unlined paper.
6. Students write armaments on one side and disarmament on the other side.
7. Students make a chart using the words on their list.

WORD MOST LIKE ADJECTIVE	DESCRIBE THE OPPOSITE OF EACH TERM	EXAMPLE
animal plant instrument color number geometric shape weather element mineral		Word "armament" 1. Choice of adjective from list--"animal" 2. Image created --"lion" 3. Opposite image --"lamb"

This chart should help the student organize words into pictures.

8. Place pictures illustrating the terms on each side of the mandala, so that the terms armaments and disarmament will be pictorially opposed.
9. A position paper on armaments or disarmament might follow from ideas gathered in the mandala.

TEACHER-DIRECTED LESSON PLAN

Subject or Course: United States Government (Grade 12)

Representative Objective: Students will discuss various viewpoints relating to current political issues such as the Strategic Defense Initiative (SDI), sometimes called "Star Wars."

Sending and Receiving Skills(s) Emphasized: Speaking ___ Writing ___ Reading _____ Listening X Thinking ___

Thinking Level or Cognitive Level: Knowledge ___ Comprehension ___ Application _____ Analysis ___ Synthesis ___ Evaluation X

1. Specific Objective and How Presented to Students:

Students will research, gather data, analyze information, participate in debate, and listen accurately and critically to information on the Strategic Defense Initiative (SDI).

2. Value to Students in Achieving the Objective:

Students will be able to recognize each others' biases. They will be made aware of words and phrases that are emotionally biased. They will achieve clarification of the Strategic Defense Initiative (SDI) so they may form their own opinions and participate in our Democratic society as informed citizens.

3. Initial Instruction:

The teacher leads a discussion on the basic concept of the SDI and what some of the controversial issues are. The class is divided into two groups, one supporting the initiative and one opposing it. Teacher developed fact sheets are passed out to the class, and instructions are given on how the debate will proceed. Students are told that each group will choose a panel of three students to represent the group's position in the debate. Following the debate, panelists will answer questions from the floor. Following the closing statements, a secret ballot vote will be taken to see if the debate changed anyone's mind.

4. Guided Group Practice:

The groups split up into subgroups to work with the fact sheets to create persuasive arguments for debate. A record sheet should be kept by the chairperson of each group to determine individual participation. The teacher should monitor group activities.

5. Independent Practice or Activity:

Students actively listen to the debate, taking notes on points being made by both sides and writing down points that they have questions about. Students should be given adequate time to formulate questions.

6. Provisions for Individual Differences:

   a. Remediation or Alternative Activities:

      Students will receive teacher and peer assistance to work with a partner on researching a subtopic.

   b. Enrichment or Supplemental Activities:

      Students may continue with further research into the topic, using newspaper editorials, monographs, and magazine articles. (See the bibliography in the Teacher Resource List.)

7. Evaluation:

   The teacher evaluates the merits of the debate, then asks students to evaluate the debate by focusing on whether: it proceeded in an orderly fashion; the facts were accurately presented; the discussion was animated; all panelists participated; class questions were clear and appropriate; and the discussion was courteous. The teacher will also use group record sheets to evaluate grades.

TEACHER-DIRECTED LESSON PLAN

Subject: The Nuclear Issue--A Nuclear Future (a summary activity)

Representative Objective:

Students will analyze the various controversial issues they have been studying, will evaluate the information they have accumulated, and will write a composition expressing their opinions of the issues and about the future they envision regarding the issues.

Sending and Receiving Skill(s) Emphasized
Speaking ___ Writing _X_ Reading _____ Listening ___ Thinking ___

Thinking Level or Cognitive Level: Knowledge _X_ Comprehension _X_ Application _X_ Synthesis _X_ Evaluation _X_

1. Specific Objectives:

   Students will express their opinions in an essay, in which they will (1) use information they received during previous classes and (2) forecast what will happen.

2. Value to Students in Achieving the Objective:

   Students will learn critical thinking and gain experience in writing a composition.

3. Initial Instruction/Teacher Presentation:

   The teacher reviews the issues that have been covered, touching on various pros and cons. The teacher explains the type of essay that is to be written. An opinion essay should state the proposition fairly and clearly and the point of view should be supported with evidence. If facts are credited, the source should be given. The essay is concluded by summarizing the main arguments and indicating a future course of action. As the subject of nuclear issues is very broad, some students may find it necessary to limit their composition to the future of just one of the issues.

4. Guided Group Practice:

   Students may wish to discuss or exchange their key points before beginning to write. The teacher should lead brief class discussions or monitor the information-sharing period.

5. Independent Practice or Activity:

   Students use accumulated notes and knowledge to write their composition.

6. Provision for Individual Differences in Ways of Learning:

   a. Remediation or Alternative Activities:

      The teacher gives individual attention and assistance.

   b. Enrichment or Supplemental Activities:

      The student presents an essay to the class.

7. Evaluation: The teacher assigns a grade to the composition and evaluates the ability of students to think critically by using the following criteria:

   (1) Are data and information organized meaningfully?
   (2) Are cause and effect relationships identified?
   (3) Are facts and opinions distinguished?
   (4) Does the student interpret information from a broad source of data and make a general statement which includes the main idea?
   (5) Are sources of ideas, facts, and opinions evaluated appropriately?

APPENDIX

NUCLEAR GLOSSARY
SOME KEY TERMS USEFUL IN STUDYING ABOUT NUCLEAR ISSUES

Aggregate: A term used in SALT and discussions of the strategic arms balance. It refers to the total number of ICBM launchers, SLBM launchers, and intercontinental bombers on a given side.

Air-Launched Cruise missile (ALCM): A cruise missile designed to be launched from an aircraft.

Air-to-Surface Ballistic Missile (ASBM): A ballistic missile launched from an airplane against a target on the earth's surface.

Antiballistic Missile (ABM) System: The interceptor missiles, radars, and associated equipment of a system designed to identify and destroy enemy ballistic missiles.

Backfire: The NATO designation for a type of modern Soviet supersonic bomber. It is currently being deployed to operational units for use in a theater or naval strike role as a replacement for older Soviet medium bombers. Backfire has characteristics which fall between the existing intercontinental or medium bombers used for naval missions and other peripheral attack missions.

Ballistic Missiles: A missile, consisting of a rocket booster and a payload (one or more warheads), which follows an archlike flight path to its target. The rocket booster operates for about the first 10 to 15 percent of the time the missile is in flight. After the desired velocity and flight direction have been achieved, the rocket booster shuts off and usually separates from the payload. Thereafter, the payload continues on its arched flight path and is acted upon predominantly by gravity--which is the meaning of the term ballistic.

Booster: That portion of a missile which contains the rocket engines and the fuel. In a single-warhead missile, the guidance system is also part of the booster.

Broken Arrow: The Defense Department code name for an accident involving nuclear weapons.

Command and Control: The facilities, equipment, and personnel that acquire, process, and disseminate information needed by decision makers in directing and controlling military operations.

Cruise Missile: A pilotless jet propelled missile--in technical terms, a guided missile that uses aerodynamic lift to offset gravity and uses propulsion to counteract drag. A cruise missile's flight path remains within the earth's atmosphere, and its engine operates throughout its flight.

Deterrence: A strategy or situation in which leaders of adversary nations are convinced that aggression is an unattractive alternative because the potential losses (and risks of escalation) offset anticipated gains.

Development: The first state in the process of producing a weapons system. Subsequent stages include testing (or flight-testing), production, and deployment.

Encryption: Encoding communications for the purpose of concealing information. In SALT, this term was applied to a practice whereby a side alters the manner in which it transmits telemetry from a weapon being tested, rendering the information undecipherable.

Fireball: The very hot (10,000,000°F) central region of a nuclear explosion.

First Strike: Literally, the first offensive move of a war. The term is frequently used to refer to a major nuclear attack on enemy nuclear forces such as ICBM silos or bomber bases. Also called pre-emptive strike.

Flight Test: The launch and flight of a missile conducted for any nonhostile purpose, including the development of the missile, the demonstration of its capabilities, and the training of operating crews.

Fractionation: The division of the payload of a missile into several warheads. The use of MIRV payloads is an example of fractionation.

Ground-Launched Cruise Missile (GLCM): A cruise missile launched from permanent or mobile ground installations.

Ground Zero: The point on the earth's surface (i.e., the geographical coordinates) at which a nuclear weapon is detonated. In an airburst, it is the point on the earth's surface directly below the point of detonation.

Guidance System: That part of the missile which contains the computer and other devices which guide a ballistic missile to the proper velocity and direction for booster (or postboost vehicle) thrust cutoff. In the case of cruise missiles, the guidance system takes the missile all the way to its target.

Hard Target: A target protected against the blast and associated effects of nuclear weapons through structural hardening. An underground concrete-reinforced ICBM silo is an example of a hard target.

Heavy Bomber: A term used in the SALT negotiations to distinguish the principal intercontinental bombers on the two sides (the B-52 and B-1 for the United States and the Bear and Bison for the Soviet Union) from other bombers.

Heavy Missile: A term used in the SALT negotiations, which divided ballistic missiles into two categories--light and heavy--according to their size and payload.

Implosion: The inverse of an explosion. In an explosion, material travels away from a central point; in an implosion, material travels toward a central point. Initially, nuclear weapons employ an implosion to concentrate and hold a critical mass of fissionable material.

Infrared Detectors: Devices that operate at infrared wavelengths and detect objects because of their temperatures. Objects of higher temperatures are said to have "larger" infrared signatures.

Intercontinental Ballistic Missile (ICBM): A ballistic missile capable of reaching targets at intercontinental distances--normally defined as a range in excess of 5,500 kilometers.

Intermediate Range Ballistic Missile (IRBM): A ballistic missile with a range of between 2,200 and 5,500 kilometers.

Kiloton: A thousand tons of TNT--a measure of the explosive power of nuclear weapons. One thousand kilotons equals one megaton.

Laser: A device which produces an intense beam of light entirely of the same wavelength.

Launch on Warning: The launching of ICBMs on the basis of information supplied by satellite and other warning systems which indicate that an enemy missile attack is coming. Also known as Launch Under Attack.

Laydown: The process of matching nuclear weapons against targets on the other side.

Limited Nuclear War: A nuclear war that involves the use of a limited number (e.g., a few dozen or a few hundred) of nuclear weapons.

Liquid-Fueled Missile: A missile in which the fuel is liquid. The fuel usually consists of two chemicals which react when brought together in a high-temperature combustion chamber.

Megaton: A million tons of TNT--a measure of the explosive power of nuclear weapons.

Military-Industrial Complex: The term coined by President Eisenhower to describe the combined interests of the military and the defense industry in obtaining new weapons systems.

Multiple Independently Targeted Reentry Vehicle (MIRV): Multiple reentry vehicles carried by a ballistic missile, each of which can be directed to a separate target. A MIRV missile employs a postboost vehicle (PBV) or other warhead-dispensing mechanisms.

Multiple Reentry Vehicle (MRV): The reentry vehicle of a ballistic missile equipped with multiple warheads, where the missile does not have the capability of independently directing the reentry vehicles--as distinct from a missile equipped for MIRVs.

Mutual Assured Destruction (MAD): The strategy of preventing nuclear war whereby each side maintains the capability of destroying the other.

National Technical Means of Verification (NTM): A SALT term which refers to the assets that a nation uses for verifying compliance with the provisions of an arms control agreement. NTM includes photographic reconnaissance satellites and aircraft-based systems (such as radars), as well as sea-and ground-based systems (such as radars and antennas for collecting telemetry).

Nonproliferation Treaty (NPT): A treaty first signed in 1968 in which the signatory nations that did not have nuclear weapons agreed to forgo them while the signatory nations that had nuclear weapons agreed to work to prevent proliferation and assist in the development of peaceful uses of nuclear energy.

Nuclear Weapon: A nuclear bomb or warhead.

Nuclear Weapon Delivery System: Any means (missile, bomber, etc.) by which a nuclear weapon is delivered to a target.

Particle Beam Weapon: A device for producing an intense beam of subatomic particles, usually electrons.

Payload: The weapons and penetration aids carried by nuclear weapons delivery vehicles (bomber or missile).

Postboost Vehicle (PBV): Often referred to as a bus, the postboost vehicle (PBV) is that part of a MIRVed missile which carries the warheads, a guidance package, fuel, and small rockets for altering the ballistic flight path so that the warheads can be directed sequentially toward different targets.

Preemptive Strike: See First Strike.

Production: Series manufacturing of a particular strategic nuclear delivery system following its development and testing.

Proliferation: The process by which one nation after another comes into possession of nuclear weapons.

Radar: A device which transmits and receives electromagnetic signals of radio wavelengths as a means of detecting missiles or aircraft. Large objects that reflect radio waves efficiently are said to have a large radar cross-section.

Reentry Vehicle (RV): That portion of a ballistic missile which carries the nuclear warhead. It is called a reentry vehicle because it reenters the earth's atmosphere in the terminal portion of the missile trajectory.

Retaliatory Strike: An attack on an enemy that has initiated hostilities with a first strike. Sometimes called a second strike.

Short-Range Attack Missile (SRAM): A missile with a range of about 100 kilometers and a warhead yield of 200 kilotons, which can be carried on a bomber.

Shroud: The metal shield that covers a MIRV payload and protects the warheads during the boost phase of the flight.

Silo Launcher: A "hard" (fixed) underground ballistic missile launcher, usually of steel and concrete, housing an intercontinental ballistic missile and the equipment for launching it.

Soft Target: A target not protected against blast or the associated effects of nuclear weapons.

Solid-Fueled Missile: A missile in which the fuel is solid. The fuel usually consists of two chemicals which burn under control once they are ignited.

SSBN: The United States Navy term for a nuclear-powered ballistic missile submarine such as the new Trident submarines.

Strategic Arms Limitation Talks (SALT): A series of negotiations between the United States and the Soviet Union which began in November of 1969. The negotiations seek to limit and reduce both offensive and defensive strategic arms. The first round of negotiations, known as SALT I, concluded in May 1972, resulting in two agreements: the ABM Treaty and an Interim Agreement on offensive arms. SALT II, signed in June of 1979 but not ratified by the United States Senate, is a comprehensive treaty limiting strategic offensive weapons. This is the agreement that President Reagan wishes to scrap.

Strategic Nuclear Weapons: A term which generally refers to long-range nuclear weapons delivery vehicles, such as ICBMs, SLBMs, and intercontinental bombers.

Submarine-Launched Ballistic Missile (SLBM): A ballistic missile carried in and launched from a submarine.

Submarine-Launched Cruise Missile (SLCM): A cruise missile launched from a submarine.

Tactical Nuclear Weapons: A term which generally refers to nuclear weapons designed to be used on the battlefield or in other limited situations of nuclear war. For example, United States nuclear weapons in Europe and on aircraft carriers are called tactical nuclear weapons.

Telemetry: The data transmitted by radio to the personnel conducting a missile test and which is used to monitor the functions and performance of the missile during the course of the test.

Thermal Radiation: The heat radiation given off by a nuclear explosion.

Thermonuclear Weapons: Nuclear weapons in which fusion reactions take place. The term reflects the requirement for achieving very high temperatures--several million degrees--before the fusion reaction takes place.

Throw-Weight: Ballistic missile throw-weight is the useful weight that is placed on a trajectory toward the target by the boost stages of the missile. For a single-warhead missile, it consists of the weight of the warhead. For a MIRVed missile, it consists of the weight of the warheads plus the weight of the postboost vehicle.

Triad: The offensive combination of ICBMs, SLBMs, and intercontinental bombers, each of which presents different defensive problems to an enemy.

Verification: The process of determining, to the extent necessary to adequately safeguard national security, that the other side is complying with an arms-control agreement.

This process of judging adequacy takes into account the monitoring capabilities of present and future intelligence-collecting systems and analysis techniques as well as the ability of the other side to evade detection if it should attempt to do so.

Warhead: That part of a missile or other munition which contains the nuclear or other explosive system.

Window of Vulnerability Yields: The energy released in a nuclear explosion. The energy released in the detonation of a nuclear weapon is generally measured in terms of the kilotons (KT) or megatons (MT) of TNT required to produce the same energy release.

TEACHER RESOURCE LIST

This section contains print and media resources, curriculum resources, organizations and public agencies, and selected audiovisual materials which are available through the Los Angeles Unified School District.

TEACHER RESOURCE LIST FOR NUCLEAR AGE ISSUES

This teacher resource list is divided into three parts. Part I, "Print and Media Resources for Teaching Nuclear Age Issues," provides a resource list covering reading materials and audiovisual materials. Part II, "Curriculum Materials for Teachers," provides the teacher with additional curriculum related resources. Part III, "Organizations and Public Agencies," will assist in identifying public and private organizations and agencies that can act as sources of information about nuclear age issues appropriate for classroom use. Part IV, "A Selected List of Los Angeles Unified School District Audiovisual Materials Available for Teacher Use," provides a current list of selected audiovisual materials for teacher use.

The following are excellent starting points in seeking assistance:

1. Educational Resources Information Center (ERIC)
   ERIC Indexes and Microfiche Collections are available at local college and university libraries.

2. Current Index to Journals in Education (CIJE) and Resources in Education (RIE) These are also available in local college and university libraries.

3. Los Angeles Center for Educational Resource Services (LANCERS)
   Los Angeles County Office of Education
   9400 East Imperial Highway
   Downey, CA 90242
   (213) 922-6397

4. How to Locate Useful Government Publications (How to Do it Series)
   National Council for the Social Studies
   3501 Newark Street, N.W.
   Washington, DC 20016

5. National Science Teachers Association
   1742 Connecticut Avenue N.W.
   Washington, DC 20009

6. Center for Public Education In International Affairs (CPE)
   School of Internationl Relations
   VKC 328
   University of Southern California
   Los Angeles, CA 90089-0043

In addition, teachers may wish to contact the various groups mentioned in this resource guide to determine the availability of speakers for classroom presentations. Approval must be secured from the principal before inviting any individual to address the class. (See Part III.)

PART I: PRINT AND MEDIA RESOURCES FOR TEACHING NUCLEAR AGE ISSUES

Books for students K-12

Ardley, Neil. Atoms and Energy. Warwick Press, 1982.
A good illustrated introduction to nuclear energy. Each page is replete with colorful drawings, diagrams, and photographs, making the most complex concepts accessible. Radiation, radiocarbon dating, nuclear reactors, fission, and fusion are presented. Nuclear pollution and wastes are discussed nonjudgmentally. Useful for classroom current events discussion.

Arkin, Alan. The Lemming Condition. Bantam Skylark Books, 1977. Grades 4-6.
In this book a lemming learns the goal of his species' suicidal run to the ocean. Excellent for discussion of many pre-adolescent issues.

Armstrong, Louise. How to Turn War Into Peace. Harcourt Brace Jovanovich, 1979.
A young child's guide to resolving conflict. A little girl and her friend resolve their argument without loss of either one's dignity or sense of selfworth.

Asimov, Isaac. How Did We Find Out About Atoms? Walker and Co., 1976.
This presentation leads the reader from the intuitive ideas of the Greeks through the stages of scientific evidence of the experiments which made possible the determination of the sizes of atoms and finally to the actual "seeing" of atoms on a field-emission microscope screen. Brief sketches are provided of the contributions of philosophers and scientists from Leucippus to Einstein and Mueller. Asimov completes the study by providing a transition to the composite structure of atoms. The contribution of each scientist is concisely presented without oversimplification and is related to previous and future developments. Top-quality Asimov--informative and never patronizing.

__________. How Did We Find Out About Nuclear Power? Walker and Co., 1976.
A chronological presentation of the important discoveries and inventions in the field of physics and how each contributed to our present knowledge of nuclear power. Present-day and future uses of nuclear power are treated.

Baker, Betty. The Pig War. Harper and Row, 1969. Grades K-3.
An "I Can Read History Book" about the rivalry between two groups, each of whom thinks an island belongs to them.

Blume, Judy. Tiger Eyes. Bradbury Press, 1981. Grades 4-6.
The story of a 15-year-old girl, whose father has been shot and killed in a store robbery, who moves to Los Alamos to live with relatives who work with nuclear arms. A lot of the usual Blume teenage romanticism.

Blumenfeld, Yorick. Jenny. Little, Brown and Co., 1982.
Fiction in a diary form: Jenny presents the moving story of a young girl in England who is confined to a fallout shelter during a nuclear war. The text of the book is printed in script, which adds a heightened touch of reality to the story.

Bograd, Larry. Los Alamos Light. Farrar, 1983. Grades 7-9.
Maggie unwillingly accompanies her scientist father to Los Alamos in 1943 and finds herself completely cut off from him and his top-secret research which will culminate in the production of the atomic bomb.

Briggs, Raymond. When the Wind Blows. Schocken. Grades 6-9.
This cartoon book written for adults uses expressive pictures and black humor to tell the moving story of an elderly British couple as they conscientiously prepare for a nuclear holocaust according to government instructions and ultimately succumb to radiation sickness.

Bruckner, Karl. The Day of the Bomb. E. M. Hale, 1962. Grades 3-6.
An account of the bombing of Hiroshima through the eyes and words of a fictionalized Japanese family. Sadako, the daughter of the family, dying of radiation poisoning, tries to fold a thousand paper birds as a good-luck charm to ward off death. (Her story has been told in several books. See Coerr, Eleanor, below.)

