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Alternative energy for the home : a demonstration project.

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ALTERNATIVE ENERGY FOR THE HOME:

A DEMONSTRATION PROJECT

A Dissertation Presented

By

W. J. Landry, Jr.

Submitted to the Graduate School of the

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Education

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ABSTRACT

Alternative Energy for the Home:

A Demonstration Project

February, 1986

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The Purpose of the Study

Energy needs, cost and environmental pollutants are major concerns of today's societies. The use of finite fossil fuels has depleted much of the world's natural resources, and people need to assume greater responsibility for producing and conserving energy.

The purpose of this study was to develop an experiential curriculum intervention strategy that would:

1. Develop a better understanding of the energy options and conservation practices available today;
2. Develop and/or reinforce a positive attitude toward the use of alternative

energy devices and practices;

3. Teach some hands-on construction techniques;

4. Foster a sharing of knowledge between the writer, seminar participants, neighbors and friends of everyone involved.

Methodology

The study was based on the use of an experiential approach to learning. Experiential learning is learning which occurs outside the traditional classroom and is a direct result of perceptive impressions obtained by the learner. Hands-on experiences were stressed as well as experiential demonstrations.

The program was divided into two parts:

1. The writer's experiential intervention resulting from the alternative energy research, experimentation and personal construction of an alternative energy home;
2. The development and implementation of an experiential curriculum intervention strategy.

For the purpose of assessing the seminars' effectiveness, an energy inventory pre/post questionnaire was developed by the researcher and administered to the sixty-four participants.

Results and Conclusions

The computer analysis of the subjects' responses to the twenty-three item pre/post questionnaire tended to indicate the seminar participants had:

1. A greater knowledge of alternative energy devices available;
2. A more complete understanding of--
   How various collectors work;
   How to build and use collectors;
   How to evaluate/audit present energy usage and efficiency;
   How to retrofit present structures to be more energy efficient;
3. Increased self assurance in regard to individual construction skills/abilities;
4. A more positive awareness of the need for greater use of conservation practices and alternative energy devices was developed or reinforced.

The experiential approach to learning was quite successful. The participants did learn, retain and use much of the information gained from their seminar experience.

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Introduction

Throughout the development of civilization, communities, societies, states and countries have assumed the responsibility of providing energy for their people. The fulfillment of energy needs was delegated to various agencies to provide for individual survival and industrial development. History shows that from the early days of the Greeks, Chinese, and Romans energy needs were primarily fulfilled through the use of wood, sun, wind, water and energy conserving practices. As civilizations developed, solar devices were implemented and refined to propel mechanical assemblies. The Industrial Revolution brought about a greater need for energy, calling upon machines to replace muscle. The discovery of inexpensive, easily transportable fossil fuels filled the increased energy needs of the newly emerging machines of this era. Consequently, previous practices of using renewable energy lost popularity.

However, today our fossil fuels are being depleted and are no longer inexpensive. Our highly technological society has transformed ancient alternative energy practices and devices into a highly efficient, viable means of energy production for today's world.

The writer has researched many of the past and present forms of energy production and various conservation practices. The data collected was then used by the writer to personally design and construct an alternative energy home and to develop an experiential curriculum intervention program that has been, and will continue to be, conducted at the construction site.

CHAPTER I

Orientation to the Study

Problem Statement

A staggering burden has been placed on the human race, not only in the monitoring of energy demands, but in the personal compromise of beliefs and philosophies. Energy availability, costs and environmental pollutants are major concerns of the day. Our energy needs have escalated to a level which make it no longer economically feasible for large utility conglomerates to be the sole providers of energy. We have depended on other countries, governments and utility companies to convert and supply energy for us. We must assume greater responsibility for producing and conserving energy for our own individual needs.

There are many alternative, viable, inexpensive energy devices and practices available to us in present day societies. Individuals can convert energy into electricity and heat for use in their homes and places of work. People need to be educated in energy alternatives if there is to be a significant conservation of energy resources. How and where the educational process begins has been a question of debate among educators. The writer proposes that alternative energy education must be developed today and begin at one's residence and workplace. Such an effort is needed to bring about the education and change necessary for a more efficient, healthier living environment. The question is whether or not exposure to an experiential curriculum intervention strategy will increase public awareness of alternative energy devices and practices available today. To address this question an experiential curriculum intervention strategy was developed, and data was collected and analyzed for some evidence of its effect on the educational and attitudinal change of the participants in the pilot curriculum study. It was expected that exposure to this program would positively effect the participants' knowledge of alternative energy practices and devices, and would change or positively reinforce their attitudes toward the use of alternative energy and conservation practices.