Burke, Kenneth. If All the Thermo-Nuclear Warheads. Cromwell, 1977. Grades 5-12.
Discusses quarks, quasars, and other quirks, in quizzical poems for the Supersonic Age. This parody of "If All the Seas Were One" describes what might happen if thermo-nuclear warheads were dropped, in the name of "progress."

Carey, Helen H. Producing Energy. Watts, 1984.

Carr, Albert. A Matter of Life and Death. Viking, 1966. Grades 6-12.
A discussion of patriotism and the necessity for the careful consideration of alternatives to war.

Clark, Leonard. Drums and Trumpets. Dufour Editions, 1962. Grades 5-12.
Poetry for young people dealing with war--some of its glories, some of its despairs.

Coerr, Eleanor. Sadako and the Thousand Paper Cranes. Putnam, 1977. Grades 3-6.
Sadako, a toddler when the bomb was dropped on her Japanese city, dies of leukemia 10 years later before she can finish folding the 1,000 paper cranes that according to Japanese legend will make her well again. A contemporary classic feelingly written with poignant restraint.

Colman, Hila. Not for Love. Morrow. 1983. Grades 8-9.
Jill must make up her own mind about the nuclear power issue when the boy she has a crush on abruptly switches sides.

Croal, Stephen. The Anti-Nuclear Handbook. Pantheon Books, 1979.
First published in 1978 in England with the title: Nuclear Power for Beginners. In an adult comic book format, the authors describe nuclear applications to weaponry, subsequent extension to the generation of electricity, and the ramifications of the technology. The book is far from comprehensive, but it is provocative enough to inspire more serious reading.

Davies, Andrew. Conrad's War. Crown, 1980. Grades 5-7.
Young boy's fantasies about war, killing, and guns.

Dukert, Joseph M. Nuclear Ships of the World. Coward, McCann and Geoghegan, 1973.
The author answers several important questions about nuclear ships, simply but authoritatively, by explaining how they work, why nuclear propulsion is advantageous, what is done to ensure their safety, and what life is like aboard a ballistic missile submarine. Silhouettes or photographs and basic data about the nuclear ships of several countries are included.

Emberly, Barbara. Drummer Hoff. Prentice-Hall, Inc., 1967. Grades K-3.
A simple attractive verse with colorful pictures about the building of a cannon.

Ferrara, Grace M. and Ira Freedman. How Did We Find Out About Nuclear Power and the Safety Controversy? Checkmark Books, 1978.
This book deals with the controversy over health and accident hazards involved in the use of nuclear power. The authors discuss both the domestic and the international aspects of the question. Pertinent events and statistics of the past 10 years are included.

Fitzhugh, Louise, and Sandra Scoppetone. Bang, Bang, You're Dead. Harper, 1969.
An anti-war lesson in words and pictures tracing the increasingly violent actions of some children who began a game of playing at war.

Halancy, Dan. Nuclear Energy. Watts, 1978. Grades 6-9.
General coverage includes a brief look at atomic structure and at some of the early atomic pioneers. Descriptions of the mining and milling of uranium precede the book's most practical feature, a description of how a nuclear power plant operates.

Hersey, John. Hiroshima. Bantam Books, 1968. Grades 7-12.
A classic story. Hiroshima is a moving historical account of the destruction and carnage wrought by the atomic bombing of the Japanese city of Hiroshima. Hersey has woven the stories of several people together in order to show exactly what it was like in Hiroshima before, during, and after the bombing.

Howe, Russell Warren. Weapon: The International Game of Arms, Money and Diplomacy. Doubleday, 1980.
The author details the international game of defense. He describes the latest systems of aircraft, missiles, tanks, etc.. discusses who manufactures and buys them; and evaluates the effectiveness of various arsenals. Country by country, he shows how power is being balanced today and explains why, with all the sophisticated weapons on display, it is not likely that the advanced betterarmed countries will use them. This is not a book in the usual sense, but a kind of encyclopedia, a compilation of virtually everything everybody has done about, thought about, and said about the world's tools of destruction for the last 35 years.

Hyde, Margaret O. Everyone's Trash Problem: Nuclear Wastes. McGraw, 1979.
Subjects include: (1) atomic power plants and their environmental effects (2) radioactivity and (3) waste products. This book discusses nuclear waste and its potential to cause irreversible damage to the environment. Also discussed are: slow breeders, fast breeders, water reactors, radiation, recycling, and the future of nuclear power plants. Includes a glossary of atomic language. Sources of further information and suggestions for further reading are included.

Johnson, Annabel. Finders, Keepers. Four Winds Press, 1981. Grades 6-9.
Without warning, there is an explosion at a nuclear plant. Burr and his sister (who have great difficulty in getting along with each other) nevertheless set out to escape the radioactive cloud. Their experiences with crowds that jam the highway, the actions of the frenzied mob, and their meeting with friends who turn out to be helpful make this a thought-provoking story on current and timely problems such as the Chernobyl accident.

Kiefer, Irene. Nuclear Energy at the Crossroads. McMelland and Stewart, 1982. This thought-provoking and informative report presents the basic principles and problems of nuclear energy and the problem of nuclear waste. Compares this power resource to other forms of energy and describes societal and political attitudes towards the use of this form of energy.

Linnebery, William P. Wilderness Survival. Wilson, 1973. The articles compiled in this volume focus on one or more aspects of arms controls--particularly the SALT II agreement--but throughout there is an underlying tone of despair that any treaty can significantly reduce the steady buildup of the current arms race. Includes an assessment of the threat posed by nuclear weapons and an account of the struggle, under way since 1945, to bring them under control. The book also includes a description of the international effort in the 1920s and 1930s to limit naval power and the consequences of that effort. Part two is given over to articles by writers who favor the SALT II accord, while part three presents authors who argue the case against the accord. The final section of this compilation looks beyond the debate on SALT II, to both the most basic issues of arms control, which remain unresolved, and the prospects for the future.

Lobel, Anita. Potatoes, Potatoes. Bowmar/Noble Publishers, Inc., 1967. Grades K-3. A story about a mother's attempt to shield her two sons from war, their eventual involvement in it, and the final resolution of the war.

Maruki, Toshi. Hiroshima no Pika. Lothrop, Lee and Shepard, 1982. Grades 4-6. A personal, pictorial account of a little girl and her parents who were eating breakfast at the time the atomic bomb was dropped on Hiroshima in 1945. The story follows what happens to them for the next few days and describes later effects of the bombing. Brilliant full page paintings express the mood and expand the text as they graphically detail the event that led to the end of war with Japan. Leads to an understanding of the devastation of nuclear warfare but does not deal with the bombing in the context of World War II.

Miklowitz, Gloria. After the Bomb. Scholastic Press, 1985. Grades 7-9. A novel that deals with what happens after the bomb. A teenager, Philip Singer, finds himself in the unlikely role of leader of his family. If the family is to live through the next few days, Philip must take charge.

Miles, Betty. Save the Earth! Knopf, 1974. Grades K-3. An ecology handbook for kids. Discusses why the earth should be kept healthy. The handbook contains lots of project ideas.

Moeri, Louise. Downwind. Dutton, 1984. Grades 5-7. Ephraim and his family flee their home to escape the threat from radiation leakage from a damaged nuclear power plant in a searing novel laced with dramatic irony. Has new meaning in light of the Chernobyl accident.

Murray, Raymond L. Understanding Radioactive Waste. Battelle Press, 198?. Grades 9-12. Presents information on radioactive wastes in a simplified and clear manner. The reference also provides additional basic information on nuclear science topics including energy and the environment, nuclear energy, radioactivity and biological effects of radiation.

Nagai, Takashi, ed. Living Beneath the Atomic Cloud: Testimony of the Children of Nagasaki. Tokyo San-Yu-Sha. Grades 4-6. A good primary source.

Nagasaki Prefecture Hibakusha Teachers Association. In the Sky Over Nagasaki. Translated by Cheryl Green. Lammers, 1983. Grades 1-3.
A peace reader for children. Story of what happened to the children of Nagasaki.

New Junior Encyclopedia of Science. Volume 10. Orbis Publishing Limited. 1974.
A standard reference work for students.

Osada, Arata. Children of Hiroshima. Gunn and Hain, 1982. Grades 6-9.
Collected in the early 1950s, these essays documenting children's remembrances of the Hiroshima blast range from the impressionistic to the relentlessly detailed; wrenching, invaluable primary-source material.

Pringle, Lawrence. Nuclear Power. Macmillan Publishing Co., 1979. Grades 6-12.
This organized, up-to-date book discusses safety, costs, politics, and alternatives to nuclear energy. Views and arguments are presented by both proponents and opponents. An excellent introduction to encourage young readers to think objectively and to involve themselves in further research. An index, a glossary, and a bibliography are included.

Rinji, Kjell. The Stranger. Random House, Inc., 1968. Grades K-3.
A fable that tells the story of people who in fear bring out their cannon against a giant stranger. When they finally get to know him, however, he is invited to stay in their country.

Rosenberg, Howard L. Atomic Soldiers: American Victims of Nuclear Experiments.
Beacon Press, 1980.
This is an account of the effects of nuclear test blasts, held between 1948 and 1963, on nearly 300,000 American soldiers who were exposed to low-level radiation during those tests. Veterans of these tests today appear to suffer more than their share of leukemia and other cancers, but ignorance of the causes of cancer make it difficult for them to prove that radiation from the bomb tests was to blame. Remains a controversial topic.

Rubinstein, Robert E. When Sirens Scream. Dodd, Mead, 1981.
Ned, a high school student lives in a town dominated by a nuclear plant whose periodic alerts produce only slight tension in the town. Ned is particularly concerned because his father was the state representative who fought for the plant. When a really serious leak occurs, his own father begins to rethink his stand. But at the town meeting that closes the book, the jobs that the plant provides outweigh any thought of disaster.

Sendak, Maurice. Where the Wild Things Are. Harper and Row, 1963. Grades 4-6.
The story of a misbehaving boy who is sent to bed where he imagines a place inhabited by bizarre, scary creatures. A classic.

Dr. Seuss. Butter Battle Book. Random House, 1984. Grades 1-3.
This satire on the arms race features Zooks and Yooks whose quarrel about butter escalates.

Shute, Nevil. On the Beach. Ballantine, 1979. Grades 10-12.
This novel is about the last generation of people on earth as they wait for the effects of radioactive fallout from an accidental nuclear war to descend upon them. The book was made into a classic movie.

Silverstein, Shel. Where the Sidewalk Ends. Harper and Row 1974. Grades 4-6. A book filled with delightful poems and drawings for children.

Steele, William O. The War Party. Harcourt, Brace, Jovanovich, 1978. Grades 4-6. A "Let Me Read" book. Participating in his ancestral ritual of war preparation, a young native American looks forward to his first battle. When he actually participates in an attack on a neighboring village, he is horrified by the brutality that surrounds him.

Stein, R. Conrad. Hiroshima. Children's Press, 1982. Grades 4-6. This segment in the BBC-TV "World at War" series offers a straightforward, dispassionate look at the bombing of Hiroshima and Nagasaki.

Sullivan, George. Inside Nuclear Submarines. Dodd, 1982. Grades 6-12. The various types of nuclear submarines, their roles, and the lives of their crew members are among the topics considered in this book. Excellent text is complemented by numerous black-and-white photographs. Grouped by operational class, all submarines of the United States Navy are listed in an appendix to this book.

Taylor, L.B. The Nuclear Arms Race. Watts, 1982. Grades 7-9. A thoroughly researched, well-balanced treatment looks at the history and controversy surrounding the buildup of nuclear arsenals.

________________. Space: Battleground of the Future? Watts, 1978. Grades 9-12. Includes the subjects of astronautics, disarmament, space warfare, and war.

The Illustrated Encyclopedia of Science and Technology: How It Works, Volume 10. Marshall Cavendish, 1978. Appropriate information for student research on the topics:

"Nuclear Magnetic Resonance," pages 1601-1602.
"Nuclear Reactor," pages 1603-1607.
"Nucleus," page 1608.

The Raintree Illustrated Science Encyclopedia. Volume 13. Raintree Publishers Limited, 1979. Appropriate information for student research on the topics:

"Nuclear Physics," pages 1163-1164.
"Nuclear Power," pages 1164-1175.

Udry, Janice May. Let's Be Enemies. Illustrated by Maurice Sendak. Scholastic Books (originally Harper & Row hardbacks), 1961. About two little boys. The theme: power struggle. A delightful, humorous treatment depicting real child problems which reflect similar adult ones.

Weiss, Ann E. The Nuclear Question. Harcourt Brace Jovanovich, 1981. Grades 7-12. Radiation hazards, waste disposal, and the Three Mile Island incident are among the issues discussed in an account that takes a hard look at the mis-information circulating on both sides of the nuclear question.

Zolotow, Charlotte. The Hating Book. Harper and Row, 1969.
The childhood problem of hating one's friend and being devastated by this feeling is presented in this book.

________. The Quarreling Book. Harper and Row, 1963.
A story about people taking out their frustrations by picking on the next smaller person.

Adult Reference Books About Nuclear Age Issues

Allanheld, Osum. The Effects of Nuclear War. U. S. Congress, Office of Technology Assessment, 1980.
This book examines the social, economic, and physical effects of a nuclear war, including its short- and long-term repercussions.

Barnet, Richard. The Giants: Russia and America. Institute for Policy Studies, 1982.
An authoritative, comprehensive account of the latest stage of the complex United States-Soviet Union relationship, how it came about, what has changed, and where it is headed.

Beckmann, Peter. The Health Hazards of Not Going Nuclear. The Golen Press, 1976.
Attempts to redress the balance for nuclear energy and away from those who are against nuclear energy. An interesting discussion of the health hazards associated with non-nuclear energy sources.

Bender, David L. Four to Six Viewpoints on Each of Four Questions on the Arms Race. Greenhaven Press, 1981.

Bukovsky, Vladimir. The Peace Movement and the Soviet Union. Orwell Press, 1982.
A Soviet dissident who spent 12 years in prison argues that the West should be wary of any Russian disarmament proposals and peace initiatives.

Burdick, Eugene, and Harvey Wheeler. Fail-Safe. Dell Publishing, 1963.
This novel is about a computer failure that sends a group of United States atomic bombers toward Russia with no way to recall them.

Caldicott, Helen. Nuclear Madness: What You Can Do! Bantam Books, 1980.
One of the best introductions available on the danger of nuclear weapons. Lucidly written, by the founder of Physicians for Social Responsibility, Nuclear Madness not only presents the hard facts, but also leaves the reader with an agenda for action. A strong anti-nuclear polemic.

Choices: A Unit on Conflict and Nuclear War. A project of the Union of Concerned Scientists in cooperation with the Massachusetts Teachers Association and the National Education Association. Washington, DC, 1984.

Collins, Larry, and Dominique LaPierre. The Fifth Horseman. Avon, 1981.
In this novel the United States President receives a nuclear ultimatum--if the United States does not surrender to certain demands, terrorists will blow up New York City with a nuclear bomb.

Cox, Caroline, and Rober Scruton. Peace Studies: A Critical Survey. London: Alliance Publishers Ltd., for the Institute for European Defense and Strategic Studies, 1984.

The Effects of Nuclear War. United States Congress, Office of Technology Assessment, 1979.
This booklet presents an account of the effects of various nuclear war scenarios involving the United States and the Soviet Union. Included in its discussion are the issues of civil defense and the long-term effects of nuclear war.

Fowler, John M. Energy and the Environment. McGraw-Hill, 1975.

Global Pages, Immaculate Heart College Center, 10951 W. Pico Blvd. Suite 2021, Los Angeles, CA 90064.

Heffernan, Patrick, Amory B. Lovins, and L. Hunter Lovins. The First Nuclear World War. William Morrow, Inc., 1983.
Subtitled "A Strategy for Preventing Nuclear War and the Spread of Nuclear Weapons," this book presents a highly readable and cogent examination of the inextricable link between nuclear power and nuclear weapons as well as the danger of regional nuclear wars and terrorism. It also presents a feasible strategy for the reduction of nuclear weapons.

Ibuse, Masuji. Black Rain. Kodansaka International Ltd., 1982.
Written by an elderly Japanese writer, this is a highly acclaimed novel about the impact that the atomic bombing had on Hiroshima and its people.

Information About Energy America Can Count on Today. A series of booklets published by the U.S. Committee for Energy Awareness, Washington, DC.

Kennedy, Senator Edward M., and Senator Mark O. Hatfield. Freeze! How You Can Help Prevent Nuclear War. Bantam Books, 1968.
An overview of the nuclear arms race and its ramifications as well as a detailed explanation of and rationale for the bilateral nuclear weapons freeze. It has an excellent question/answer section which could be used in the classroom.

Len, Sidney. The Bomb. Lodestar Book/E.P. Dutton, 1982.
Excellent for young adults, this primer presents a lucid, succinct, and hard-hitting history of American nuclear weapons policy. A proponent of nuclear disarmament, Len has written a frightening but measured account of the threat humanity lives with in the nuclear age.

Lifton, Robert Jay, and Richard Falk. Indefensible Weapons: The Political and Psychological Case Against Nuclearism. Basic Books, Inc., 1982.
An excellent resource for teachers, this book explores how nuclearism "undermines national security, destroys political legitimacy, and psychologically impairs a future." Key excerpts would be useful for classroom discussion. Strongly anti-nuclear.

Lovins, Amory. The Energy Controversy, Soft Path Questions, Answers. Ed. Hugh Nash. San Francisco: Friends of the Earth, Inc., 1979.

Mayers, Teena. Understanding Nuclear Weapons and Arms Control. Publishers, 1983.

Murray, Ramond L. Understanding Radioactive Waste. Dattille Press, 1982.

Myrdal, Alva. The Game of Disarmament: How the United States and Russia Run the Arms Race. Pantheon Books, 1982.
Written by the 1982 Nobel Peace Prize recipient, this book presents a comprehensive study of the arms race including why real disarmament has never been attempted by the major powers.

The New Reality: Update on Nuclear Plan Safety. Atomic Industrial Forum, Inc., March 1983.

Nuclear Terms: A Glossary. U.S. Atomic Energy Commission Division of Technical Information Extension, Oak Ridge, TN

Nuclear Power and the Environment - Book 2 - Fuel/Waste. La Grange Park, IL: American Nuclear Society. 1982.
Excellent coverage of the topic by a recognized professional group.

Nuclear Power and the Environment - Book 4 - Energy Alternatives. La Grange Park, IL.: American Nuclear Society, 1982.

Poole, Robert W. Jr. Defending a Free Society. Lexington, MA: Lexington Books, 1984.

Russ, George D, Jr. Closing the Circle. Public Affairs and Information Program, Atomic Industrial Forum. Inc., Besthesda, MD. June, 1984.

Sakharow, Andreu D. My Country and the World. Vintage Books

Schell, Jonathan. The Fate of the Earth. Alfred A. Knopf, 1982.
Powerfully written, this book details the possible effects of a nuclear war, including human extinction. Good as fiction.

Scheer, Robert. With Enough Shovels: Reagan, Bush and Nuclear War. Random House, 1982.
A critical analysis of the Reagan administration's stance on the nuclear arms race and policies regarding nuclear war. Interviews Scheer conducted with such policy makers as Reagan, Bush, and Rostow. Especially of interest to students.

Smith, Gerald. The Story of SALT I. Doubleday, 1980.
Smith headed the SALT I delegation that negotiated the agreement with the Soviet Union. A three-year ordeal recounted in detail by one who was there.

Ulam, Stanishiaw. Adventures of a Mathematician: Memoirs of the Manhattan Project. Scribner's, 1976.
Ulam captures the wartime cast of mind regarding the reasons for developing an atomic bomb.

United Nations, Nuclear Weapons: Report of the Secretary General. Autumm Press, 1980.
This book, a report to the United Nations by an international committee of experts, covers the history of the nuclear arms race, nuclear arsenals, the effects of nuclear explosions, and disarmament negotiations.

What About The Russians and Nuclear War? Pocket Books, for Ground Zero, 1983.
Fascinating and cogently written, this book presents a succinct but comprehensive overview of Soviet nuclear policy, and its impact on the rest of the world. A key book for helping high school students to understand the complexities of the nuclear arms race.

Weisman, Steve, and Herbert Krosney. The Islamic Bomb. Times Books, 1981.
This fascinating and highly significant book examines the nuclear arms race in the Middle East.

Weiss, Ann E. The Nuclear Arms Race: Can We Survive? Houghton, 1983.
This account, spanning the forty-odd years since the development of the atomic bomb, surveys the arms race and arms control issues from a pronounced anti-nuclear stance.

Willrich, M., and T. Taylor. Nuclear Theft: Risks and Safeguards. Bellinger Publishing Company, 1974.
An interesting review of a very serious problem with strong implications for the future.

Working With the Atom: Careers for You. Atomic Industrial Forum, Inc., Washington, DC.

WRI Films Educational Materials Catalog 1985-86. San Diego: World Research, Inc., 1985.

Magazines, Journals, and Newspapers

The following popular journals and magazines provide the reader with a variety of articles presenting various points of view regarding nuclear issues: Bulletin of the Atomic Scientists, Forbes, Foreign Affairs, National Review, Foreign Policy, The Nation, Reason, Scientific American, Popular Science, Commentary, Scientific Digest, Science News, The Atlantic, The Washington Monthly. (Points of view may not necessarily represent the position of the publications.)

National newspapers such as The New York Times, The Washington Post, Christian Science Monitor, USA Today, St. Louis Dispatch, or the Los Angeles Times are excellent sources for current events in nuclear age issues. For an alternative perspective, check such newspapers as In These Times, The Village Voice, The Guardian and similar domestic and foreign newspapers. The New York Times and The Washington Post which may be found in many libraries have their own indexes. More than sixty popular newspapers and periodicals are indexed and digested by Mead Data Central, P. O. Box 933, Dayton, OH 45401; telephone (800) 227-4908, a computerized service available to dozens of special libraries, corporate libraries, and members of Congress. (Many members of Congress will help constituents with projects by sending them a printout on a particular subject.).

Nuclear Times provides continuing up-to-date coverage of the activities, groups, and issues mentioned in this kit. Easy to read in the style of a news magazine. In addition, military strategic affairs journals such as Air Force Magazine are easily accessible and provide interesting and timely information dealing with selected topics in nuclear age issues.

Magazine Articles About Nuclear Age Issues

Arkin, W. M. "Conventional Buildup--A Deliberate Delusion." Bulletin of the Atomic Scientists. (February 1985): 8-9.
Does the United States support conventional weapons or nuclear modernization in Europe? This article examines the United States' role in the European defense system.

Bennett, R. K. "Nuclear Power in Perspective." Readers Digest. (June 1981): 131-136.
A review of the problems surrounding the construction and use of nuclear power plants in the United States in proportion to the benefits obtained from these plants.

Boslough, J. "Worlds Within the Atom." National Geographic. (May 1985): 634-663.
A comprehensive report about the machines which are exploring the atom and subatomic particles and their applications for the future.

Caldicott, H. "Open Forum: Against Nuclear Energy." Saturday Evening Post. (September 1981): 45-46.
Dr. Helen Caldicott, pediatrician and antinuclear spokesperson, expresses her concern over "unmanageable" radioactive wastes from nuclear reactors. In support of her arguments, Dr. Caldicott reviews the actual and possible problems relating to high-level liquid wastes and their effect on the environment. A very strong anti-nuclear bias.

Carter, A. B. "The Command and Control of Nuclear War." Scientific American. (January 1985): 32-39.
A look at C^3I ("strategic command, control, communications, and intelligence") and its vital role in deterring nuclear war. This seven page article examines in detail the first three components of C^3I systems.

Dudney, R. S. "New Soviet Arms Buildup: How Big a Threat?" U.S. News and World Report. (June 10, 1985): 37-38.
A look at the Soviet's growing arsenal of intercontinental ballistic missiles, submarine launched ballistic missiles, bombers, and nuclear warheads, and the Reagan administration's dilemma in the making of critical decisions.

Jacobson, W. J., et al. "Teaching About Nuclear Weapons." Education Digest. (November 1984): 26-29.
This article discusses six conceptual topics in the study of nuclear weapons and concludes that the role of "education is to teach students how to think about nuclear issues, not what to think."

Jervis, R. "MAD is the Best Possible Deterrence." Bulletin of the Atomic Scientists. (March 1985): 43-45.
Jervis concludes that MAD (Mutual Assured Destruction) is "here to stay," and we as a nation should accept this deterrence as "a fact of life."

Manning, R. "The Future of Nuclear Power." Environment. (May 1985): 12-17.
A positive look ahead into our "second nuclear era," which will occur after scientists explore and solve the many problems of today's nuclear power to make it more safe, reliable, and economical.

"Nuclear Power: What Do World Readers Think?" National Geographic World. (October 1985): 30-31.
A sampling of letters written by students expressing their opinions on nuclear power. A third of the students wrote that "nuclear power was a good idea," while one third expressed negative opinions. The other third had "mixed" thoughts.

"Nuclear Woes." National Review. (June 14, 1985): 16-17.
A look at the lack of growth in the nuclear power industry due to the overestimation of power consumption, poor management, and poor regulation of nuclear power.

Powaski, R.E. "Living With Nuclear Weapons: Deterrence and Strategic Arms Reduction." USA Today. (January 1983): 10-14.
In exploring the theory of deterrence, this article examines the controversies surrounding the choices and dangers of counterforce programs.

Starr, R. "The Case for Nuclear Energy." New York Times Magazine. (November 8, 1981): 122-129.
This article, after reviewing the possibilities of other sources of energy and dispelling the fears of using nuclear power plants, emphasizes the advantages of nuclear energy to improve the quality of life worldwide.

Teller, E. "Open Forum: For Nuclear Energy." Saturday Evening Post. (September 1981): 45-46.
In this article, Dr. Edward Teller ("father of the hydrogen bomb") upholds the remarkable safety record of nuclear energy. He reviews the history and development of nuclear reactors while deprecating the fears of accidents and the problems of waste disposal and inadequate fuel supplies. This article opposes most of the positions taken in the article by Dr. Helen Caldicott.

"Tiny Atoms, Big Power." National Geographic World. (January 1985): 12-17.
This article discusses both the uses of nuclear energy and its possible dangers. The text, along with the illustrations and photographs, is excellent for use in the elementary classroom.

Journal Articles About Nuclear Age Issues

Adragna, Steven P. "Ballistic Missile Defense: National Security and the High Frontier of Space." Georgia Social Science Journal. 16, 2 (Spring 1985): 7-11.
Ballistic missile defense is discussed, and the rationale behind the proposal to place defensive weapons in space is examined. Argues that strategic defense is a national security, political, and moral imperative.

Alexander, Susan and Barclay, Jeanne. "Teaching about the Soviet Union in Relation to the Nuclear Arms Race." Georgia Social Science Journal. 16, 2 (Spring 1985): 27-31.
A study of the nuclear arms race usually involves curiosity about the Soviet Union. Students want to know about all aspects of the USSR. How teachers can help students see the human side of the Soviets and understand the Soviet point of view is discussed.

Chavez, Linda. "Teaching About Nuclear War." American Educator: The Professional Journal of the American Federation of Teachers. 7, 3 (Fall 1983): 16-21.
Useful information for the classroom teacher.

Domestic Policy Association. "Nuclear Arms and National Security." National Issues Forum. (1983)
An excellent non-partisan exploration of the topic. Shows both sides of the issue.

"Education and Politics. Dilemmas of the Nuclear Age." The Harvard Education Letter. II, 3 (May 1985): 1-3.
Discusses the issue of how to teach about nuclear issues to young people. Addresses the problem of reconciling education and politics in a nuclear age without indoctrination. Argues that balance has been lost to bias when teaching about this topic.

Gormley, Dennis M. and Douglas M. Hart. "Soviet Views On Escalation: Implications for Alliance Strategy." European American Institute for Security Research.
Calls for the development of advanced conventional attack systems and their use in a carefully controlled way to offset the need for nuclear strikes against an adversary should the situation arise. This strategy could raise the threshold of a nuclear strike.

"Guidelines Proposed for Nuclear Education." PTA Today. 10, 5 (March 1985): 24-25.
Discusses ideas and questions to be considered before implementing a nuclear education curriculum in the schools are discussed.

Grover, Herbert D. "The Principles and Implications of Nuclear Winter." Georgia Social Science Journal. 16, 2 (Spring 1985): 35-41.
The ecological consequences of nuclear war are discussed. Proposes that ultimately, the solution to the nuclear dilemma lies in education.

Hoffman, Fred. "The SDI In U.S. Nuclear Strategy." International Security. 10. (1985): 13-24.
Written by the Director of Pan Heuristics, a Los Angeles-based policy research group, the article provides a look at the role of the Strategic Defense Initiative (SDI) in American nuclear strategy.

Hogeboom, William L. "Another Side to Nuclear Education." Social Science Record. 21, 2 (Fall 1984): 36-37.
Education about nuclear arms should be balanced. Most of the supplementary materials dealing with nuclear war that are available to teachers are published by anti-war groups. Basic materials are discussed and information which can be used to present the other side of the story is provided.

Kahn, Andrew Lerner. "Social Studies in the Nuclear Age: The Doomsday Issue." Social Studies Journal. 13 (Spring 1984): 41-46.
A major nuclear exchange between America and the Soviet Union would probably result in the total annihilation of humankind. Social studies educators have a special responsibility to their students to search out all viable alternatives to nuclear deterrence and to make them known.

Krauthammer, Charles. "On Nuclear Morality." Commentary. (October 1983): 48-52.
This article by a senior editor of the New Republic states that nuclear weapons are useful only to the extent they are never used, but the will to use them is what the anti-nuclear moralists find unacceptable. But it is precisely on that will that the structure of deterrence rests.

Sakharov, Andrei. "The Danger of Thermonuclear War." Foreign Affairs. (Summer, 1983): 1001-1016.
An important article by the famous Soviet dissident who argues that it is impossible to win a nuclear war. However, he says it is necessary to strive carefully for complete nuclear disarmament based on strategic parity in conventional weapons and that there must also be strategic parity of nuclear forces so neither side will start even a "limited" nuclear war.

Totten, Sam. "Introduction to This Special Issue of Georgia Social Science Journal on the Nuclear Arms Race." Georgia Social Science Journal. 16, 2 (Spring 1985): 1-2.
Of the many serious problems now facing the world, the most important is the threat of nuclear destruction. Social studies educators should provide ample classroom time for discussing and examining the facts concerning nuclear warfare, and they must make sure that various points of view are presented.

Wellington, J. J. "Nuclear Weapons and Science Education." School Science Review. 65, 232 (March 1984): 440-447.
Provides suggestions on how science teachers can, and should, deal with the nuclear weapons debate in a balanced and critical way. Includes a table outlining points for and against deterrence and disarmament.

Wohlstetter, Albert. "Is There A Strategic Arms Race (II)?" Foreign Policy. 16 (Fall, 1974): 48-81.
Argues that United States and Soviet Union competition produces a great power rivalry but not a strategic "arms race." This article describes the arms race as a myth. (See also the article by the same author: "Is There A Strategic Arms Race (I)?"

Foreign Policy. 15, (Summer 1974): 3-20.

________________. "Threats and Promises of Peace: Europe and America In the New Era." Orbis. XVII, 4 (Winter, 1974): 1107-1144.
Reviews the problem of trying to maintain peace amidst the need for a strong defense to counter Soviet threats. Argues for the devising of a variety of responses to avoid drifting into dependence on total nuclear war.

Additional Resources For Dealing With Nuclear Age Issues: Behavioral Approaches

Beardslee, William, and John Mack. "The Impact on Children and Adolescents of Nuclear Developments." The Psychosocial Aspects of Nuclear Developments, American Psychiatric Association Task Force Report #20, 1981.

Chivian, Eric. "The Bomb Threat and Child Development." Report delivered at the Sixtieth Annual Meeting of the American Orthopsychiatric Association, Boston, April 4-8, 1983.

Escalona, Sibylle. "Issues and Solutions: The Nuclear Threat." Remarks made as Moderator of the April 7 evening session, the Sixtieth Annual Meeting of the American Orthopsychiatric Association, Boston, April 4-8, 1983.

Fraiberg, Selma. The Magic Years: Understanding and Handling the Problems of Early Childhood. Scribner's, 1959.

Gould, Benina F. "Families and the Nuclear Threat." 1983. Paper issued by the Family Therapy Institite of California, 3738 Mt. Diablo Boulevard, Suite 100, LaFayette, CA 94549.

Kubler-Ross, Elizabeth. Living with Death and Dying. Macmillan, 1982. p. 4.

Macy, Joanna Rogers. "How to Deal with Despair." New Age. (1979): 40-45.

"Peace Games." WORKING WOMAN. (June 1983): 134.

Peterson, Norma. "Nuclear War: A Modern Day Bogeyman." USA Today. (November 16, 1983): Life Section.

"Project COPE." San Mateo Unified School District.

Schell, Jonathan. The Fate of the Earth. Knopf. 1982.

Schwebel, Milton. "Effects of the Nuclear War Threat on Children and Teenagers: Implications for Professionals." American Journal of Orthopsychiatry 52. (1982): 616

Snow, Roberta. "Issues and Solutions: The Nuclear Threat." Report delivered at the Sixtieth Annual Meeting of the American Orthopsychiatric Asociation, Boston. April 4-8, 1983.

Van Ornum, William and Mary Wicker Van Ornum. "Talking to Children About Nuclear War." Continuum. (1984): 18, 52-54, 59-62.

Verdon-Roe, Vivienne. "Nuclear Threat: Our Children Are Afraid." Presbyterian Survey. (January 1983): 10-11.

Walsh, Roger. Staying Alive. Colorado: New Science Library. 1984.

What Shall We Tell the Children? Booklet produced by Parenting in a Nuclear Age, 6501 Telegraph Ave., Oakland, CA 94609. 1983. 10.

Winter, Metta. "Talking to Kids." MS Magazine. (August 1983): 85.

Zimbardo, Philip G. "The Age of Indifference." Psychology Today. (August 1980): 72.

PART II: CURRICULUM MATERIALS FOR TEACHERS

CHOICES: A UNIT ON CONFLICT AND NUCLEAR WAR (Available from the National Education Association, 1201 16th Street, NW, Washington, DC 20036.) This new junior high curriculum is the product of a joint effort by the Union of Concerned Scientists, the Massachusetts Teachers Association, and the National Education Association. The introduction states that the curriculum is designed to help students understand the power of nuclear weapons, the consequences of their use, and most importantly, the options available to resolve conflicts among nations by means other than nuclear war. Paperback. 200 pp. $10.00.

CROSSROADS: QUALITY OF LIFE IN A NUCLEAR AGE (Available from Jobs with Peace Education Task Force, 10 West Street, Boston, MA.) A six-day unit covering the threat of nuclear war, the Soviet Union and the arms race, the Soviet threat, military spending and possibilities for action. Uses simulation, cartoons, quotes from major spokespersons for security policy, statistics, graphs and charts to achieve objectives stated at beginning of each self-contained daily lesson plan. Jobs with Peace has also prepared units for English and science. Each unit sells for $2.50.

DAY OF DIALOGUE: PLANNING AND CURRICULUM RESOURCE GUIDE DEALING WITH ISSUES OF NUCLEAR WAR IN THE CLASSROOM (Available from Educators for Social Responsibility, 23 Garden Street, Cambridge, MA 02138.) This is a resource guide of curriculum ideas and lessons that was developed by Educators for Social Responsibility. It includes an adult study guide, essays on the age-appropriateness of different topics and materials, and annotated lists of resources. Paperback. 200 pp. $12.00.

DECISION MAKING IN A NUCLEAR AGE (Available from Educators for Social Responsibility.) This curriculum provides for an exploration of nuclear war issues "that are relevant to developing the social insight, interest, and decision-making skills that encourage young people to participate in a democracy." The course is for students of high school age and may be taught in units from 3 to 12 weeks in length. Paperback. $12.50.

ENERGY EDUCATION. David C. King et al. 1980. (Available from Global Perspectives in Education (GPE), 218 East 18th Street, New York, NY 10003.) Materials on a variety of energy issues. Global and local implications of energy situations examined as part of a growing educational agenda. $2.50.

GROWING UP IN A NUCLEAR WORLD: A RESOURCE GUIDE FOR ELEMENTARY SCHOOL TEACHERS TEACHING NUCLEAR ISSUES by Paulette Meier and Beth McPherson. (Available from: Nuclear Information and Resource Service, 1346 Connecticut Ave., NW., 4th Floor, Washington, DC 20036.) $5.00 plus $.85 postage. Provided in this guide are annotated lists of teacher and students resources for teaching and learning about nuclear issues in the elementary/junior high school (grades K-8). Resources are grouped into five major sections. The first section (background reading for teachers) contains books and articles focusing on nuclear issues (nuclear war: arms race/disarmament; nuclear weapons and policy making; nuclear weapons/power link; nuclear power; health and environmental impacts; and safe energy alternatives) and approaches to teaching about nuclear issues (addressing developmental/ psychological considerations; values education; and recognizing propaganda). The second section lists classroom materials on nuclear issues: (1) curriculum guides, teaching units, plays, and teacher resources on peace education and (2) student/teacher materials on non nuclear energy versus nuclear power. Includes teaching units, curriculum guides, simulation exercises, texts, plays, coloring books, and catalogs. Fiction and non-fiction books for children to read on their own are presented in the third section, grouped by K-3, 4-6, and 7-8 grade levels. The last section lists over 100 slide shows, films, and audio tapes which provide a broad choice of resources on nuclear weapons/war, nuclear energy/weapons, and alternative energy.

ISAAC CURRICULUM MATERIALS BIBLIOGRAPHY This annotated bibliography for teachers serves as a guide to elementary and secondary resources available on teaching about nuclear-related issues. The extensive list is divided into sections dealing with existing curriculum materials, text and reference books, audiovisual aids, as well as articles and a list of other bibliographies. Advocacy positions are noted but not endorsed. $3.00.

THE NUCLEAR AGE: A CURRICULUM GUIDE FOR SECONDARY SCHOOLS (Available from Ground Zero, 806 15th Street NW, Suite 421, Washington, DC 20005.) Guide is comprised of five lessons: "Nuclear Weapons: The Quantum Leap," "The U.S.-U.S.S.R. Arms Race--A Timeline," "Where We Are Now?," "The Effect of Nuclear War," and "What Can Be Done to Prevent Nuclear War?" Each lesson contains an outline, relevant quotes, and learning and discussion questions. The guide serves as a primer and introduction to these complex issues, but teachers who use it will need to use supplementary materials and various pedagogical methods to round it out. Paperback. 58 pp. $2.50.

NUCLEAR ARMS AND NATIONAL SECURITY. 1983 NATIONAL ISSUES FORUM by Keith Melville (Public Agenda Foundation, New York, NY.) (Available from: Order Department, Domestic Policy Association, 5335 Far Hills Avenue, Dayton, OH 45429.) $3.00. Appropriate for secondary school social studies, this outstanding booklet outlines approaches for dealing with the threat of nuclear warfare in six sections. The first section, "Learning to Live with Nuclear Weapons," introduces the topic and considers what can be done to decrease the risk of nuclear warfare without jeopardizing the nation's security. "Arms Control" discusses the importance of the negotiation process. "Peace through Strength" stresses the need to display military strength to deal with the threat from the Soviet Union. "Freezing the Arms Race" advocates a bilateral freeze on the production and deployment of nuclear weapons while "Unilateral Reductions" argues that nuclear weapons are a threat in and of themselves. The sixth section, "Complex Issues, Hard Choices," concludes the booklet by stressing the need for citizen participation. Two self-administered questionnaires intended for completion before and after participating in a public forum or reading of the booklet are included as well as a list of recommended readings.

NUCLEAR DANGERS: A RESOURCE GUIDE FOR SECONDARY SCHOOL TEACHERS TEACHING NUCLEAR ISSUES by Paulette Meier and Beth McPherson. (Available from: Nuclear Information Services, 1346 Connecticut Avenue, NW, 4th Floor, Washington, DC 20036.) $5.00 plus $.85 postage. Provided in this guide are annotated lists of teacher and student resources for teaching and learning about nuclear issues in the secondary school. Resources are grouped into five major sections. The first section (background reading for teachers) contains books and articles focusing on nuclear issues (nuclear war; arms race/disarmament; nuclear weapons and policy making; nuclear weapons/power link; nuclear power; health and environmental impacts; and safe energy alternatives) and approaches to teaching about nuclear issues (addressing developmental/psychological considerations; values education; and recognizing propaganda.) The second section lists classroom materials on nuclear issues: (1) curriculum guides, teaching units, plays, and teacher resources on war and peace and (2) student/teacher materials on non nuclear energy versus nuclear power, including teaching units curriculum guides, simulation exercises, texts, plays, solar energy projects and catalogs. Fiction and non-fiction books for students to read on their own are presented in the third section. The last section lists over 100 slide shows, films, and audio tapes which provide a broad choice of resources on nuclear weapons/war, nuclear energy/weapons, and alternative energy.

NUCLEAR WAR: OPPOSING VIEWPOINTS (Available from: Greenhaven Press, Inc., 577 Shoreview Park Road, St. Paul, MN 55112.) An excellent set of materials dealing with nuclear issues. Presents both sides of a number of issues in a balanced, non-judgmental fashion. Topics include "How Can a Nuclear War Begin?", "Would Humanity Survive a Nuclear War?", Will Civil Defense Work?", "Will Nuclear Arms Agreements Work?" and, "Can Space Weapons Reduce the Risk of Nuclear War?" $100.81.

A STUDY IN SCIENCE, POLITICS AND THE ETHICS OF WAR, TEACHER AND STUDENT MANUALS by Jonathan Harris (Available from: Office of Education (DHEW), Washington, DC. Bureau of Research. By focusing on the question of whether it was right or wrong to drop the atomic bomb on Hiroshima, this social studies unit seeks to illuminate the political, military, scientific, and moral complexities involved in making far-reaching decisions today. Sections of the unit use primary materials from American, Japanese, and English sources to explore the following questions: (1) What was the choice in terms of Japanese versus American lives? (2) Was the A-bomb a military necessity? (3) As the agony of the atomic scientists and the Japanese reaction to the Potsdam Declaration are reviewed in light of recent history, was there a better way to win the war? (4) Was Russia the reason that the United States used the bomb? and (5) Was the use of the A-bomb morally defensible? Included are excerpts from the opinions of atomic scientists, military officers, and political leaders. Not available in hard copy due to marginal legibility of original document.