Rationale

The stability of international relations has been radically altered by the cost of energy and public unrest. World events, which have been controlled by the United States and the U.S.S.R. since 1945, have strained international relations. The response of the Third World to the actions of the world powers has, in many situations, been resentment and despair. However, this pattern has been broken by the emergence of the privileged Third World group. In the past, a few oil producing nations held the economic health and wealth of many countries, including the world powers, in their hands. They dictated their demands to the industrialized nations and catered to none but themselves. As a result, a fourth world of the very poor emerged with no chance of upgrading their standard of living. They have had little or no education, high unemployment and poor housing and health-care. One of the main causes of their deprivation has been the rising cost of energy. Renewable energy usage will help reduce the dependence and depletion of the world's fossil fuels. The United States has an obligation, having already used much of the world's energy, to develop and perpetuate the use of renewable energy. The World Bank estimates the cost of providing a minimum level of water, food, shelter and energy to over two billion people in the poor nations will be one hundred billion dollars a year for the next ten years. Forty percent of this will be spent on energy alone.

We have navigated ourselves into our present dilemma by opting to use oil and nuclear fission to provide our energy. This was easy and relatively inexpensive in the past, but has become exhorbitant in both financial output and personal compromise. In 1971, crude oil was two dollars a barrel, in 1973, three dollars a barrel, in 1974 prices quadrupled to twelve dollars a barrel, and continued to rise into the 1980's. In 1980, eighty billion dollars worth of oil was imported to the United States. This translates into a cost of two hundred and fifty million dollars a day for oil. Even with conservation efforts and recession reductions, we are still using more oil each year. Dependence on oil in the past has weakened the American dollar in the international exchange and caused the price of oil to rise. Although still high, oil prices have stabilized.

Moreover, fossil fuels are finite. Hydrocarbon fuels, like oil, gas and coal, are limited. Once used they are gone forever. Renewable energy sources--solar, wind, water, and geothermal--can be re-used indefinitely. The legacy we leave our descendants should not point to the major powers of the world as being responsible for stripping the planet of the bulk of its resources in a mere few hundred years.

Revolution and political strife have disrupted the flow of oil to the west three times in the last decade. The Mid-East Arab embargo of 1974-75, the Iranian revolution of 1979 and hostile oil producing nations like Libya have contributed to the oil problem. Which Mid-East country or countries will be the world agressor in the future? Twentieth century Americans, Russians and Chinese have primarily looked at each other as possible life-theatening war machines of tomorrow. However, some futurist predictions look to the Mid-East as a source for fanaticism which could result in a major world conflict.

Nuclear reactors and the plutonium produced are potential threats to world destruction. The United

States supplies about one-tenth of its electricty through nuclear fission. Nuclear fission also produces the majority of energy used by France and much of the energy used by Russia. Nuclear News (1983) reported the following nuclear power plants in operation: U.S.A. - 77, Soviet Union - 34, Great Britain - 34, France - 31, Japan - 25, Canada - 12, West Germany - 12, Sweden - 10, Spain - 6, Belgium - 5, East Germany - 5, Switzerland - 4, India - 4, Italy - 3, Czeckoslovakia - 2, South Korea - 1, Argentina - 1, and 12 in the rest of the world to a total of 282 plants of 173,587 megawatts capacity. On order are an additional 227 plants producing 209,384 megawatts, making the total commitment 509 plants producing 382,971 megawatts. The inherent dangers, as evidenced by Three Mile Island and other world incidents, are warnings that should not go unheeded. The U.S. Department of Energy's goal is to produce 20% of its energy needs from renewable energy sources by the year 2000. The federal government has been spending some six hundred million dollars a year on nuclear fusion efforts which are likely to take forty years or more to perfect. Nuclear fusion may be an answer of the distant future, but today's use of nuclear fission is far too dangerous to present and future generations. We need to adapt our lifestyles, be more conserving with our use of energy, and develop a philosophy, based on the use of renewable energy, for the betterment of humankind.