UNDERSTANDING NUCLEAR WEAPONS AND ARMS CONTROL (Available from Arms Control Research, Box 1355, Arlington, VA 22210.) Key concepts and major events are in bold print in the margins. Text is simple, straightforward, factual, and readable. It is well illustrated with diagrams, charts on the arms race, and maps. Lists acronyms, arms control terms, significant United States and Soviet leaders, and the policies they advocated. $2.50.

Films, Videotapes, Slide Show Sets

A IS FOR ATOM, B IS FOR BOMB, 1980. The Nova Series. Producer: WGBHTV, 125 Western Avenue, Boston, MA 02134. Distributor: Public Broadcasting Service (PBS), 475 l'Enfant Plaza, SW, Washington, DC 20024.
Presents a portrait of Edward Teller, one of the brilliant scientists who developed the hydrogen bomb. (58 min.)

AMERICAN MILITARY STRENGTH--SECOND TO NONE, 1979. Producer: ABCNEWS. Distributor: MTI Teleprograms (MTI), 3710 Commercial Avenue, Northbrook, IL 60062.
Examines the inception of nuclear weaponry, the status of the arms race, civil defense, military intelligence, and prospects for arms limitation. Features interviews with Harold Brown, Bernard Rogers, Zbigniew Brezezinski, and others.

COUNTDOWN FOR AMERICA, 1982, A STRATEGY FOR PEACE THROUGH STRENGTH, 1984, AND THE PRICE OF PEACE AND FREEDOM. Sate $300. American Security Council (ASC),

Coalition for Peace Through Strength. Ask for a local contact to provide a free loan. May be useful in a "battle of the films" debate. (30 min.)

THE DAY AFTER. Embassy Home Video at your local video store.

ABC's nationally televised fictional account of a nuclear attack affecting the citizens of Lawrence, Kansas, with Jason Robards as the physician facing the impossible task of attempting recovery.

THE DAY AFTER TRINITY, 1981. Rental $125, sale $950. Pyramid Films.

Tells the story of the father of the A-bomb, Robert Oppenheimer, what it was like working with the development of the bomb, and how it felt to live with the decision to use it on Hiroshima and Nagasaki. (90 min.)

THE DEFENSE OF THE UNITED STATES, 1981. The series was inspired by the work of the Center for Defense Information (CDI) and utilized CDI research. CBS Broadcast International, 51 West 52nd Street, New York, NY 10019. Video rental $60 per part, sale $390 per part.

A CBS series in five parts. Part One, 'Ground Zero,' discusses the effects of nuclear weapons; Part Two, 'Nuclear Battlefield,' deals with Nuclear capabilities in Europe; Part Three, 'Call to Arms,' discusses conventional warfare; Part Four, 'The War Machine,' examines the military-industrial complex. (Part Five, 'The Russians,' is not available.)

FAIL SAFE. Direct Cinema Ltd. (DIRECT), P.O. Box 69589, Los Angeles, CA 90069.

A cinematic account of how, after a computer error launches a nuclear attack, the heads of both the United States and the Soviet Union struggle to save the world.

HIROSHIMA: A DOCUMENT OF ATOMIC BOMBING. B/W with some color, Produced in Japan.

Japanese photographers document the suffering inflicted by the use of the atom bomb on Hiroshima. (30 min.)

HIROSHIMA DECISION: WAS THE USE OF THE A-BOMB NECESSARY? Color filmstrip LP record, 10 photo aids, teacher guide.

Arguments for and against the use of bombs by leaders of the time and historian. (19 min.)

IF YOU LOVE THIS PLANET, 1982. Dr. Helen Caldicott on Nuclear War. Producer: National Film Board of Canada (NFBC) 1251 Avenue of the Americas, 16th Floor, New York, NY 10020. Distributor: Direct Cinema, Ltd. (DIRECT), P.O. Box 69589, Los Angeles, CA 90069. Media Type: 3/4 or 1/2 inch.

Presents Dr. Helen Caldicott's plea that the world reorder its priorities in regards to nuclear weaponry interspersed with scenes of nuclear devastation at Hiroshima and pieces of official documentaries which seem either misguided or purposefully incorrect. A strong anti-nuclear bias, verges on polemic.

IN OUR DEFENSE, Rental $65. 16 mm film $435. Video $265. Public Media, Inc.

Exposes planning for a first-strike capability and shows how the quest for security through nuclear weapons has actually made us less secure, while undermining social and human-oriented programs. Interviews Pentagon officials, business leaders, and average citizens. (26 min.)

THE LAST EPIDEMIC--THE MEDICAL CONSEQUENCES OF NUCLEAR WEAPONS AND NUCLEAR WAR, 1980. Producer: Physicians for Social Responsibility (PSR) 639 Massachussetts Avenue, Cambridge, MA 02139. Distributor: University of Winsconsin, Bureau of Audiovisual Instruction (UWISC). University Extension, 1327 University Avenue, P.O. Box 2093. Madison, WI 53701. Color.

Presents a series of excerpts from the conference on the medical consequences of nuclear weapons and nuclear war. Includes documentary footage, illustrations, and demonstrations. (47 min.)

LIVING IN A NUCLEAR AGE, 1985. With Strobe Talbott, Washington Bureau Chief, Time. Q & A/T, Tape #668. Produced for the Closeup Foundation.

As an author of several books on arms control and United States-Soviet realtions, Stobe Talbott brings both a journalist's and historian's viewpoint to this discussion of living in a nuclear age. He discusses with a teacher audience such issues as the morality of nuclear weapons, a first-strike capability, the arms control process and the proposed Strategic Defense Initiative. In addition, he stresses the importance of a well-informed public and of playing an active role in developing our nation's arms control policy. (60 min.)

NUCLEAR PROLIFERATION: THE SPREAD OF NUCLEAR WEAPONS TECHNOLOGY, 1985. With Neil C. Livingstone, President, Institute on Terrorism and Subnational Conflict. Roger Molander, President. Roosevelt Center for American Policy Studies. Q & A/S, Tape #656. Produced for the Closeup Foundation.

Roger Molander and Neil C. Livingstone discuss the complex issues involved in controling the spread of nuclear weapons technology as they respond to student questions. Some of the topics covered are: controls on the export of nuclear technology and materials, the threat of Third World nuclear capabilities and the role that conventional weapons might play in decreasing the "need" for nuclear weapons. Students also ask about the effectiveness of international negotiations and treaties, as well as whether the American public can influence foreign policy decision making on the issue of nuclear proliferation. (30 min.)

NUCLEAR STRATEGY FOR BEGINNERS, 1982. The Nova Series. Producer: WGBHTV, 125 Western Avenue, Boston, MA 12134. Distributor: Time-Life Films, Inc. 100 Eisenhower Drive, P.O. Box 644, Paramus, NJ 07652. 3/4 or 1/2 inch. Color.

Looks back over the four decades of the atomic age to try to understand who the modern world has acquired an arsenal of over 50,000 nuclear weapons ready to be fired at a moment's notice. Explores whether nuclear weapons deter such a war or only make it more likely.

SADAKO AND THE THOUSAND PAPER CRANES, 1977, 59 color slides, cassette, script, Putnam. Rental $5.

Narrated by Wilmington storyteller Jeanne Logett. For older elementary children. From Sadako and the Thousand Paper Cranes by Eleanor Coer, (25 min.)

DR. STRANGELOVE, 1964. Available from Direct Cinema, Ltd., for $65, video, or local video stores.

A darkly humorous feature length film about nuclear war, with Peter Sellers.

THE STRATEGIC DEFENSE INITIATIVE, 1985. Videotape.
Senior Administration officials explain the rationale for the Strategic Defense Initiative research program, including the basic technologies being investigated, how such a defensive system might protect us from a nuclear attack, and the relative deterrent value of offensive and defensive systems. Also included are discussions of Soviet space defense research, compliance with the ABM Treaty, the reaction of our NATO allies, and the Soviet attitude toward SDI at the Geneva arms control negotiations. (25 min.)

STRATEGIES FOR SURVIVAL. Produced and directed by David Brown, Energon Films, 2114 Golden Gate Avenue, San Francisco, CA 94118.
This film addresses the issues surrounding the nuclear freeze, disarmament, and United States and NATO policies.

U.S. vs U.S.S.R.: WHO'S AHEAD?, 1/2 inch. VHS color videotape cassette. Arms race Education Project (Fund for Peace). Narrated by Martin Sheen. Rental $10.
Reagan gives his views; they are countered by renowed military and intelligence experts. (28 min.)

WAR GAMES, 1983. Local video stores.
A fictional movie about a student who penetrates military computers, accidentally starting the countdown to nuclear war, and then races against the nuclear establishment to avert catastrophe. The computer teaches the lesson that a nuclear war would end without winners.

WHAT ABOUT THE RUSSIANS?, 1982. 16 mm rental $50. Sale $300. Video rental $35. Sale $55. Educational Film and Video Project.
This film uses the testimony of military scientific, and political leaders to explore the relative strength of the United States and the Soviet Union. The film deals with the question of how to reconcile the desire for national security with the threat of nuclear war. (26 min.)

WHAT SOVIET CHILDREN ARE SAYING ABOUT NUCLEAR WEAPONS. Produced by International Physicians for the Prevention of Nuclear War. Intersection Associates, 56 Chestnut Street, Cambridge, MA 02139.
Doctors from Harvard Medical School talk to Soviet children, ages 10 to 15, who speak frankly of their fears of nuclear destruction.

MORE RECENT CURRICULUM MATERIALS TO BE ADDED BY THE TEACHER

PART III: ORGANIZATIONS AND PUBLIC AGENCIES

American Enterprise Institute for Policy Research. 1150 17th Street, NW, Washington, DC 20036. AEI is a think tank. Many of its publications provide interesting and solid information on the nuclear arms race.

American Nuclear Society. 3333 Michelson Drive, Irvine, CA 92730. A scientific and educational organization supporting the peaceful uses of nuclear energy and knowledge of the atomic nucleus. The organization provides written information, films, and speakers on topics relating to understanding nuclear energy and its applications.

Bureau of Public Affairs. Correspondence Management Division, Room 5819, United States Department of State, Washington, DC 20520. Distributes free, single copies of articles useful in nuclear age issues. For example: "Geneva and Beyond: New Arms Control Negotiations," "The Importance of the MX Peacekeeper Missile," "Strategic Defense Initiative," "SDI and the ABM Treaty,"

"Soviet Noncompliance with Arms Control Agreements," "Continuing the Acquisition of the Peacekeeper Missile," "The Strategic Defense Initiative," "The President's Strategic Defense Initiative," "Arms Control: Objectives and Prospects," and "The Objectives of Arms Control." Send for their free catalog. Also have films and videotapes available.

Center for Defense Information. Capitol Gallery West, Suite 303, 600 Maryland Avenue, SW, Washington, DC 20024. CDI supports a strong defense, but opposes excesses and waste in military spending and programs that increase the danger of nuclear war. It publishes the Defense Monitor, a monthly analysis of military issues. Its education materials include the "Nuclear War Prevention Kit" which is used in high schools. Useful Center for Defense Information publications include:

Nuclear War in Europe Documents. Used by the First Conference on Nuclear War in Europe (1981), the book contains excerpts from Army Field Manual 100-5 (Tactical Nuclear Operation), from The Modernization of NATO's Long-Range Theater Nuclear Forces, from The Effects of Nuclear War by the United States Office of Technology Assessment, and other key government studies. $5. Nuclear War in Europe Report. Written by Dr. Leslie Dunbar. The book discusses the First Conference on Nuclear War in Europe held in the Netherlands. $3. Nuclear War: Quotes. The booklet covers the period from pre-Hiroshima to the present with quotes from military officials, scientists, and Presidents. $1.50. United States Military Force-1980: An Evaluation. A common sense analysis in plain language of United States national defense forces and needs. $2.50.

Committee for National Security, 2000 P St., NW, Washington, DC 20036. The program of the Committee includes developing position papers, issues briefs and reports focusing on arms control negotiations; conducting national and regional leadership conferences; organizing intensive courses, speakers' training, and briefings for a variety of audiences; and arranging national and regional press conferences.

Congressional Budget Office, Office of Intergovernmental Relations. House Annex No. 2, 2nd and D Streets, SW, Washington DC 20515. The CBO is an agency of Congress established to review the budgetary implications of various programs. Budget issue papers consider a host of narrow issues, but also very broad strategic analyses. Write for a list of publications. All CBO publications can be received free.

Defense Nuclear Agency. Washington, DC. Attn: Lt. Col. Carlton Brown (U.S. Army), Public Affairs Officer (202) 325-7095.

Department of Defense. The Washington Headquarters Service Directorate of Information, Room 4B, 935 Pentagon, Washington, DC 20301. Distributes a number of publications about Pentagon contracts, bases, personnel, etc. Write for a list of publications and an order form. Particular reports can often be obtained free by calling and asking for the reports by name. Other information on military issues can be obtained from the Office of Public Correspondence, Staff Assistant for Public Affairs, OASK/PA, Room 2E 777 Pentagon, Washington, DC 20301. The Department of Defense maintains a large film library.

Department of Defense/U.S. Government Documents: Arms Control Report of the U.S. Arms Control and Disarmament Agency (ACDA). Developments in arms control negotiations, forces in Europe, strategic weapons, chemical and biological weapons, etc., are explored in these publications. $6.50. Some sample titles available: (1) Arms Control and Disarmament Agreements: Texts and Histories of Negotiations chronicles all U.S. arms control agreements (ACDA). $5.50. (2) Department of Defense Annual Report by the Secretary of Defense and U.S. Military Posture by the Chairman, Joint Chiefs of Staff. A wealth of officials data on U.S. and Soviet forces and outlooks for U.S. military programs and planning. (3) The Effects of Nuclear War: A Report Prepared by Congress.

Department of Energy. The Forrestal Building, 1000 Independence Avenue, SW, Washington, DC 20585. Attn: Director of Communication; (202) 252-5730. Office of Nuclear Energy (202) 252-9720. Office of Defense Programs (202) 252-1870.

Educators for Social Responsibility. 23 Garden St. Cambridge, MA 02138. A national organization of teachers, administrators, school-committee members, and parents, ESR is in the forefront of the movement to educate U.S. citizens about the ramifications of the nuclear arms race. It believes it is important for students to hear different sides of the issues. In light of that, it has developed and will continue to develop curricular materials. It also has available an excellent selective annotated bibliography on nuclear issues. It publishes a quarterly newsletter. "Forum."

Federation of American Scientists. 307 Massachusetts Ave., NE, Washington, DC 20003. FAS is a lobbying organization with a membership of about 60,000 scientists concerned with the role of science in society. They produce books and reports on a full range of arms control and disarmament issues. The FAS Nuclear War Education Project, with a speakers bureau and educational materials, supports individuals and schools involved in the movement against nuclear war. Porject's newsletter, "FAS Countdown," includes articles on various aspects of the nuclear arms race and includes information on resources.

Government Printing Office. North Capitol at H St. Washington, DC 20401 Attn: Jack Wooley, Director of Legislative & Public Affairs (202) 275-2894.

Ground Zero. 806 15th St., NW, Suite 421, Washington, DC 20005. This organization is dedicated to educating citizens about the issue of nuclear war. It emphasizes mutual initiatives on the part of the United States and the Soviet Union to end the nuclear arms race. It has produced an excellent 20-page booklet, "Thinking About Preventing Nuclear War," which is a valuable resource for the high school classroom. Also available from Ground Zero are several bibliographies on various subjects: "Arms Control," "Effects of Nuclear War," "The Russians," and "Nuclear War Films,"

Institute for Defense and Disarmament Studies. 251 Harvard St., Brookline, MA 92146. IDDS is a research and public education organization concerned with military and disarmament issues. It regulary issues reports on various aspects of the nuclear arms race, including obstacles to and opportunities for disarmament.

International Physicians for the Prevention of Nuclear War. 225 Longwood Ave., Boston, MA 02146. Comprised of physicians from around the world, it educates the world community about the medical facts of nuclear war. Six of its members, three Americans and three Russians, took part in an hour-long discussion on the medical effects of nuclear war which was broadcast in prime time on Soviet television to an estimate 150 million viewers. Its members have also visited primary and secondary schools to hear the thoughts of children about the nuclear arms race.

The National Directory of Audiovisual Materials on the Arms Race edited by Karent Sayer and John Dowling (60 pages, 1983) lists more than 400 films, videos, slide shows, and filmstrips, including distributors and rates. Available for $4 from Michigan Media.

The Nuclear Film Guide. David Brown. Lists more than 100 films on nuclear issues, including nuclear power and weapons. An offshoot of the Nuclear Film Forum. $5.50 for Nuclear Film Guide, 2114 Golden Gate Avenue, San Francisco, CA 94118.

Nuclear War Films. Jack Shaheeen. Southern Illinois Press, 1978. Two dozen films of the genre.

Nuclear Weapons Freeze Campaign: National Clearing House. 4144 Lindell, Room 201, St. Louis, MO 63108. This organization is working to implement a bilateral nuclear weapons freeze. It has numerous resources on the nuclear arms race and the freeze concept.

Physicians for Social Responsibility. 639 Massachusetts Ave., Cambridge, MA 02139. PRS is an organization of doctors committed to professional and public education on the medical dangers of nuclear weapons and nuclear war.

Union of Concerned Scientists. 1384 Massachusetts Ave., Cambridge, MA 02238. A group of engineers and other professionals who are dedicated to ending the nuclear arms race. It conducts an annual "Convocation on the Threat of Nuclear War" on college campuses across the United States.

United States Arms Control and Disarmament Agency. 300 21st St., NW, Washington, DC 20421. Attn: Joe Lehman, Public Affairs Advisor (202) 647-8715. Publishes information on disarmament treaties, ongoing negotiations, and non-proliferation and other arms control issues. Annually publishes World Military Expenditures and Arms Transfers.

United States Committee for Energy Awareness. P.O. Box 1537 (N7), Ridgeley, MD 21681. A lobbying group supporting nuclear power. Provides excellent and informative material on nuclear energy and the nuclear power industry.

United States Government Accounting Office, Document Handling and Information Services Facility. P.O. Box 6015, Gaithersburg, MD 02760. The GAO reviews the general efficiency of government administration and particular procurement programs. It is a good source of authoritative critiques of Pentagon programs. Write for the Monthly List of GAO Reports which includes an order form. A single copy of any GAO report is free.

United States Nuclear Regulatory Commission. Washington, DC 20555. Attn: Joseph Fouchard, Director of Public Affairs (301) 492-7715. This agency will send material to any teacher.

Women Strike for Peace. 145 S. 13th St., Philadelphia. PA 19107. (215) 923-0861. WSP is an organization of women committed to disarmament under international controls. WSP and its local churches work actively on banning nuclear testing and ending the arms race. National Legislative Office, 201 Massachusetts Avenue, Washington, DC 20002, (202) 543-2660.

PART IV: A SELECTED LIST OF LOS ANGELES UNIFIED SCHOOL DISTRICT AUDIOVISUAL MATERIALS AVAILABLE FOR TEACHER USE

This section contains a selected list of films, with ordering numbers, currently available for loan from the Los Angeles Unified School District Film Library. For a complete annotated list of all the films available, please refer to the Catalog of Films for Secondary and Adult Levels (Los Angeles Unified School District, Office of Instruction, Audiovisual Services, Publication No. SC 881, 1985). Ordering information may be obtained by consulting the latest edition of the "Film Ordering Procedures Reference List," distributed to all schools in May for the next school year. For additional information, call Audiovisual Services at 625-6982.

Elementary

ENERGY
2340 10 minutes, Science (3-6)
Discusses the use of water, wind, coal, oil, and natural gas for production of energy and introduces the theme of conservation. Describes scientific efforts toward expanding the use of nuclear, geothermal, and solar sources of energy. (1975-OxF)

THE GREAT SEARCH: MAN'S NEED FOR POWER AND ENERGY
2193 13 minutes, Science (4-6)
Uses photography and animation to tell the story of the discovery, development, and application of major sources of energy--muscles, animal power, water, wind, machines, steam, petroleum, electricity, and atomic energy. Discusses some possible sources of power for the future. (1973-WDP)

Secondary

ATOMIC ENERGY FOR SPACE
4118 17 minutes, Science (sh)
Discusses nuclear space propulsion and power plants showing how heat is produced by neutrons and how the Rover Project develops hardware for astronauts. (1967-HFC)

ENERGY: 2000
6702 25 minutes, Social Science (sh)
Examines the short-term and long-range search for alternate energy sources to meet America's needs in the year 2000 and beyond. Discusses the pros and cons of such sources as coal, shale oil, off-shore oil, nuclear fission, nuclear fusion, the sun, wind tides, geothermal wells, burning garbage, etc. (1977-HMN)

FUSION: THE ULTIMATE FIRE
6638 14 minutes, Science (sh)
Describes the process of nuclear fusion as it occurs in nature at the center of the sun and discusses problems involved in the development of practical nuclear fusion technology for utilizing the hydrogen in water as an energy source. Shows experimental nuclear fusion projects with electro-magnets and lasers. (1976-BFA)

NUCLEAR WEAPONS: CAN MAN SURVIVE?
7158 24 minutes, Social Science (jh, sh)
Presents an overview of the development of nuclear weapons, of the death and destruction that would result from their use, and of the efforts that have been made to prevent their use. Interviews with Dr. Edward Teller and United States Senator Mark Hatfield provide contrasting views regarding the need for further development of nuclear weapons and the dangers such development represents for mankind. Science Screen Report series. (1982-HMN)

PLOWSHARE
6231 28 minutes, Science
Shows some of the peaceful uses of atomic energy. (1970-USAE)

Building Level Materials

The following materials have been evaluated by District Audiovisual Evaluation committees and listed in edition of the Audiovisual Materials Resource List. Price and other ordering information can be obtained from the sources indicated in each annotation.

Secondary

DEVELOPING THE A-BOMB: DECISION OF DESTINY, c. 1982, 2 color filmstrips, 2 cassettes, thermal master, guide (Source: Random House School Division, Set $537-60151-1)
Traces the history of the atomic bomb, beginning with the research of Einstein, Fermi, and others in the 1930's, detailing the development of the bomb by the Manhattan Project and describing the 1945 bombing of Hiroshima. Political and military decisions involved are presented in a straightforward, unbiased manner. Current issues such as the threat of nuclear proliferation and the United Nations efforts to control stockpiling are considered. The presentation is detailed and the vocabulary sophisticated, making it too difficult for below average students. (Grades 8-12)
Random House School Division, Educational Enrichment Materials, 400 Bennett Cerf Dr., Westminster, MD 21157, Phone: (800) 638-6460

DISARMAMENT: THE QUEST FOR LASTING PEACE, c. 1983, 4 color filmstrips, 4 cassettes, guide (Source: Human Relations Media, Set $776-00-CSTR)
Uses interviews with experts, narration, and a variety of graphics to consider the questions of war, arms, and arms control from a broad historical perspective. Discussion covers ancient times, the Napoleonic Wars, the 1815 Congress of Vienna, and the SALT treaties. The presentation concludes with a consideration of the issue as it appeared in 1983. Differing points of view are presented. Graphics include color maps, symbols, diagrams, and photographs of weapons. The presentation gives students a sense of the continuity of history and the roots of the current nuclear dilemma. (Grades 8-12)
Human Relations Media, 175 Tompkins Ave., Pleasantville, NY 10570, Phone: (800) 431-2050

GHOSTS OF HIROSHIMA, c. 1983, one 30-minute viceocassette, 1/2 inch VHS (Source: Filmakers Library, Inc., Set #LC83707176)

Presents Debra Lubar's play of the same title, intercut with historic photographs of Hiroshima and Nagasaki in 1945 and with testimonies of survivors of the bombing of those cities. The presentation considers U.S. government policies on nuclear accidents and civil defense from the perspective of those who actually witnessed an atomic explosion. Students will need to be prepared for graphic descriptions of the effects of the blasts; however, the overall effect of the program is provocative and it will be a superior discussion starter. The use of stylized drama, symbolism and satire limit the use of this program to advanced students. (Grades 9-12)

Filmakers Library, Inc. 133 East 58th Street, New York, NY 10022,
Phone: (212) 355-6545

THE LOST GENERATION, c. 1983, one 20-minute videocassette. 1/2 inch VHS (Source: Films Incorporated)

Survivors of the bombing of Hiroshima and Nagasaki recall their experiences at the time of the blasts and discuss their lives in the years that have followed. Documentary footage clearly shows the nature and extent of the injuries incurred and of the destruction that took place. Students will need preparation before viewing the graphic scenes of injury and death in this presentation. The film concludes by asking viewers to evaluate the necessity of nuclear war. (Grades 11-12)

Films Incorporated, 1213 Wilmette Ave., Wilmette, IL 60091,
Phone: (800) 323-4222

NUCLEAR POWER, c. 1984, 2 color filmstrips, 2 cassettes, guide (Source: Hawkhill Associates, Inc.)

Provides a scientific overview of nuclear power, showing its use as an energy source for homes and industry, and its potential for destruction when used as a weapon. Current controversies surrounding the issue of nuclear power are explored without bias. Some of the myths about radiation are dispeled, but the risks that come with nuclear power are explained. Program could be used in a team-teaching format with a social science/science team. Uses include computer graphics and labeled diagrams. (Grades 9-12)

Hawkhill Associates, Inc. 125 East Gilman Street, Madison, WI 53703,
Phone: (800) 422-4295

NUCLEAR WAR, c. 1984, 1 color filmstrip, 1 cassette, guide (Source: Society for Visual Education, Inc., Set #232-5T)

Describes the effects of the nuclear bomb dropped on Hiroshima and discusses the strength and the possible effects of current nuclear weapons. Program also presents an overview of the current status of nuclear weapons in the world and stresses the dangers of proliferation. The presentation is historically accurate, but it may be slightly biased in its attempt to analyze the United States-Soviet Union arms buildup. Useful for creating awareness and motivating discussion. (Grades 11-12)

Society for Visual Education, Inc. 1345 Diversey Parkway, Chicago, IL 60614
Local: Gordon W. Burke, 22912 Broadleaf, El Toro, CA 92630;
Phone: (714) 768-6723

Additional Available District Materials

The following videotapes were developed by the Thursday Night Group in association with the Los Angeles Unified School District for exclusive use within the Los Angeles Unified School District. The materials are available at no cost from the District's Audiovisual section.

DEALING WITH FEELINGS REGARDING NUCLEAR ISSUES. © TNG, Inc. 1987.
(Running time 28:30)

Excerpts of a two-hour teacher workshop featuring Los Angeles Unified School District teachers as they consider ways to deal with negative emotions which may arise when exploring nuclear age issues. Addressing these emotions, the teachers are involved in a process which can enhance teaching and learning about nuclear issues.

A leader's guide and participant's workbook accompany this videotape. These materials are available at cost from:

The Thursday Night Group
1431 Ocean Avenue, Suite B
Santa Monica, CA 90401

DEALING WITH FEELINGS REGARDING NUCLEAR ISSUES. © TNG, Inc. 1987
In the Classroom (Running time 14:30)

Designed as part of a two-hour teacher training workshop, this videotape presents one teacher dealing with the emotions which arise in junior high school students as they discuss nuclear age issues. The videotape illustrates a workshop process for handling emotions generated by controversial subjects with students of varying ages.

The materials include videotape excerpts of the workshop, the leader's guide, a participant's workbook accompany this videotape and are available from:

The Thursday Night Group
1431 Ocean Avenue, Suite B
Santa Monica, CA 90401

SKILLS CONTINUUMS

(will include)

Elementary Science Continuum

Elementary Social Studies Continuum

Secondary Science Continuum

Secondary Social Science Continuum

ELEMENTARY SCIENCE CONTINUUM

Science is a basic subject within the curriculum. It is viewed as a body of collected knowledge that explains the universe. It is also viewed as a set of processes and skills that can be used to acquire and compile information systematically. The dynamic relationship between systematic processes and knowledge is the essence of the scientific enterprise. In this regard, science is the acquiring and organizing of knowledge in such a way that natural phenomena are more adequately explained and their usefulness to humankind is enhanced. A major area of emphasis is the development of those values and attitudes that relate to the personal involvement of the individual with her or his environment and with all other human beings.*

*Adapted from Science Framework for California Public Schools (Sacramento: State Department of Education. 1978).

ORGANIZATION

The Science Continuum encompasses the four competency strands of knowledge, thinking processes, skills, and attitudes. Within each strand, the continuum includes essential student objectives. However, the continuum does not limit the scope of the science curriculum. Teachers should encourage students to progress to the extent of their interests and abilities. In the continuum, certain symbols are used. Although these symbols identify specific grade-level applications, introduction and emphasis may occur at earlier grade levels.

Knowledge Strand: The goal is to assist students in developing knowledge of processes, facts, principles, generalizations, and applications - the products of science - and to encourage their use in the interpretation of the natural environment. Acquisition of organized knowledge is a long-range goal of science and science education. Through an understanding of contributing facts, unifying principles, and relevant processes, organized knowledge gradually takes on meaning for the learner.

At all levels, the knowledge goal must be in balance with and consistent with the other components of thinking processes, skills, and attitudes. Special types of knowledge can be included within this area:

- Knowledge that enables the learner to communicate the thinking processes and skills of science
- Knowledge that constitutes broad generalizations which interrelate the many facts, concepts, and principles of all sciences
- Knowledge of how science and technology affect society
- Knowledge that constitutes the content, basic concepts, and structure of the major disciplines in science

Knowledge areas within the continuum include Organisms, Matter and Energy, and the Universe (geology, meteorology, and astronomy).

Thinking Process Strand: The goal is to help students develop and apply rational and creative thinking processes. As defined here, these processes refer to the cognitive techniques involved in scientific inquiry as well as those which are basic to all rational thinking. Such processes as observing, measuring, comparing, and classifying lead to more sophisticated processes, such as inferring, generalizing, and theorizing.

Skill Strand: The goal is to help students develop and use fundamental skills in the manipulation of materials and equipment; in caring for and handling living organisms; and in gathering, organizing, and communicating information relating to science. Various skills are utilized when the student employs thinking processes to develop a conceptual understanding of the natural environment and collects information through observation, manipulation of materials and apparatus, reading, listening, use of measuring instruments, and handling of living organisms. The learner employs language and mathematical skills in recording and organizing information. A major goal of science education is to provide opportunities for learners to develop and use these manipulative and communicative skills. The skills goal is not only critical to science education and learning, but it is also important to the development of competencies necessary for effective citizenship.

Attitudes Strand: The goal is to assist students in the development of values, aspirations, and attitudes which promote the personal involvement of the individual with the environment and society. The attitudes listed relate to what is hoped students will accomplish individually, through self-motivation, and as a result of science instruction. Positive attitudes toward science and learning are prerequisites to effective learning in other strands. Objectives of the attitudes strand include the ability of the learner to internalize scientific attitudes; to establish the personal and social relevance of what has been learned about science, scientists, and society; and to enjoy and appreciate science.

IMPLEMENTATION

Science knowledge, processes, skills, and attitudes relate to the total curriculum of the school. Specifically, the teaching of science promotes language development by providing learners with an experiential basis for reading, writing, speaking, and listening. The nature of science stimulates motivational experiences that encourage language development.

As with language instruction, science utilizes and reinforces mathematical skills. Science instruction, with its accompanying laboratory activities, makes the use of such skills more interesting, more useful, and more applicable to "real-life" situations. Problem-solving skills and knowledge, learned in conjunction with science studies, assist the individual with decision making in everyday-life situations and lead to the goal of creating scientifically literate citizens.

SCIENCE CONTINUUM

KINDERGARTEN, GRADES 1 - 6

SYMBOLS
---- = AWARENESS/EXPOSURE
□ = INTRODUCTION/DEVELOPMENT
■ = MASTERY/EMPHASIS
—— = MAINTENANCE/REINFORCEMENT

KNOWLEDGE

DEMONSTRATES KNOWLEDGE OF THE PROCESSES AND PRODUCTS OF SCIENTIFIC INQUIRY.		K	1	2	3	4	5	6	7-8
RELATIONSHIP BETWEEN KNOWLEDGE AND SCIENTIFIC INQUIRY.									
Science is concerned with how and why natural phenomena occur and function.	*	----	□	■	——	■	——	■	——
Controlled experiments differ from a random trial and error approach.	*		----	----	□	——	■	——	——
Scientific inquiry is used in investigations and experiments.		□■	——	■	——	■	——	■	——
DEMONSTRATES KNOWLEDGE OF SCIENTIFIC CONTENT: ORGANISMS.									
EACH TYPE OF ORGANISM HAS ADAPTED TO SPECIFIC CONDITIONS FOR LIFE.									
There are characteristics which distinguish living from non-living organisms.	*	□■	——	■	——	■	——	■	——
Living things are interdependent.	*	----	□	——	■	——	■	——	——
Each organism is adapted by structure, function, and behavior to its environment.	*	□	■	——	■	——	■	——	——
The cell is the microscopic unit of structure basic to most living organisms.	*				----	□■	——	■	——
Organisms may be classified by similarities and differences in characteristics.	*	----	□■	——	■	——	——	■	——
Organisms have similar functions.		----	□	——	——	——	■	——	----

*Essential objectives and skills are identified with an asterisk; however, they are not formally assessed.

KNOWLEDGE

DEMONSTRATES KNOWLEDGE OF SCIENTIFIC CONTENT: ORGANISMS. (CONT.)		K	1	2	3	4	5	6	7-8
Every species has a life cycle in which the same pattern of development is repeated from generation to generation.	*	□ ■		■		■		■	
THERE IS CONTINUOUS EXCHANGE OF MATTER AND ENERGY BETWEEN ORGANISMS AND THEIR ENVIRONMENT.									
There are many cycles in an ecosystem.						□		■	
The environment affects the survival of organisms.	*		□			■		■	
Living things capture matter and energy from the environment and return them to the environment.	*		□	■		■		■	
Organisms affect the environment.			□	■		■		■	
DEMONSTRATES KNOWLEDGE OF SCIENTIFIC CONTENT: MATTER AND ENERGY.									
MATTER EXISTS IN VARIOUS FORMS WHICH HAVE SPECIFIC PROPERTIES.									
The physical conditions of temperature and pressure determine in which of the states of matter a substance will be found.			□ ■			■			
Each kind of matter may be identified and classified by its characteristic physical and chemical properties.	*	□		■			■		
A physical change is a change in the size, shape, or state of matter.	*		□ ■			■			
A chemical change is a change in the molecular structure of matter.	*				□		■		
Matter consists of particles.						□	■		

SCIENCE

KNOWLEDGE

DEMONSTRATES KNOWLEDGE OF SCIENTIFIC CONTENT: MATTER AND ENERGY. (CONT.)		K	1	2	3	4	5	6	7-8
ENERGY EXISTS IN VARIOUS FORMS WHICH HAVE SPECIFIC PROPERTIES.									
There are various forms of energy.	*			□				■	
Energy may be changed from one form to another.	*			□		■		■	
Energy must be applied to do work.	*		□					■	
DEMONSTRATES KNOWLEDGE OF SCIENTIFIC CONTENT: THE UNIVERSE.									
ORDER AND CHANGE EXIST IN THE UNIVERSE.									
There are many kinds of objects in space.		□■		■			■		
The relationships between the earth and the sun affect daily, seasonal, and annual changes in the environment.	*	□	■		■			■	
As the earth rotates on its axis, it revolves around the sun.					□		■		
The moon is the natural satellite of the earth.				□			■		
THERE ARE PATTERNS IN THE UNIVERSE.									
The motion of objects in space can be predicted.	*	□■			■		■		
Conditions for life are affected by available sunlight.		□■		■			■		
There is continuous interaction between matter and energy throughout the universe.	*		□			■		■	
THERE ARE FORCES IN THE UNIVERSE.									
Gravity and momentum affect the relationship of objects in space.	*		□■		■			■	
Astronomers use a variety of instruments in observing changes in the universe.						□		■	

KNOWLEDGE

DEMONSTRATES KNOWLEDGE OF SCIENTIFIC CONTENT: THE UNIVERSE. (CONT.)		K	1	2	3	4	5	6	7-8
THERE ARE FORCES IN THE UNIVERSE.									
The sun is the source of energy for life on earth.	*		□		■			■	
The amounts of the sun's energy absorbed by land, water, and air affect weather and climate.	*			□		■		■	
Earth's matter is in continuous change.	*		□			■		■	
The atmosphere affects the amount of solar energy reaching the earth.			□ ■		■			■	
Solar energy can be converted into other forms of energy.	*		□ ■			■		■	
Light and matter interact in various ways.			□		■		■		
DEMONSTRATES THAT A SYSTEM IS A GROUP OF RELATED OBJECTS WHICH HAVE CERTAIN PROPERTIES AND FUNCTIONS.									
A SYSTEM IS A GROUP OF RELATED OBJECTS OR EVENTS WHICH FORM A WHOLE.									
Systems have specific properties, functions, and boundaries.	*			□	■				
A model may be designed to provide a possible explanation of how a system functions.					□			■	
Objects within a system may interact.			□			■			
There may be one or more sub-systems within a system.					□			■	
THERE ARE RELATIONSHIPS BETWEEN MATTER AND ENERGY.									
Energy can be used to change matter from one state to another.	*	□			■		■		

SCIENCE

KNOWLEDGE

DEMONSTRATES THAT A SYSTEM IS A GROUP OF RELATED OBJECTS WHICH HAVE CERTAIN PROPERTIES & FUNCTIONS.		K	1	2	3	4	5	6	7-8
THERE ARE RELATIONSHIPS BETWEEN MATTER AND ENERGY.									
On earth, living things have an important part in the relationship between matter and energy.	*		□			■			
Matter and energy can be changed from one form to another, but the total sum of matter and energy remain the same.	*				- -	□		■	
Interaction of matter and energy occurs in non-living things.			□	■		■			

THINKING PROCESSES

DEVELOPS ABILITY TO GENERATE DATA.		K	1	2	3	4	5	6	7-8
Explores, observes, and examines objects or events, using a combination of senses to collect and process data.	*	□ ■	■	■	■	■	■	■	
Gathers and interprets data by using the appropriate instruments to aid the senses in making observations (appropriate to the learner's stage of development).	*	- -	- -	□ ■	■	■	■	■	
Determines the need to repeat observations as a means of improving reliability and verifying data.	*			- -	□			■	
Identifies the names of objects and sequences of events.	*	□ ■			■		■		
Recalls information formerly obtained and integrates it with new information.		- -	□			■		■	
Identifies, names, and measures the conditions of changing events and the changes in characteristics of materials.		- -	□					■	
Uses direct comparisons and simple measurements to generate data.	*	□							

THINKING PROCESSES

DEVELOPS ABILITY TO ORGANIZE AND REPORT DATA.		K	1	2	3	4	5	6	7-8
Develops and uses various classification systems.	*	□			■			■	
Organizes material in a serial or sequential form.	*	□			■		■		
Develops ability to communicate data.	*	□	■			■		■	
DEVELOPS ABILITY TO APPLY AND EVALUATE DATA AND TO GENERATE HYPOTHESES.									
Identifies statements or data having direct relationship to the solution of a specific problem.	*			---	□			■	
Suggests possible reasons as to why and how events have taken place.	*	□	■		■				
Predicts and draws inferences from data.	*		---	□	■	■	■	■	
Evaluates consistency and accuracy of data obtained.	*				□		■		
Recognizes the differences between facts and hypotheses.	*		□	■	■	■	■	■	
Designs simple investigations to support or refute an hypothesis.	*	□	■	■	■	■	■	■	
PARTICIPATES IN SCIENTIFIC INQUIRY AT THE APPROPRIATE LEVEL.									
By questioning, identifies and delineates a problem by forming questions likely to be answered through investigation.	*		---	□		■		■	
Proposes a possible answer to identified problems.	*	□		■		■			
Plans an experiment or an appropriate science investigation.	*		□	■			■		
Generates, records, and organizes data.	*	□	■	■	■	■	■	■	

SCIENCE

THINKING PROCESSES

PARTICIPATES IN SCIENTIFIC INQUIRY AT THE APPROPRIATE LEVEL. (CONT.)		K	1	2	3	4	5	6	7+8
Analyzes, evaluates, and interprets data, reaching a judgment about situations or events.	*	- - -	□ ■		■		■		
Summarizes experiences and relates them to others.	*		□		■		■		
SKILLS									
ASSEMBLES AND USES LABORATORY APPARATUS.									
Selects and manipulates science materials and equipment in a safe manner.	*	□	■	■	■	■	■	■	
Follows directions and safety procedures in classroom and individual laboratory investigations.	*	□	■	■	■	■	■	■	
DEMONSTRATES PROPER TECHNIQUES IN HANDLING AND CARING FOR LIVING ORGANISMS.									
Handles classroom animals and plants in a careful and safe manner, following prescribed procedures.	*	□	■	■	■	■	■	■	
Provides and maintains environments for animals and plants that are conducive to optimum life functions.		□	■	■	■				
Develops and maintains a record system for living organisms delineating their life processes and environmental relationships.		□				■		■	
GATHERS DESCRIPTIVE AND QUANTITATIVE INFORMATION.									
Makes and records observations of objects and events, identifying basic characteristics.	*	□	■		■		■		
Asks relevant questions.	*	□	■			■		■	
Identifies and orders objects by basic characteristics.	*	- - -	□ ■		■		■		

SKILLS

GATHERS DESCRIPTIVE AND QUANTITATIVE INFORMATION. (CONT.)		K	1	2	3	4	5	6	7-8
Utilizes quantitative methods to gather information.	*		□	—	—	■	—	■	—
Describes expected outcome from data of past observations.		- - -	□	■	—	■	—	■	—
Seeks and evaluates explanatory ideas of others.		- - -	- - -	□ ■	—	—	■	—	—
GATHERS DATA AND IDEAS, USING READING SKILLS.									
Selects and uses science textbooks, reading references, and audio-visual materials.	*	- - -	□	—	—	■	—	■	—
Utilizes appropriate reading skills in comprehending science content.	*	- - -	□ ■	■	■	■	■	■	—
RECORDS, ORGANIZES, AND PRESENTS DATA AND IDEAS, USING MATHEMATICAL SKILLS.									
Records data from observations in an appropriate graphic format.	*	- - -	□	■	—	■	—	—	—
Uses mathematical tools in manipulating data and solving problems.	*		- - -	□	—	■	—	■	—
Constructs scaled models of objects in three-dimensional shapes.					- - -	□	—	■	—
Uses S.I. metric and English systems effectively.	*		□	—	■	—	■	—	—
RECORDS, ORGANIZES, AND PRESENTS DATA AND IDEAS, USING ORAL AND WRITTEN LANGUAGE SKILLS.									
Explains orally or in writing data, methods, and procedures.	*	□	—	■	—	■	—	■	—
Develops a science vocabulary.	*	□	■	■	■	■	■	■	—