The air we breathe and the atmosphere that protects our planet have been severely altered by our past practices. The by-products of coal burning (sulphur, nitrogen oxides and heavy metals) have contributed to the impairment or death of numerous water and land creatures. If we continue to accumulate carbon mon/dioxides and other debris in our atmosphere, it will trap more of the Earth's heat causing an increased greenhouse effect. As a result there could be a significant rise in global temperature. A rise in global and polar temperature of as little as seven degrees could have catastrophic effects. Rainfall distribution would change and could turn fertile soil into desert. Consequently, famine and disease could follow.

The energy problem is global. What we do here in the United States affects everyone on this small planet in one way or another. Energy efficiency and conservation are of greatest importance to us now. What we do to educate our citizens and the direction we take to supply our energy will have far reaching effects on much of the world.

We have the technology to bring more sophisticated, inexpensive, easily constructed energy devices into the lives of humankind. Maximizing the use of renewable energy sources would result in: 1) financial savings; 2) greater conservation of resources; 3) the development of new industries; 4) a clearer understanding of energy and its uses; and 5) increased independence and self-sufficiency. The goal of this study is to show the value of an experiential education mode of instruction for people of varying ages and socio-economic status. It is the writer's opinion that one of the most effective means of educating people is through the use of a curriculum based on experiential education intervention. An experiential education intervention, in these writings, may be defined - except as otherwise indicated - as planned learning which occurs outside of the classroom and which is a direct result of perceptive impressions that have been obtained through use of the learner's senses. In addition, using and evaluating renewable alternative energy devices and practices, that can be used in the learner's own living situation, will help to have an impact on the education necessary to accomplish changes in attitude and lifestyle.

Methodology

A positive public attitude toward the use of alternative energy and conservation practices needs to be developed. In addition, the public needs to be equipped with the necessary skills to maintain their present living conditions and to augment existing energy systems through the construction of renewable energy collectors.

A picture is worth a thousand words and a hands-on experience is priceless. A hands-on approach is the use of one's physical being to move, manipulate, construct or in some way handle the learning medium. This is the primary learning style used in physical education and vocational education. By adding the sense of touch to an experience, another pathway to learning is used in the process. This is the main teaching style employed in this project, hypothesizing that it is through this medium that alternative energy education can be accomplished.

In many ways, the hands-on appproach is experiential. In experiential learning the subjective aspects rather than conceptual aspects are emphasized. The student becomes part of the experience using as many of the senses as possible during the learning intervention. The conscious emotional process and appreciation of the educational intervention results in the reconstruction of the individual's values, thereby altering the direction of their future experiences (Carter V. Good, 1983).

As previously stated, the position espoused here is that in today's society we have the technology to maximize the use of conservation practices and to introduce inexpensive, easily constructed, renewable alternative energy devices for humankind. This dissertation will show the processes through which self-sustaining alternative energy education can be nurtured. Energy alternatives, do-it-yourself projects and construction of simple collectors to a solar home will be discussed.

To more clearly understand the past practices and values of alternative energy proponents, a review of the energy practices used from ancient times to the present day was undertaken. Upon completion of this review several collectors were designed and built on three separate locations in two states in the Northeast. On one of these sites the writer researched, designed and constructed an alternative energy home - from the procurement of land, to the erection of a working model. The working model home is being used to demonstrate the use of various building and insulating techniques, alternative hot water heating techniques, and the use of a wood-fired furnace/sauna room for space heating. During the construction of the house, designs discovered through the research of past to present practices and new techniques resulting from personal experimentation have been incorporated into the structure, and shared with participants in the learning sessions. The learning sessions included information on energy audits, energy conservation practices, suggested monitoring practices for saving money on utility bills (electric, water, gas and heating), and some hands-on skill development--discussed in chapters four and five.

During the construction, on-site instructional seminars were conducted. The seminar curriculum began with the participants filling out the pre-questionnaire, after which they were given a tour of the project--observing and discussing energy saving construction techniques, use of insulation, glazing/sealing techniques and construction siting and landscaping techniques which might be useful in their living situations. Next the participants observed and discussed how alternative energy devices work and what their applications are for space heating and water heating through exposure to several working alternative energy models. These models were built on a small scale and included the use of a simple flat plate collector for space heating, a solar reflective hot water heater, and a photovoltaic solar calculator--to demonstrate how light energy is converted to electrical energy. Through the construction and use of these alternative energy models and exposure to energy saving practices, a more positive attitude toward the use of alternative energy, energy conservation and energy efficient maintenance was stressed to the seminar participants. The seminars also developed a better understanding of energy saving building techniques; an understanding of how alternative energy collectors work; and provided a body of knowledge to facilitate the use of alternative energy and energy conservation practices in their lives. A copy of the session hand-outs is included in Appendix D. Following the experiential educational intervention, the participants filled out a post-questionnaire--which was the same as the pre-questionnaire. The subjects were then interviewed several weeks after the seminar to ascertain any changes in awareness or attitude toward the use of alternative energy devices and practices. A copy of the pre/post questionnaire and interview questions are included in appendices F and G. The research was expected to show that as a result of this experiential approach with small groups and individuals, a more positive attitude toward the use of alternative energy and energy saving practices would be developed or reinforced. The hypothesis was that the questionnaire/interviews would substantiate this.