SCIENCE

ATTITUDES

SHOWS CURIOSITY.		K	1	2	3	4	5	6	7-8
Examines unfamiliar objects and events carefully.	*	□	■	■	■	■	■	■	
Relates classification to everyday-life situations.				□	■		■		
SHOWS AN AWARENESS OF AND RESPONSE TO BEAUTY AND ORDERLINESS IN THE ENVIRONMENT.									
Expresses consciousness of and/or pleasure in spatial relationships and environments.	*	□			■	■	■	■	
Seeks opportunities to share ideas with other persons about the relationships within the universe, including the immediate environment.	*	□	■	■			■		
Shows evidence of enthusiasm when observing scientific phenomena.		□ ■	■	■	■	■	■	■	
Shows a willingness to examine and organize objects and events in the environment.	*	□ ■				■		■	
APPRECIATES AND RESPECTS THE NATURAL ENVIRONMENT AND ALL LIVING ORGANISMS (INCLUDING SELF).									
Understands concern for the safety and well-being of self and others.	*	□	■	■	■	■	■	■	
Accepts responsibility for the humane treatment of living organisms in natural and artificial environments.	*	□	■	■	■	■	■	■	
Shows appreciation of both the interdependence of living organisms in the natural environment and the implications of that interdependence for their continued survival.	*		□		■		■	■	
TAKES AN ACTIVE ROLE IN SOLVING SOCIAL PROBLEMS RELATED TO SCIENCE AND TECHNOLOGY.									
Practices conservation in use of food, energy, and materials.	*	□ ■	■	■	■	■	■	■	

ATTITUDES

TAKES AN ACTIVE ROLE IN SOLVING SOCIAL PROBLEMS RELATED TO SCIENCE AND TECHNOLOGY. (CONT.)		K	1	2	3	4	5	6	7-8
Shows concern and responsibility for conserving human and natural resources.	*	---	---	---	□■	—	—	■	—
WEIGHS ALTERNATIVE SCIENTIFIC, ECONOMIC, PSYCHOLOGICAL, AND SOCIAL FACTORS.									
Considers possible resolutions to some problems.		---	---	---	□	■	—	■	—
Shows a willingness to change the experimental conditions when seeking explanations about events.	*		---	---	□	■	■	—	—
ORGANIZES AND REPORTS THE RESULTS OF SCIENTIFIC INVESTIGATIONS IN AN HONEST AND OBJECTIVE MANNER.									
Reports data and ideas willingly.	*	□	■	—	■	—	■	—	—
Seeks and considers explanations of others.	*	---	---	□■	—	—	■	—	—
SHOWS A WILLINGNESS TO SUBJECT DATA AND IDEAS TO CRITICAL EVALUATION OF PEERS.									
Shows willingness to share tentative ideas and explanations with others and seeks and considers their critical evaluations.	*		---	---	□	—	—	■	—
Reacts to discrepancies in a positive and objective manner.	*			---	□	—	—	■	—
HAS A CRITICAL, QUESTIONING ATTITUDE TOWARD INFERENCES, HYPOTHESES, AND THEORIES.									
Points out contradictions between data and conclusions.	*				---	■	—	—	—
Shows willingness to change ideas in the light of new evidence.	*			---	□	■	—	—	—

SCIENCE

ATTITUDES

APPLIES THINKING PROCESSES WHEN INVESTIGATING RELATIONSHIPS AND SOLUTIONS TO PROBLEMS.		K	1	2	3	4	5	6	7-8
Uses senses to analyze and report phenomena.	*	□■	■	■	—	—	—	—	—
Looks for problems and notes discrepancies.	*			---	□	■	—	—	—
VALUES SCIENCE AS AN ENDEAVOR OF HUMAN BEINGS FROM ALL RACIAL, ETHNIC, AND CULTURAL BACKGROUNDS.									
Values the scientific contributions of human beings from varied cultural backgrounds.	*				□	—	■	■	—
Recognizes that cultures throughout the world have contributed to the growth of scientific knowledge.	*				□	—	■	■	—
CONSIDERS SCIENCE-RELATED CAREERS AND MAKES REALISTIC DECISIONS ABOUT PREPARING FOR SUCH CAREERS.									
Shows respect for the many science-related careers of people in our society.	*		□	—	—	■	■	■	—

ELEMENTARY SOCIAL STUDIES CONTINUUM

The central purpose of social sciences education today is to "develop responsible citizens who will, in turn, preserve and continue to advance progress toward a just society."*

In California, five goals have been identified to promote the achievement of civic competency. These goals relate to the development of knowledge and understandings drawn from the various fields of the social sciences, including geography, economics, history, government, sociology, anthropology, and psychology; the development of intellectual and workstudy skills appropriate to the study of social issues; the development of understanding and respect for individual and cultural differences and similarities; the development of a personal set of values that enables the individual to act with dignity and maturity; and participation in the activities of society that allow for growth in decision making and problem solving.

*Social Sciences Education Framework for California Public Schools, Kindergarten and Grades One Through Twelve (Sacramento: California State Department of Education, 1975).

ORGANIZATION

The content of social studies, incorporating its unique body of knowledge about the human experience, differs markedly from that of other subject fields. However, it cannot be taught and its learnings applied unless important skill areas of English, reading, and mathematics are utilized. Therefore, in addition to the standard map and globe skills and valuing skills identifiable with social studies content, the Social Studies Continuum includes those skills that enable pupils to perform research and to organize information, to do critical thinking and problem solving, and to validate concepts.

The elementary school continuum retains the identical skill areas as contained in the continuum for secondary schools. These skills are:

- Locating information
- Interpreting graphic materials
- Understanding maps and globes
- Organizing information
- Critical thinking
- Problem solving
- Valuing
- Participating in society

Each broad skill area on the continuum identifies not only the components of that skill but also its subparts since many pupils may have missed a significant segment of a key needed to achieve mastery of that skill.

Those skills that are essential for success at a particular grade level are indicated with an asterick. Symbols are also included to designate awareness/exposure, introduction, maintenance/reinforcement, and mastery levels.

No formal assessment of these skills is planned for elementary school pupils. However, it is expected that teachers will provide informal tests and evaluations throughout the year to assess pupil progress in achieving mastery of each skill introduced and maintained.

IMPLEMENTATION

In using the continuum, the teacher first defines the skills to be learned at a specific grade level and then develops learning units around a set of course objectives that includes these skills. Once introduced each skill should be maintained through application and reinforcement at increasingly higher levels of sophistication in succeeding grades. Various materials and teaching-learning strategies can be utilized to assist the student in mastering the skills assigned.

The teacher utilizes various schedules and grouping practices in conducting instruction on the concepts, skills, and values of social studies. The subject content may be taught as a core around which learnings in other subject areas are combined. Social studies may also be taught as an independent subject within a pre-determined daily and/or weekly schedule, or in support of other subject content.

Different types of pupil groupings may be arranged in the classroom, depending upon the topic or problem under study. In the problem-solving approach, pupils hypothesize the answer to a question; they divide into several groups to locate information about the question or topic from textbooks and multimedia materials; and they discuss (in groups) what they have found out, select a leader to present their ideas to other class members, and analyze the data presented by all groups. After analysis, the concluding information is compared with the original hypothesis. In succeeding lessons, the acquired information is used in various activities (for example, to build a model city) for application and reinforcement of concepts.

During the group time, the teacher instructs individual pupils in special skills and moves from group to group, assisting with ideas and explanations.

Placement of pupils in groups (or at centers) may be determined by difficulty of material, type of material, or by special interest or activity. Because they learn from each other, the teacher may also use the alternative approach of grouping pupils in a heterogeneous manner by levels of achievement and ethnic representation.

The Social Sciences Education Framework* delineates the broad program of the social studies. Based on the Framework, the Social Studies Scope and Sequence Guidelines** was prepared to provide a:

- Description of the areas of study and settings for Social Studies instruction.
- Correlation of specific work-study skills with other subject fields.
- Discussion of the social studies goals.

In addition, the Guidelines suggest study units and skills of other subject areas that are also part of the social studies. Indicated skills are included for reading, listening and speaking, writing, mathematics, and using maps and globes.

The following suggested settings or study units pertain to the theme which has been established for each grade:

Kindergarten***

Theme: "People Everywhere"

Look at Me!
My Friends and I - Likenesses and Differences
Learning About My School
Exploring My Neighborhood
People Who Help Me
Holidays for Me and Others
The Changing Seasons
Rules I Know

*Social Science Education Framework for California Public Schools, Kindergarten and Grades One Through Twelve (Sacramento: California State Department of Education, 1975).

**Social Studies Scope and Sequence Guidelines: Implementating the State Framework, K-12. An Instructional Bulletin With Illustrative Units and Lesson Outlines (Sacramento: California State Department of Education, Instructional Planning Division: Publication No. GC-64, 1977).

***First Experiences: The Kindergarten Year, A Social Studies Program for Young Children (Los Angeles Unified School District, Instructional Planning Division: Publication No. EC-451, 1977).

Grade 1

Theme: "The Individual - Developing a Self-Concept"

Being Myself
Learning From Others
My Needs
Rules, Rights, and Responsibilities*
The World Around Me
Holidays I Celebrate
My Heritage

Grade 2

Theme: "Relationships With Others"

Groups - Changing Roles and Responsibilities
Living in Different Environments
Using our Natural Resources
How We Obtain the Things We Need and Want*
Meeting People of the Other Cultures
Learning About Holidays, Customs, and Traditions
Ways that People and Places Change

Grade 3

Theme: "People and Their Communities"

Communities in Early America
Groups in Communities*
Communities and Social Patterns
Geography and Resources
How People Change Communities
Needs of Communities
Los Angeles - Its Changing Needs
My Community - A Link With Other Places
The Cultures of Different Communities
Earning and Spending Money - Making Choices

*Social Studies Scope and Sequence Guidelines: Implementing the State Framework, K-12. An Instructional Bulletin With Illustrative Units and Lesson Outlines (Los Angeles Unified School District, Instructional Planning Division: Publication No. GC-64, 1977).

Grade 4

Theme: "Cultural Groups Within Society"

Regions of California*
California's Cultural Profile - Multicultural Studies
Comparative Cultures (i.e., Africa, Mexico, Japan)
Technology and Change in the West
Environment and Changing Lifestyles
Immigrants to California
Climates and Regions Around the World
Resources We Need

Grade 5

Theme: "The United States - A Nation of Cultural and Technological Change"

Pre-Columbian America
Colonial America
Explorers to the New World
Regions of the United States and Their Influence on Cultural Adaptation
Scientific Discoveries and Inventions
The Birth of Cities in America
Government Institutions
Settlement and Expansion of National Boundaries
The Industrial Revolution in America*
The Practice of Democracy in American Life
Mobility in America
Cultural Contributions to American Life

Grade 6

Theme: "Global Societies"

Ancient Civilization*
The Growth of Medieval Cities
Countries and Societies of the Modern World
The Influence of Democracy in the World Today
The Economics of World Powers
Third World Countries
The American Justice System
Consumer Practices
The Future--Our Challenge
Cultural Pluralism in America

*Social Studies Scope and Sequence Guidelines: Implementing the State Framework, K-12. An Instructional Bulletin With Illustrative Units and Lesson Outlines (Los Angeles Unified School District, Instructional Planning Division: Publication No. GC-64, 1977).

SOCIAL STUDIES CONTINUUM

KINDERGARTEN, GRADES 1 - 6

SYMBOLS
- ---- = AWARENESS/EXPOSURE
- □ = INTRODUCTION/DEVELOPMENT
- ■ = MASTERY/EMPHASIS
- —— = MAINTENANCE/REINFORCEMENT

LOCATING INFORMATION		K	1	2	3	4	5	6	7
Exchanges ideas on a specific topic.	*	□	——	■	——	——	——	——	——
Listens for the following purposes:									
To receive directions and explanations	*	----	----	----	----	□	——	■	——
To expand word meanings	*		----	----	□	——	——	■	——
To comprehend ideas									
. To identify a problem	*				----	□	——	■	——
. To interpret facts and form opinions	*						□	——	——
. To determine point of view of speaker	*							□	——
. To interpret and evaluate ideas	*						□	■	——
Acquires information from pictures, charts, direct observation, and people.	*	□	——	■	——	——	——	——	——
Writes simple business letters for information.	*			----	□	——	■	——	——
Locates pertinent information from various reading sources:	*								
. Picture/story books		□	■	——	——				
. Textbooks			□	——	——	——	■	——	——
. Dictionary				----	□	——	——	■	——
. Newspapers			----	□	——	——	——	■	——
. Periodicals				----	□	——	——	■	——
. Library card file						----	□	■	——
. Atlas						----	□	■	——
Uses parts of a book to find information:	*								
. Author		----	----	----	□	■	——	——	——
. Title page		----	----	----	□	■	——	——	——
. Table of contents			----	----	□	■	——	——	——
. Index				----	----	□	■	——	——
. Chapter and unit headings				----	□	——	——	■	——
. Glossary					----	----	□	■	——

*Essential objectives and skills are identified with an asterisk; however, they are not formally assessed.

LOCATING INFORMATION (CONT.)		K	1	2	3	4	5	6	7
Collects facts on a selected topic and writes an explanation using them.	*				□	—	—	■	—
Selects and compares information acquired from various sources.	*			- - -	- - -	- - -	□	■	—
Discriminates between primary and secondary source materials.	*						□	—	—
INTERPRETING GRAPHIC MATERIALS									
Interprets pictures.									
. Observes and explains content.	*	□	—	■	—	—	—	—	—
. Compares information from several different (or similar) pictures.	*	- - -	□	—	■	—	—	—	—
. Relates words and phrases to pictorial content.	*	- - -	□	—	■	—	—	—	—
. Relates pictorial content to main ideas, supporting details.	*	- - -	□	—	—	■	—	—	—
Interprets charts, tables, graphs, diagrams, time lines.									
. Categorizes given information.	*			- - -	□	—	■	—	—
. Classifies information individually collected.	*		- - -	- - -	□	—	■	—	—
. Makes lists under specific headings.	*			□	—	■	—	—	—
. Submits information for classroom charts, tables, graphs.	*	- - -	□	—	■	—	—	—	—
. Prepares a chart, table, graph from given information/individually researched information.	*				- - -	□	—	■	—
. Reads, identifies, and explains information contained in various chart materials.	*		□	—	—	—	—	■	—
. Places chronological facts and events in sequential order.	*	- - -	- - -	- - -	□	—	—	■	—

INTERPRETING GRAPHIC MATERIALS (CONT.)		K	1	2	3	4	5	6	7
. Prepares a time line from given information/individually researched information.	*						□		
. Reads, identifies, and explains information contained in a time line.	*					□		■	
Interprets posters and cartoon materials.									
. Reads and explains information or message contained in various posters and simple cartoons.	*				□				
. Describes uses of specific illustrative materials.	*							□	
. Creates individual posters and cartoons to voice a particular idea.	*							□	
Analyzes and compares information contained in various graphic materials.	*				□				
UNDERSTANDING MAPS AND GLOBES									
Identifies the globe as a model of the earth.	*	□			■				
Provides definition of a map.	*		□		■				
Identifies various physical and human-made features (land, bodies of water, bridges) illustrated on a map.	*			□				■	
Compares sizes and shapes of land and water masses.	*				□			■	
Recognizes and applies map and globe concepts and terms such as the following:	*								
. Area/region			□			■			
. Location		□		■					
. Direction		□						■	
. Boundary/territory			□				■		
. Distance				□			■		
. Hemisphere					□		■		
. Solar system					□			■	
. Rotation, axis, orbit						□			
. North and South Poles			□			■			
. Seasons				□				■	
. Equator				□			■		
. Climate zones						□			

UNDERSTANDING MAPS AND GLOBES (CONT.)		K	1	2	3	4	5	6	7
. Time zones							□		
. Degree						□			
. Latitude and longitude						□		■	
. International Date Line						□			
Identifies, describes, and uses the following major parts of a map:	*								
. Title				□			■		
. Legend			□			■			
. Map compass						□		■	
. Scale					□		■		
. Map grid						□	■		
Uses the International Color Scheme to determine correct elevations.	*					□			
Interprets the elevation of land from the flow of rivers.	*							□	
Compares maps of different areas. (Notes a smaller scale must be used to map larger areas.)	*					□		■	
Identifies, describes, and reads the following types of maps:									
. Situational maps	*								
Classroom	*	□			■				
Neighborhood			□			■			
Community	*			□			■		
. Resource/products	*			□				■	
. Transportation	*			□			■		
. Vegetation	*					□		■	
. Relief	*				□		■		
. Population	*					□		■	
. Weather	*					□			
. Climate	*					□		■	
. Historical	*					□		■	
. Political	*			□			■		
. Physical	*			□		■			
Computes distances between points, using a mileage scale.	*					□		■	
Constructs maps for a specific purpose.	*	□		■					
Recognizes purposes of various map projections.	*							□	
Relates cultural adaptations to such factors as climate and the earth's physical features.	*					□		■	

UNDERSTANDING MAPS AND GLOBES (CONT.)		K	1	2	3	4	5	6	7
Recognizes relationship of political boundaries to conflicts among nations.	*							□	
ORGANIZING INFORMATION									
Answers questions related to topic, using complete sentences.	*		□		■		■		
Classifies the following items:	*								
. Objects and pictures		□		■					
. Words, according to category				□			■		
Places the following types of items in sequential order:	*								
. Pictures		□		■					
. Days of the week		□			■				
. Months of the year		□			■				
. Ordinal numbers (first, second, third, etc.)			□		■				
. Personal experiences			□			■			
. Story details		□							
. Directives, processes, or procedures					□		■		
Recounts factual version of an event, discussion, or encounter.	*			□		■			
Memorizes pertinent songs and poems relating to study topic.	*	□				■			
Uses indefinite time concepts (past, future, long ago, after, etc.) in discussions and in oral and written work.	*		□				■		
Prepares oral and written communications such as the following:	*								
. Signs, captions, labels	*	□		■					
. Group letters	*		□		■				
. Descriptions of persons, places, things, interests, and events	*		□		■			■	
. Descriptions using special words to describe emotions, attitudes, value commitments					□			■	

ORGANIZING INFORMATION (CONT.)		K	1	2	3	4	5	6	7
. Answers to questions related to a unit of study	*		- - -	□	—	■	—	■	—
. News articles for school paper				- - -	□	—	—	■	—
. Paragraph on opinion/persuasion	*				- - -	□	—	■	—
. Paragraph supporting a point of view	*				- - -	□	—	■	—
Takes part in discussions, building upon the ideas of others.	*				- - -	□	—	■	—
Prepares material for, and takes part in, a debate.							- - -	□	—
Creates and participates in various activities involving a study of people, events, and ideas.									
. Writes dialogue for plays, puppet shows.				- - -	□	—	—	■	—
. Communicates thoughts through facial expressions, body movement, pantomime.	*					- - -	□	—	—
. Prepares information for original class-room dances, songs, instrumental renditions.							- - -	□	—
Provides summaries in various forms.	*								
. Writes lists.	*	- - -	□	—	■	—	—	—	—
. Paraphrases information orally.	*		- - -	□	—	—	■	—	—
. Paraphrases information in written paragraphs.	*				- - -	- - -	□	■	—
. Chooses best title for a picture, story.	*		□	—	■	—	—	—	
. Provides appropriate, original title for a picture and a story.	*		- - -	□	—	■	—	—	
. Writes details to support main ideas.	*					- - -	□	■	—
. Writes given facts under prepared outline headings.	*				- - -	□	—	■	—
. Makes outline of topics to be investigated	*						- - -	□	—

ORGANIZING INFORMATION (CONT.)		K	1	2	3	4	5	6	7
. Makes outline preliminary to written work.	*						- - -	□ —	—
. Writes paragraphs from a written outline.	*						- - -	□ —	—
Takes notes.	*								
. Condenses an oral report, a discussion, to key words and phrases.	*					- - -	□ —	—	—
. Arranges notes for a specific purpose.	*						- - -	□ —	—
Prepares a bibliography.									
. Develops a simple bibliography from given resources.	*						□ —	—	—
. Prepares a bibliography based on independent research.							- - -	□ —	—
CRITICAL THINKING									
Compares ideas contained in various sources.	*								
. Explains ideas.	*	- - -	□ —	—	—	—	■ —	—	—
. Identifies similarities and differences among the ideas.	*	- - -	□ —	—	—	—	—	■ —	—
Explains main ideas and supporting ideas in:	*								
. Pictures and stories	*	- - -	□ —	—	—	—	—	■ —	—
. Paragraphs	*			- - -	□ —	—	—	■ —	—
Predicts the outcome of a particular behavior.	*	- - -	- - -	□ —	—	—	■ —	—	—
Differentiates between fact and imagination.	*	- - -	- - -	- - -	□ —	■ —	—	—	—
Differentiates between fact and opinion.	*				- - -	□ —	—	■ —	—
Orders the sequence of a process or procedure.	*		- - -	□ —	—	—	—	■ —	—
Uses sequence and chronology in discussions.	*				- - -	□ —	■ —	—	—
Regroups previously categorized facts according to different relationships and gives new interpretations based on the regroupings.	*					- - -	□ —	—	—

CRITICAL THINKING (CONT.)		K	1	2	3	4	5	6	7
Interprets data.	*								
. States the meanings of various concepts.	*			- - -	□	—	■	—	—
. Uses correct terminology in explaining information.	*			- - -	- - -	□	—	■	—
Generalizes about people and events.									
. Demonstrates conceptual understanding about the topic under study.	*				- - -	□	—	■	—
. Acquires relevant factual information.	*				□	—	—	—	—
. Shows relationship among several concepts.	*						□	—	—
. States a generalization based upon factual evidence.	*					□	—	■	—
Comprehends relationships among ideas.	*		- - -	- - -	- - -	□	—	■	—
Applies information to new situations.	*		- - -	□	—	—	■	—	—
Infers and gives reasons for inferences.	*				- - -	□	■	—	—
Analyzes cause-and-effect relationships among political, social, and economic events.	*					- - -	□	—	—
Uses logic in addressing issues.							- - -	□	—
Judges the adequacy of information for a specific purpose.									
. Ascertains reliability according to purpose of the information.								□	—
. Ascertains reliability according to agreement of other sources								□	—
Distinguishes between relevant and irrelevant information.								□	—
Expresses opinions based upon appropriate information.	*						- - -	□	—
Uses given facts about a society or social situation to formulate hypotheses about the past or the present and to reach conclusions.						- - -	- - -	□	—

CRITICAL THINKING (CONT.)		K	1	2	3	4	5	6	7
Reserves judgment until opposing sides in a controversy have been heard.	*							□	
Judges the merits of an issue; makes choices based on possible consequences to individuals and society.								□	
Synthesizes known information by combining ideas in a different and original way.								□	
PROBLEM SOLVING									
Identifies or states a problem about a given situation.	*	□				■			
Formulates possible solutions to a problem (hypothesizing).	*		□			■			
Identifies steps in the problem-solving method.	*				□		■		
Determines data needed to solve a problem.	*				□			■	
Applies problem-solving method, using deductive and/or inductive reasoning.				□			■		
Selects from various alternatives best solution to a problem.	*					□		■	
Relates a school problem to a community problem.	*				□			■	
Identifies problems needing solution.	*						□	■	
VALUING									
Identifies the following values when presented in actions or words:	*								
. Integrity	*			□				■	
. Courage	*		□				■		
. Responsibility	*			□		■			
. Justice	*			□			■		
. Reverence	*				□		■		
. Love	*	□			■				
. Respect for law and order	*	□						■	

VALUING (CONT.)		K	1	2	3	4	5	6	7
Clarifies through discussion and/or actions an awareness of one's values based on such foundations as:									
. Family traditions	*	□							
. Societal traditions	*				□				
. Religious beliefs	*						□		
. Peer associations	*			□					
Identifies pleasant and non-pleasant feelings.	*	□							
Identifies the relationship of feelings and knowledge in determining one's personal actions.	*			□					
States one or more experiences that may lead to positive changes in values.	*			□			■		
Identifies several different ways in which values may change behavior.	*					□		■	
Identifies or states one or more examples of a value conflict related to:									
. Home	*				□		■		
. School	*		□			■			
. Community					□		■		
. World	*				□				
Identifies or states opposing values in a value conflict.	*						□		
Identifies or describes changes in behavior resulting from the resolution of a value conflict.	*							□	
PARTICIPATING IN SOCIETY									
Cooperates with other persons.	*								
. Cooperates with other class members in planning individual and group work.	*	□							
. Assists other students who are working to achieve a common goal.	*	□							
. Follows through with individual and group tasks.	*	□							
. Makes contributions to small and large group discussions.	*			□					

PARTICIPATING IN SOCIETY (CONT.)		K	1	2	3	4	5	6	7
. States own opinion on a given topic.	*	- - -	□	—	—	—	—	—	—
. Sets goals for individual and group work.	*		- - -	- - -	□	—	—	—	—
. Listens to and evaluates fairly the ideas and points of view of others.	*				- - -	□	—	—	—
. Identifies or states one or more advantages of the ability to interact cooperatively with otherpersons.	*				- - -	- - -	□	—	—
Recognizes that all individuals live within a framework of rules and laws.	*								
. Explains the difference between "rights" and "responsibilities."	*		- - -	- - -	- - -	□	—	—	—
. Identifies various responsibilities that people assume relating to the:									
. Home		□	—	—	—	—	—	—	—
. School		□	—	—	—	—	—	—	—
. Immediate community			- - -	- - -	□	—	—	—	—
. Larger community					- - -	□	—	—	—
. Identifies or gives examples of rights people have under the law.		- - -	□	—	—	—	—	—	—
. Identifies one or more ways in which rights may be altered as a result of failure to exercise responsibility.					- - -	- - -	□	—	—
Respects diversity.	*								
. Identifies or cites contributions made by people of diverse cultures to American society.	*	- - -	□	—	—	—	—	—	—
. Demonstrates the ability to empathize with points of view of two opposing sides.	*			- - -	□	—	—	—	—
. Demonstrates the ability to function effectively with representatives of various cultural groups.	*	- - -	- - -	- - -	- - -	□	—	—	—

SECONDARY SCIENCE CONTINUUM

PURPOSES

Science is the discipline which involves the acquiring and organizing of knowledge to explain natural phenomena and to increase its usefulness to humankind. Through the science instructional program in secondary schools, students develop an understanding that science is a body of knowledge comprised of interconnected sets of principles, laws, and theories that explain the known universe and our relationship to it. Students use learning processes to systematically investigate phenomena and acquire and refine information. Outcomes include understanding how human beings use scientific information and discoveries to comprehend and practice the pursuit of objective knowledge as a source of truth.

COMPONENTS

The Science Continuum encompasses the four competency strands of attitudes, thinking processes, skills, and knowledge. Within each strand, the continuum includes objectives and the kinds of performance necessary for the student to achieve each objective. However, the continuum does not limit the scope of the science curriculum. Teachers should encourage students to progress to the extent of their interests and abilities. In the continuum, certain symbols are used. Items with a solid dot identify the expectancy level for all students. Those items without dots identify levels above those expected for all students. An open circle in the K-6 column indicates that certain items are first introduced to the student in elementary school.

Attitude Strand. This strand emphasizes the development of values, aspirations, and attitudes which promote the personal involvement of the individual with the environment and society. The attitudes listed relate to what is hoped students will accomplish, individually, through self-motivation, and as a result of science instruction. Positive attitudes toward science and learning are prerequisites to effective learning in other strands.

Objectives of the attitudes strand include the ability of the learner to: internalize scientific attitudes; establish the personal and social relevance of what has been learned about science, scientists, and society; and enjoy and appreciate science.

Thinking Processes Strand. The goal is to help the student develop and apply rational and creative thinking processes. As defined here, these processes refer to the cognitive techniques involved in scientific inquiry as well as those basic to all rational thinking. Such processes as observing, measuring, comparing, and classifying lead to more sophisticated processes, such as inferring, generalizing, and theorizing.

Skills Strand: The goal is to help the student develop and use fundamental skills in the manipulation of materials and equipment, in caring for and handling living organisms, and in gathering, organizing, and communicating information relating to science.

Various skills are utilized when the student employs thinking processes to develop a conceptual understanding of the natural environment and collects information through observation, manipulation of materials and apparatus, reading, listening, use of measuring instruments, and handling of livings organisms. He or she employs linguistic, mathematical, graphical, and tabular skills in recording and organizing information.

A major goal of science education is the provision of opportunities for learners to develop and use these manipulative and communicative skills. Many areas of the curriculum relate closely to the skills that are critical to science education. Reading, writing, speaking, and listening skills are all basic to the communication needs of science students. Many of the skills described in the section are essential in a broad spectrum of occupations. For example, people in almost every occupation must be able to obtain, record, process, interpret, and report information and to communicate ideas in a clear, convincing manner. The skills goal is not only critical to science education, but it is also important in the development of competencies necessary for effective citizenship.

Knowledge Strand. The goal is to assist the student in developing knowledge of processes, facts, principles, generalizations, and applications -- the products of science -- and to encourage their use in the interpretation of the natural environment. Acquisition of organized knowledge is a long-range goal of science and science education. Through an understanding of contributing facts, unifying principles, and relevant processes, organized knowledge gradually takes on meaning for the learner. He or she will acquire some knowledge as a by-product of instruction intended to develop attitudes, skills, and thinking processes and will acquire other knowledge as a deliberate result of instruction. At all levels, the knowledge goal must be in balance with and consistent with the other goals of science education.

Four types of knowledge can be highlighted as components of this goal: (1) knowledge that enables the learner to communicate the thinking processes and skills of science; (2) knowledge that constitutes broad generalizations which interrelate the many facts, concepts, and principles of all the sciences; (3) knowledge of how science and technology affect society; and (4) knowledge that constitutes the content, basic concepts, and structure of the major disciplines in science.

IMPLEMENTATION

Through the in-service process, the teacher should become fully cognizant of the Science Continuum, its rationale, and its possible use. The goals and objectives of the continuum are basic to all science courses. District-developed pretests and posttests are planned to assist teachers in evaluating each student's level of achievement in relation to the Science Continuum. The results of pretests should be used in planning instruction to meet more effectively group and individual needs. In addition, the teacher should formulate a variety of ways to assist the student needing additional instruction.

Approaches to instruction may include:

Development of learning centers
Assignment to independent study projects
Improvement of classroom management

Use of additional instructional resources
Introduction of changes in organization within the science department; e.g., use of minicourses, team teaching
Expansion of tutoring program
Improvement of counseling

Pretests and other tests prepared by the teacher should:

Be used to evaluate continuum goals and learner performance objectives.
Consist only of items based on performance objectives expected of all students.
Assess understanding of science concepts rather than reading ability.
Avoid items which are of a controversial nature with respect to individual religious or political beliefs.
Relate to life situations common to individuals in all cultural groups.
Involve problem statements with supporting data, as expressed in graphs, tables, pictorials, and other illustrations.
Wherever possible, relate items from skills, thinking processes, and attitudes objectives to knowledge objectives.

Test items related to attitudes should give the learner an opportunity to utilize knowledge applicable to the appropiate scientific attitude. This may or may not reflect the learner's personal attitude.

Test items related to thinking processes should be based on hypothetical problem solving experiments and include questions that assess the student's understanding of scientific methods.

Test items related to skills should include questions about science apparatus, rules of safety, materials, and equipment common to both biological and physical science. Illustrations should be included.

SCIENCE CONTINUUM
GRADES 7-12

SYMBOLS

- ---- = Awareness/Exposure
- O = Introduction/Development
- ● = Assessment/Evaluation
- ——— = Maintenance/Reinforcement

ATTITUDES

	K-6	7	8	9	10	11	12
SHOWS CURIOSITY ABOUT OBJECTS AND EVENTS.							
Shows willingness to examine and organize objects and events in the environment.	O	—	●	—	●	—	—
RECOGNIZES AND REPORTS EVIDENCE OF ORDER AND SYMMETRY IN THE ENVIRONMENT.							
Relates classification to everyday life situations.	O	—	●	—	●	—	—
APPRECIATES AND RESPECTS ALL LIVING ORGANISMS, INCLUDING SELF AND HIS/HER RELATIONSHIP TO THE ENVIRONMENT.							
Accepts responsibility for the care of living organisms in natural and artificial environments.	O	—	●	—	●	—	—
Appreciates the interdependence of living organisms in the natural environment and the implications for continued survival.	O	—	●	—	●	—	—
TAKES AN ACTIVE ROLE IN SOLVING SOCIAL PROBLEMS RELATED TO SCIENCE AND TECHNOLOGY.							
Practices conservation in use of food, energy, and materials.	O	—	●	—	●	—	—
Develops and expresses an opinion on a social issue.	O	—	—	—	—	—	—
Seeks to influence the views and behaviors of others with respect to social issues related to science and technology.					—	—	—
WEIGHS ALTERNATIVE SCIENTIFIC, ECONOMIC, PSYCHOLOGICAL, OR SOCIAL FACTORS WHEN CONSIDERING POSSIBLE SOLUTIONS TO SOME PROBLEMS.							
Recognizes the alternative factors to be considered when examining possible solutions.	O	—	●	—	●	—	—
Examines a variety of alternative viewpoints on scientific issues to form opinions about them.			—	—	—	—	—

ATTITUDES (CONT.)

	K-6	7	8	9	10	11	12
ORGANIZES AND REPORTS THE RESULTS OF SCIENTIFIC INVESTIGATIONS IN AN HONEST AND OBJECTIVE MANNER.							
Understands the need to log only those data he/she has actually gathered.	0		●		●		
Forms opinions only after seeking a variety of data and ideas.			●		●		
Assumes responsibility for reporting results in an honest and objective manner.	0		●		●		
HAS A CRITICAL, QUESTIONING ATTITUDE TOWARD INFERENCES, HYPOTHESES, AND THEORIES.							
Shows an interest in responding to contradictions between data and theory.							
APPLIES RATIONAL AND CREATIVE THINKING PROCESSES WHEN TRYING TO FIND RELATIONSHIPS AMONG SEEMINGLY UNRELATED PHENOMENA AND WHEN SEEKING SOLUTIONS TO PROBLEMS.							
Attempts spontaneously to describe an object or event that has attracted his/her attention.	0		●		●		
Applies science problem-solving techniques in everyday life situations.	0		●		●		
RECOGNIZES THE VALUES OF SCIENCE AS A HUMAN ENDEAVOR REPRESENTING ALL RACIAL, ETHNIC, AND CULTURAL BACKGROUNDS.							
Chooses to gather information and report on the contributions of all cultures to the scientific world.	0		●		●		
Acknowledges that race, sex, or nationality should not constitute a barrier to scientific study.	0		●		●		
Values the scientific contributions of human beings from varying cultural backgrounds.	0		●		●		

ATTITUDES (CONT.)

	K-6	7	8	9	10	11	12
CONSIDERS SCIENCE-RELATED CAREERS AND MAKES REALISTIC DECISIONS ABOUT PREPARING FOR SUCH CAREERS, TAKING INTO ACCOUNT ABILITIES, INTERESTS, AND PREPARATION REQUIRED.							
Values the abilities, interests, and preparation required for a science-related career.			●	—	●	—	—
Assumes responsibility for making a realistic decision about the pursuit of a science-related career.			—	—	—	—	—

THINKING PROCESSES

	K-6	7	8	9	10	11	12
DEVELOPS ABILITY TO GENERATE DATA BY OBSERVING, RECALLING, RECOGNIZING, IDENTIFYING, AND MEASURING.							
Examines objects carefully, using a combination of senses to collect and process data; derives meaning from the observation; recognizes the need to use simple instruments to aid the senses in collecting data.	0	—	●	—	●	—	—
Determines the need to repeat observations as a means of improving reliability.	0	—	●	—	●	—	—
Uses measurement procedures to improve accuracy of observations.	0	—	●	—	●	—	—
Identifies changes in properties and rates of change.	0	—	—	—	—	—	—
DEVELOPS ABILITY TO ORGANIZE DATA BY COMPARING, CLASSIFYING, RELATING, AND ORDERING.							
Perceives similarities and differences in a set of objects; separates a set into groups according to a single characteristic.	0	—	●	—	●	—	—
Develops arbitrary classification systems wherein objects can be put into mutually exclusive categories; uses quantitative measurements as criteria for grouping.			—	—	—	—	—

THINKING PROCESSES (CONT.)

	K-6	7	8	9	10	11	12
DEVELOPS ABILITY TO APPLY AND EVALUATE DATA AND GENERATE THEORIES BY HYPOTHESIZING, PREDICTING, INFERRING, GENERALIZING, THEORIZING, EXPLAINING, JUSTIFYING, JUDGING, AND INTERPRETING.							
Examines environmental issues, pointing out contradictions and discrepancies in the positions of various groups.							
Gathers own data to form own point of view, satisfying any former contradictions.	0						
Recognizes contradictions and unusual events.							
Designs experiments to produce specific data to support or refute a hypothesis.							
PARTICIPATES IN SCIENTIFIC INQUIRY AT THE APPROPRIATE LEVEL.							
Defines a problem related to an unusual event.							
Identifies data needed to test a hypothesis; designs an experiment to generate the data; records and organizes data; and evaluates the hypothesis in light of new data.							

SKILLS

	K-6	7	8	9	10	11	12
ASSEMBLES AND USES LABORATORY APPARATUS, TOOLS, AND MATERIALS IN A SKILLFUL MANNER, GIVING DUE ATTENTION TO SAFETY MEASURES.							
Manipulates simple materials, apparatus, and equipment in a safe manner.	0		●		●		
Demonstrates growth in the ability to manipulate more complex science materials and equipment.			0		●		
Acquires and assembles appropriate science apparatus, materials, and equipment in order to obtain designated data.							

SKILLS (CONT.)

	K-6	7	8	9	10	11	12
DEMONSTRATES PROPER TECHNIQUES FOR HANDLING AND CARING FOR LIVING ORGANISMS.							
Handles plants and animals carefully, following suggested procedures.	O—	—	●	—	●	—	—
Provides an environment for plant and animal life that is conducive to the support of normal life functions.	O—	—	●	—	●	—	—
GATHERS THE INFORMATION NEEDED FOR DEVELOPING OR TESTING INFERENCES AND HYPOTHESES BY MAKING PURPOSEFUL, OBJECTIVE OBSERVATIONS OF THINGS AND EVENTS.							
Makes purposeful, objective observations.	O—	—	●	—	●	—	—
Determines the timing of a series of events.			—	—	—	—	—
GATHERS NEEDED INFORMATION, WHICH HAS BEEN GENERATED BY OTHERS, FROM A VARIETY OF SOURCES APPROPRIATE TO HIS/HER ABILITY LEVEL.							
Listens to the ideas of others.	O—	—	●	—	●	—	—
Gathers information from science textbooks, reference materials, science films, and television.	O—	—	●	—	●	—	—
Finds sources of information needed to solve a problem related to a specific topic.	O—	—	●	—	●	—	—
RECORDS OBSERVATIONS ACCURATELY AND ORGANIZES DATA AND IDEAS IN WAYS THAT IMPROVE THEIR USEFULNESS.							
Orally describes a series of events that have taken place.	O—	—	●	—	●	—	—
Tabulates information and uses tables.			—	—	—	—	—
Interprets graphs and displays data graphically.	O—	—	—	—	—	—	—
COMMUNICATES WITH OTHERS IN A MANNER THAT IS CONSISTENT WITH KNOWLEDGE.							
In group settings, orally describes observations and answers questions.	O—	—	●	—	●	—	—
Explains, either orally or in writing, the methods and procedures involved in carrying out an investigation.	O—	—	—	—	—	—	—

SKILLS (CONT.)

	K-6	7	8	9	10	11	12
USES THE METRIC SYSTEM EFFECTIVELY.							
Counts, uses numbers, and balances objects on an equal-arm balance scale.	O		●		●		
Measures linear distances, using a metric ruler.	O		●		●		
Uses a balance to determine the mass of objects.	O				●		
Measures volume of liquids in a graduated cyclinder marked in metric units.							
APPLIES APPROPRIATE MATHEMATICAL CONCEPTS AND SKILLS IN INTERPRETING DATA AND IN SOLVING PROBLEMS.							
Calculates rates from data.							
Finds the mean and median of a series of measurements.							
Utilizes exponential notation to express very large and very small numbers.							
Determines degree of precision of measurement and quantities derived from measurements.							
Uses calculators and/computers to advantage in manipulating data and solving problems.							

KNOWLEDGE

	K-6	7	8	9	10	11	12
DEMONSTRATES KNOWLEDGE OF THE PROCESSES OF SCIENTIFIC INQUIRY.							
Distinguishes between trial and error and controlled investigations.	O		●		●		
Matches names of various processes and products of scientific inquiry with examples.							
Evaluates procedures in the inquiry process that have been omitted or inadequately performed.							

KNOWLEDGE (CONT.)

	K-6	7	8	9	10	11	12
DEMONSTRATES UNDERSTANDING OF BASIC GENERALIZATIONS, RELATIONSHIPS, AND PRINCIPLES.							
Identifies simple cause-effect relationships.	O	—	●	—	●	—	—
Uses a cause-effect relationship to make a prediction.	O	—	—	—	—	—	—
Recognizes that atoms are composed of electrons, protons, neutrons, and other particles.	O	—	—	—	●	—	—
Recognizes that electrons are negatively charged and protons are positively charged.			—	—	●	—	—
Illustrates that the number of atomic particles varies with each element.			—	—	●	—	—
Recognizes that matter is composed of particles which are in constant motion.			—	—	●	—	—
Describes interaction and reorganization of units of matter and their association with changes of energy.			—	—	—	—	—
Recognizes the uses of fuels.	O	—	●	—	●	—	—
Identifies examples of kinetic and potential energy.			—	—	●	—	—
Identifies pairs of objects having similar properties.	O	—	●	—	●	—	—
Describes systems of classification used to sort a group of miscellaneous objects.	O	—	●	—	●	—	—
Recognizes that classification systems are developed by humans for the use of humans and are one way of helping to understand the basic organization and pattern of nature.			●	—	●	—	—
DEMONSTRATES KNOWLEDGE OF RELATIONSHIPS BETWEEN SCIENCE AND SOCIETY.							
Gives examples of ways in which the use of scientific knowledge has affected society.	O	—	●	—	●	—	—
Describes aspects of a society that tend to encourage or inhibit the advancement of science.			—	—	—	—	—
Identifies types of data valuable in planning environmental changes.			—	—	—	—	—

KNOWLEDGE (CONT.)