The questionnaire was given to two groups of thirty-two people before and after the educational intervention. One of the groups (the experimental group) was the people who had been exposed to the small group and individual learning experiences. The other group (the control group) was the group who were not exposed to the project. Both of these groups were matched according to age and gender. Exposure to the educational intervention was expected to result in a better understanding and more positive attitude toward the use of renewable alternative energy devices and energy conservation practices. The degree of educational/attitudinal change was evaluated by the administering of the questionnaires and follow-up interview. The results of the pre/post questionnaire then underwent a computer analysis to compare the two groups. Chapter six includes sections on the results and conclusions of the pre/post-questionnaires from the education intervention sessions and the interviews. The appendices include: a glossary of terms; addresses for energy information and materials; a list of available energy materials; a copy of the seminar text hand-out; a copy of the consent form used in the study; the pre/post questionnaire; the telephone interview questionnaire; the cover letter to European energy advisors; and a complete copy of the pre/post questionnaire responses of the participants.

C H A P T E R II

Energy: An Historical Overview

Energy Practices Past to Present

In an effort to compile as much information as possible, the writer conducted an extensive review of the literature, corresponded with various energy organizations throughout the world, and traveled to Great Britain and Europe. Interviews with national energy advisors in England, France, Germany and Switzerland were arranged and conducted by the writer (see Appendix H). As a result of these interviews, various correspondence and the extensive literature review, the writer gained a global perspective of energy and its usage from the past to the present.

Alternative energy practices are noted as far back as 400 B.C. - over 2500 years ago. Some early uses of the sun included solar converting devices and architectural designs; for example: burning mirrors, solar greenhouses, solar driven motors, solar space heaters, and solar hot water heaters.

Socrates (c.470 B.C. - 399 B.C.) felt that the ideal house should be warm in the winter and cool in the summer. The Greeks had no artificial means of cooling in summer and only inadequate heating systems in winter. They used mainly wood and charcoal burning braziers which resulted in wood shortages.

Fuel shortages have affected not only the early Greek, Roman and Chinese civilizations, but many other cultures throughout the world as well. From the time fire was harnessed as a heat source, supplying enough wood for home and industry has been a problem. Unfortunately, forests throughout the world have been ravaged. Plato (c.427 B.C. - 347 B.C.), in the fifth century B.C., compared the hills and mountains of his homeland to the bones of a wasted body with only the skeleton of the land remaining after all the trees had been taken, (Ken Butti, 1980).

Consequently, the sun's plentiful supply of free energy was used to help eliminate the wood shortage. The Greeks designed and positioned their buildings so as to capture the maximum rays of the sun in the winter, while avoiding the same heat in the summer. These efforts were among the first in the development of solar architectural design. The Greeks venerated the sun, and they believed the sun nurtured good health. Through the use of sundials, seasonal variations of the sun's angle and course, as well as the time of day were observed from the angle and length of the sun's shadow.

Because the sun traveled in a low arc accross the southern sky in the winter and a high arc overhead in the summer, the houses were built with a south facing portico, similar to a covered porch with abundant stone mass to absorb and retain the heat. The city streets were laid out in north-south and east-west directions to further facilitate the siting of homes. In addition, a row of houses would be built at one time with a common foundation and roof. The reason for this was to stop the wind from blowing between the houses and cooling the walls. The north wall was an adobe wall about one and one-half feet thick. The east and west walls, for all houses except the end house, were shared walls. When a second story was built, the southern section was built lower than the northern part so as not to cut off the winter sun from the second floor rooms. A walled courtyard on the southern side helped to keep out ground wind which allowed more heat to be absorbed in the black sand floors and the adobe brick walls of the structures.