	K-6	7	8	9	10	11	12
DEMONSTRATES KNOWLEDGE OF SCIENCE-RELATED CAREER OPPORTUNITIES AND THE PREPARATION NEEDED.							
Compares the work performed by persons in science occupations.	0						
Identifies ways in which careers are science related.	0						
DEMONSTRATES KNOWLEDGE OF CONTRIBUTIONS TO SCIENCE AND TECHNOLOGY MADE BY MEN AND WOMEN OF VARIOUS RACES AND NATIONALITIES.							
Matches significant discoveries to persons responsible.	0						
DEMONSTRATES KNOWLEDGE OF THE RELATIONSHIPS OF SCIENCE TO OTHER AREAS OF HUMAN ENDEAVOR.							
Identifies how modern techniques of determining the age of specimens contribute to knowledge of earlier civilizations.							
DEMONSTRATES KNOWLEDGE OF WAYS IN WHICH ATTITUDES, THINKING PROCESSES, AND SKILLS CAN BE RELATED FOR USE IN PERSONAL DECISION-MAKING.							
Given a list of foods, identifies items that would constitute a nutritious, balanced meal.	0		●		●		
Given manufacturers' literature and consumer research data, selects an object on the basis of comparison of various factors.					●		
Uses data from scientific investigations in presenting a position on a political issue.							
DEMONSTRATES GENERAL KNOWLEDGE OF SCIENCE.							
Recognizes that a cell is the basic unit of structure and function of a living organism.	0		●		●		
Recognizes that all living organisms have the same life processes.	0		●		●		
Demonstrates a basic knowledge of the structures and functions of the human organism.	0		●		●		
Understands and describes living organisms that grow and develop in different environments.	0		●		●		
Recognizes that the sun is the source of energy for green plants and is basic to the growth and maintenance of living organisms.	0		●		●		

KNOWLEDGE (CONT.)

	K-6	7	8	9	10	11	12
Recognizes the importance of energy levels as related to ecosystems.			—	—	—	—	—
Recognizes that living organisms utilize matter and return it to the environment.	0	—	—	—	—	—	—
Describes examples of humankind's dependence on and interference with natural ecosystems.	0	—	●	—	●	—	—
Recognizes that a living organism is a product of its heredity and environment.	0	—	●	—	●	—	—
Recognizes that all forms of life are composed of the same elements in different DNA blueprints.			—	—	—	—	—
Understands relationships of structure and function of living organisms to their environment.			—	—	●	—	—
Recognizes that living organisms have changed over the ages and that some species are now extinct.	0	—	●	—	●	—	—
Recognizes that the motion and path of celestial bodies are predictable.	0	—	●	—	●	—	—
Describes the regular movements of the earth and moon.	0	—	●	—	●	—	—
Demonstrates an appreciation and understanding of time/space relationships.	0	—	—	—	—	—	—
Demonstrates knowledge of basic differences between planets, stars, the solar system, the Milky Way Galaxy, and the known universe.	0	—	●	—	●	—	—
Cites some of the accomplishments in humankind's exploration of space.	0	—	●	—	●	—	—
Demonstrates knowledge of the effects of moon and sun on ocean tides.	0	—	—	—	—	—	—
Recognizes that matter exists as solids, liquids, and gases.	0	—	●	—	●	—	—
Demonstrates that in chemical or physical changes the total amount of matter remains unchanged.	0	—	●	—	●	—	—
Recognizes that in nuclear reactions a loss of matter is a gain in energy; the sum of matter and energy remains constant.			—	—	—	—	—

KNOWLEDGE (CONT.)

	K-6	7	8	9	10	11	12
Recognizes that there are continuous changes on earth.	O	—	●	—	●	—	—
Recognizes that rocks contain one or more kinds of minerals.	O	—	—	—	—	—	—
Recognizes the three major types of rocks that make up the earth.	- -	- -					
Recognizes the value of using renewable energy sources instead of non-renewable sources.	O	—	●	—	●	—	—
Identifies major factors that cause weather changes and patterns.	- -	- -	—	—	—	—	—
Identifies the effect of weather on the local environment.	O	—	●	—	●	—	—
Identifies the ocean as a major influence on weather.	O	—	●	—	●	—	—
Recognizes simple machines and their functions.	O	—	—	—	—	—	—
Understands the definitions and interrelationships of force, work, and energy.			—	—	—	—	—

SECONDARY SOCIAL SCIENCE CONTINUUM

Purpose

The discipline of social studies concerns the knowledge and skills necessary to achieve civic competence and the ability to participate successfully as a member of society. It is implemented through selected studies of the human experience in both America and the world, in the past as well as in the present. These disciplinary and interdisciplinary studies have five purposes or goals:

1. To enable students to develop understandings based on data, generalizations, and interdisciplinary and disciplinary concepts drawn from the various social sciences, including anthropology, economics, geography, history, political science, psychology, and sociology.

   The first goal focuses on conceptual learning. A concept is a cluster of mental images associated with the word naming the concept. Within the social sciences, 18 concepts have been selected as keys to the study of all social sciences. As listed in the Social Science Education Framework for California Public Schools (California State Department of Education, 1976), they include the following:

Citizenship	Culture	Multiple Causation
Justice	Diversity	Interdependence
Freedom	Environment	Scarcity
Truth	Resources	Property
Morality	Needs/Wants	Authority/Power
Conflict	Change	Social Control

2. To enable students to develop and practice a variety of intellectual and work-study skills appropriate to the social sciences.

   The skills addressed by the second include reading, writing, and computation, which are covered in other subject continuums. The social studies continuum emphasizes those skills particularly relevant to social sciences.

3. To enable and encourage students to understand and respect individual and cultural differences and similarities.

   The third refers to an interdisciplinary process designed to assure the development of cultural awareness, recognition of human dignity, and respect for each person's origins and rights in society. The field of social sciences is in a unique position to assume leadership in the process of multicultural education since social studies deals primarily with the study of all human culture. Further information related to multicultural education appears in Multicultural Education Resources and Services (Los Angeles Unified School District, Instructional Planning Division, Publication GC-61, 1977) and Guide for Multicultural Education (California State Department of Education, 1977).

4. To enable students to reflect on society's values and encourage each individual to develop and clarify a personal set of values.

   Values education, the fourth goal, cannot be separated from the teaching of skills and knowledge. The school, by the nature of its activities, must be a character building institution. Techniques for implementing this goal are described in the Teaching of Values (Los Angeles Unified School District, Instructional Planning Division, Publication GC-56, 1978).

5. To enable students to participate in activities in the society as individuals and as members of groups.

   The fifth has meaning for all education in the United States because a democracy cannot exist without an enlightened, participating citizenry. In working toward this goal, teachers should provide opportunities for student participation in school and community affairs to see that students may apply the concepts required for competent citizenship.

Programs for social science include the development and practice of a wide variety of intellectual and work-study skills. These skills are taught in the context of, and applied to, the body of knowledge constituting the content of social studies. This continuum identifies only the skills.

The content and organization of the social science as defined in various instructional guides and outlines, including the Social Studies Scope and Sequence Guidelines (Los Angeles Unified School District, Instructional Planning Division, Publication GC-64, 1977).

The continuum provides the following:

- A common framework for instruction in specific skills related to the social science
- A guide for the individualization of instruction
- A basis for assessment of student progress in social science
- A basis for the articulation of skills development throughout Grades 7 and 12

Components

The continuum involves eight skill areas:

- Locating information
- Interpreting graphic materials
- Understanding maps and globes
- Organizing information
- Critical thinking
- Problem solving
- Valuing
- Participating in our society

Implementation

Each of the skills may be taught at various levels of sophistication and in the context of a variety of content areas. Each skill should be introduced at a level appropriate to the students and to the specific course being taught. Once introduced, each skill should be maintained through application and reinforcement at increasingly higher levels of sophistication in succeeding grades.

The continuum is in no way designed to limit the scope of social science instruction. The teacher should encourage students to progress to the extent of their interests and abilities.

District assessment of student progress in the development of skills will be offered in Grades 8 and 11. Special remediation courses will be offered in Grades 9 and 12 for students who demonstrate a need for such instruction.

SOCIAL SCIENCE CONTINUUM
GRADES 7–12

SYMBOLS
- 0 = Introduction/Development
- ● = Assessment/Evaluation
- ——— = Maintenance/Reinforcement

LOCATING INFORMATION

	K-6	7	8	9	10	11	12
STUDENTS SHOULD KNOW ABOUT AND BE ABLE TO USE THE MANY SOURCES OF INFORMATION AND IDEAS AVAILABLE TO THEM. THESE WOULD INCLUDE VARIOUS MEDIA ENCOUNTERED IN AND OUT OF SCHOOL.							
Identifies or describes a person who might serve as a useful resource in obtaining specific information.	0	—	●	—	—	●	—
Identifies or names a book appropriate for finding certain types of information.	0	—	●	—	—	●	—
Describes how to find information in a book by using the table of contents.	0	—	●	—	—	—	—
Defines the meaning of an unknown word by using a glossary of social science terms.	0	—	●	—	—	—	—
Describes how to find material using an index.	0	—	●	—	—	—	—
Locates the best source of information on a specific topic.	0	—	●	—	—	●	—
Locates information in an encyclopedia, magazine, atlas, and/or almanac.	0	—	●	—	—	●	—
Summarizes the information given in a newspaper article.	0	—	●	—	—	●	—
Finds information by using the card catalog.	0	—	●	—	—	—	—
Identifies or states information found in a given historical document.			0	—	—	●	—
Identifies or describes a resource person most likely to have useful information about a given social problem.			0	—	—	●	—
Distinguishes between primary and secondary source materials.	0	—	●	—	—	—	—
Evaluates the use of primary and secondary sources of information.					0	●	—
Identifies the location of or finds information using the Reader's Guide to Periodical Literature.	0	—	●	—	—	●	—
Selects from several media sources that which is most informative about a specific event.	0	—	●	—	—	●	—

INTERPRETING GRAPHIC MATERIALS

	K-6	7	8	9	10	11	12
MATERIALS, SUCH AS CHARTS, CARTOONS, GRAPHS, POSTERS, AND TIME LINES, SHOULD BE RECOGNIZED AS WAYS OF GROUPING INFORMATION AND UNDERSTOOD AS MEANS OF SIMPLIFYING COMPLEX IDEAS AND STATISTICS.							
Identifies and/or reads information presented in a given graph.	O	—	●				
Compares and interprets information given in a graph.	O	—	—	—	—	●	
Identifies and/or reads information/data presented in a table.	O	—	●				
Compares and interprets information/data given in a table.	O	—	—	—	—	●	
Identifies and/or reads information presented on a time line.	O	—	●				
Completes a time line, given a time span and a list of events and their dates.	O	—	●				
Develops graphs, tables, and time lines as part of a presentation of information.	O	—	—	—	—	●	
Describes one or more uses of charts, cartoons, or posters.	O	—	●				
Interprets the content of charts, cartoons, or posters.	O	—	—	—	—	●	

UNDERSTANDING MAPS AND GLOBES

	K-6	7	8	9	10	11	12
MAPS AND GLOBES ARE IMPORTANT TOOLS IN HELPING STUDENTS TO UNDERSTAND GEOGRAPHIC, HISTORICAL, POLITICAL, AND CULTURAL RELATIONSHIPS.							
Identifies or states a definition of a "map."	O	—	●				
Recognizes and applies the following basic map and globe concepts and terms:							
Sphere	O	—	●	—	—	—	—
Globe	O	—	●	—	—	—	—
Equator	O	—	●	—	—	—	—
Poles	O	—	●	—	—	—	—
Universe	O	—	●	—	—	—	—
Solar system	O	—	●	—	—	—	—
Planet	O	—	●	—	—	—	—
Natural satellite	O	—	●	—	—	—	—
Orbit	O	—	●	—	—	—	—
Axis	O	—	●	—	—	—	—
Rotate	O	—	●	—	—	—	—
Degree	O	—	●	—	—	—	—
Latitude	O	—	●	—	—	—	—
Longitude	O	—	●	—	—	—	—
Parallels	O	—	●	—	—	—	—
Meridians	O	—	●	—	—	—	—
Tropic of Cancer	O	—	●	—	—	—	—
Tropic of Capricorn	O	—	●	—	—	—	—
International Date Line	O	—	●	—	—	—	—
Time zone	O	—	●	—	—	—	—
Great Circle	O	—	●	—	—	—	—
Matches a set of geographical or physical features illustrated on a map with a list of the names of those features, such as the following:							
Hill	O	—	●	—	—	—	—
Mountain	O	—	●	—	—	—	—
Valley	O	—	●	—	—	—	—
River	O	—	●	—	—	—	—
Road	O	—	●	—	—	—	—
Railroad	O	—	●	—	—	—	—
Dam	O	—	●	—	—	—	—
Bridge	O	—	●	—	—	—	—
City	O	—	●	—	—	—	—
Bay	O	—	●	—	—	—	—
Canal	O	—	●	—	—	—	—

UNDERSTANDING MAPS AND GLOBES (CONT.)

	K-6	7	8	9	10	11	12
Sea	0	—	●	—	—	—	—
Ocean	0	—	●	—	—	—	—
Continent	0	—	●	—	—	—	—
Harbor	0	—	●	—	—	—	—
Strait	0	—	●	—	—	—	—
Peninsula	0	—	●	—	—	—	—
Plateau	0	—	●	—	—	—	—
Isthmus	0	—	●	—	—	—	—
Gulf	0	—	●	—	—	—	—
Lake	0	—	●	—	—	—	—
Identifies, describes, and interprets the major parts of a map, as follows:							
Title	0	—	●	—	—	—	—
Legend	0	—	●	—	—	—	—
Compass direction	0	—	●	—	—	—	—
Map scale	0	—	●	—	—	—	—
Geographic grid	0	—	●	—	—	—	—
Identifies, describes, and reads the following types of maps:							
Road map	0	—	●	—	—	—	—
Physical map	0	—	●	—	—	—	—
Political map	0	—	●	—	—	●	—
Historical map	0	—	●	—	—	●	—
Climate map	0	—	●	—	—	—	—
Resource map	0	—	●	—	—	—	—
Computes distances between points, using a mileage scale.	0	—	●	—	—	—	—
Designs a map with appropriate symbols, map scale, and key, given a paragraph description of a location.	0	—	●	—	—	●	—

ORGANIZING INFORMATION

	K-6	7	8	9	10	11	12
THERE IS LITTLE VALUE IN GATHERING INFORMATION UNLESS IT CAN BE ORGANIZED IN MEANINGFUL WAYS. ORGANIZING CAN TAKE THE FORM OF A WRITTEN OR ORAL ACTIVITY.							
Classifies items which have characteristics in common.	O		●				
Identifies or explains why an item does not fit a given classification.	O		●				
Prepares an outline of the major points of a given selection of material.	O		●				
Develops an outline of major points, using reference materials.	O					●	
Takes notes while listening to a lecture or observing an audio-visual presentation.	O		●			●	
Identifies the chronological order, events, or ideas which show the stages of a developmental process.	O		●			●	
Demonstrates the ability to organize information by writing a bibliography on one topic, when given various resources.	O					●	

CRITICAL THINKING

	K-6	7	8	9	10	11	12
ONE OF THE MAJOR OBJECTIVES OF SOCIAL STUDIES SHOULD BE TO HELP THE STUDENT LEARN TO THINK CRITICALLY.							
Identifies similarities and differences and summarizes these findings.	O		●				
Formulates a concept by obtaining data and organizing the information into meaningful clusters.	O		●			●	
States thoughts and feelings that are not explicit in a given data source and states reasons for these inferences.	O		●			●	
Identifies cause- and -effect relationships.	O		●				
Analyzes cause- and -effect relationships.	O					●	
Distinguishes between facts and opinions.	O		●			●	
Identifies generalizations.	O		●				
Interprets information from a broad source of data and and makes a general statement (generalization) which includes the main ideas.	O		●			●	
Predicts, forecasts, or anticipates what might happen in a given situation.	O		●			●	
Combines main ideas to form an original product (report, dramatization, project).	O		●			●	
Formulates questions relevant to a given topic.	O		●			●	
Evaluates sources of ideas, facts, and opinions.	O		●			●	

PROBLEM SOLVING

	K-6	7	8	9	10	11	12
PROBLEM SOLVING IS A DAILY ACTIVITY. MANY OPPORTUNITIES TO DEVELOP THE PROCESS OF PROBLEM SOLVING SHOULD BE PART OF THE STUDENT'S EXPERIENCE.							
Identifies or provides the steps in the problem-solving method.	O	—	●	—			
Identifies or states a problem developed from a given situation.	O	—	●	—	—	●	—
Determines the data needed to solve a particular problem.	O	—	●	—	—	●	—
Identifies or states one or more reasons why a particular hypothesis is tentative.					O	●	—
Identifies or states one or more ways to validate an hypothesis.					O	●	—
Identifies or states a proposal to solve a problem when given data about the problem.	O	—	●	—	—	●	—
Applies the problem-solving method.	O	—	—	—	—	●	—
Applies inductive reasoning.	O	—	●	—	—	●	—
Applies deductive reasoning.	O	—	●	—	—	●	—
Selects or gives a solution to a problem which incorporates as many given points of view as possible.	O	—	—	—	—	●	—
Recognizes reasons for accepting one plan over the alternatives to solve a specific problem.	O	—	●	—	—	—	—
Evaluates reasons for accepting one plan over the alternatives to solve a specific problem.	O	—	—	—	—	●	—
Identifies or gives one or more ways a solution to a school problem might also apply to a community problem.	O	—	●	—	—	●	—
Identifies or describes how a given generalization might apply to a new situation.	O	—	●	—	—	●	—

VALUING

	K-6	7	8	9	10	11	12
ALTHOUGH THE PRACTICE OF VALUING IS INHERENT IN SOCIAL STUDIES EDUCATION. SPECIFIC OPPORTUNITIES SHOULD BE AFFORDED THE STUDENT TO CLARIFY AND DEVELOP HIS/HER OWN SET OF VALUES.							
Identifies values from actions and words.	O	—	●	—	—	●	—
Develops an awareness of one's values as based on such foundations as family and societal traditions, religious beliefs, peer associations, and other factors.	O	—	●	—	—	●	—
Identifies or states the difference between having feelings and acting upon those feelings.	O	—	●	—	—	●	—
Identifies or states one or more experiences that may instill values in a person.	O	—	●	—	—	●	—
Identifies ways in which values may change.	O	—	●	—	—	●	—
Identifies or states one or more examples of a value conflict.	O	—	●	—	—	●	—
Identifies or states opposing values reflected in a situation of value conflict.	O	—	●	—	—	●	—
Identifies or describes changes in behavior resulting from the resolution of a value conflict.	O	—	●	—	—	●	—

PARTICIPATING IN SOCIETY

	K-6	7	8	9	10	11	12
EACH INDIVIDUAL SHOULD BE RESPECTED AND ACCORDED EQUAL JUSTICE AND OPPORTUNITY. MUTUAL RESPECT SHOULD BE EMPHASIZED IN GROUP ACTIVITIES. IN THE PROCESS OF INQUIRY, FREEDOM OF THOUGHT, SPEECH, AND BELIEF SHOULD BE RESPECTED. STUDENTS SHOULD BE HELPED TO UNDERSTAND THAT DIVERSITY EXISTS WITHIN THE CLASSROOM, THE COMMUNITY, THE UNITED STATES, AND THE WORLD.							
States clearly to the class one's own opinion on a given topic.	0	—	●	—	—	—	—
Identifies roles and procedures for effective group work.	0	—	●	—	—	—	—
Identifies or states one or more advantages of the ability to interact cooperatively with others in large or small groups.	0	—	●	—	—	●	—
Demonstrates the ability to make relevant contributions in large and small group discussions.	0	—	●	—	—	●	—
Demonstrates the ability to interact cooperatively with representatives of various cultures.	0	—	●	—	—	●	—
Gives evidence to support the conclusion that various cultures have made contributions to civilization.	0	—	●	—	—	●	—
Identifies qualities necessary for effective participation in our society.	0	—	●	—	—	—	—
Analyzes qualities necessary for effective participation in our society.					0	●	—
Identifies or gives an example of one or more ways in which rights might be altered as a result of failure to exercise responsibility.	0	—	●	—	—	●	—
Identifies or gives examples of people's respecting individual rights.	0	—	●	—	—	●	—
Identifies or gives one or more ways a person's feelings and behavior toward another can affect that other person's feelings and behavior.	0	—	●	—	—	●	—
Identifies or describes the differences between the rights and responsibilities of a citizen.	0	—	●	—	—	—	—
Evaluates ways available to a citizen of the United States to make maximum use of citizenship potential.					0	●	—
Identifies or explains the practical importance to an individual in a democracy of participation in the political process.			0	—	—	●	—