The adobe brick was used in order to conserve wood. Each cubic foot of brick saved one hundred and fifty cubic feet of wood, (Eugene Ayers, 1953). Because a southern exposure was not always possible, the second choice was a western orientation to help capture the afternoon sun.

Ancient Chinese architecture was similar to the Greeks'. The streets were aligned north-south and east-west, and there were few, if any, windows on the north, east or west walls. However, there were large wood-latticed windows covered with transluscent rice paper or silk on the southern wall (a definite improvement over the open walled porticoes of the Greeks).

The early Roman empire, because of its many conquests, covered various latitudes. Therefore, they had to develop a variety of alternative energy sources as wood became less plentiful. Their heavy demand on wood as a fuel for industry, for the heating of public baths and private homes, for the construction of many great ships, and the providing of housing, nearly depleted the indigenous forests of the Italian peninsula. By the first century B.C., the hypocaust (a wood burning furnace that circulated hot air through hollow bricks in the floors and walls) burned as much as two cords of wood a day. That converts to a staggering two hundred and eighty pounds per hour, (R.J. Forbes, 1966).

Due to the wood shortage, wood was imported from distances of over a thousand miles. This became too expensive to continue and resulted in the adoption, improvement, and implementation of Greek and Chinese solar designs. Because the Roman empire was so vast, they had to adapt to different climates. By using clear window coverings, like mica or selenite (thin transparent sheets of stone) and even glass in the later years, they increased the efficiency of heat collection and retention (Eugene Ayers, 1953). In addition, some solar architecture included greenhouses for winter planting. They even had greenhouses on wheels that were moved outside in the morning and back inside at night.

The Roman public baths, used for year round bathing, were also heated by solar techniques. In fact, solar architecture in Roman life was so much a part of their culture that "Sun-Rights-Guarantees" were enacted into law. This law stated that no one could build a structure which created a shadow in a place where sunshine was absolutely necessary for solar collection (Ken Butti, 1980). The name given to the south facing room, with openings on both the east and west walls was the heliocamus. In Latin, helio means solar and camus means furnace. More often than not, the floors of the southern oriented rooms, sweat rooms and Roman baths, were of stone and/or black sand which acted as a storage area for evening heating. The living quarters were above the baths and heated areas. In the floors were vents that could be opened as needed for night and day heating since the heat convectively rose toward the ceiling, (Ken Butti, 1980).

In addition to the preceding forms of solar entrapment, the ancient Greeks, Chinese and Romans experimented with flat, spherical, cylindrical and parabolic reflectors. Some of these curved, mirror-like concentrators reflected with enough intensity to cause low kindling objects to burst into flames. These "burning mirrors", as they were called, were first used in Chinese religious ceremonies, according to the Chou Li, a book on Chinese rituals. At about the same time, 20 A.D., the Greeks were experimenting with the burning mirrors to be used as solar weaponry. Legend has it that Archemides, in 212 B.C., used burning mirrors to set afire and destroy invading Roman ships at Syracuse, (R.J. Forbes, 1966).

Leonardo Da Vinci was the first to propose a peaceful, rather than a military, use for solar reflectors. He proposed the construction of a mirror four miles across that would supply heat to a boiler which could heat a large vat of water and produce steam. Although Da Vinci began construction in 1515 A.D., he never completed the project, (Carlo Pedretti, 1973).

Early uses of spherical mirrors date back to the beginning of the sixteenth century. They were first used for making perfume, melting metals, soldering copper, driving water pumps, and making steam and other vapors to propel mechanical motors. Peter Hoscan's model, built in the late 1700's, was a parabolic dish with pieces of highly polished brass, skillfully fitted to a parabolic wooden contour. They ranged from five to ten feet in diameter and concentrated the sun's rays onto a target less than one inch accross. This reflector instantly melted lead. Copper ore melted in one second, the hardest stones melted in only a few seconds, and asbestos turned into a black glassy material in twelve seconds, (Eugene Ayers, 1953).

By the early 1800's the Industrial Revolution had begun. Industry was now calling on machines to replace muscle. The implementation of old and new solar devices for driving mechanical assemblies was developed. Solar pumps were used for moving water from one place to another and for irrigation. This was done by heating the air in a closed sphere with a cylindrical reflector, the air then expanded, which forced the water out on one side while drawing it in on the other side.

Solar stills were used for pasteurization, distilling of alcohol, distilling of salt water to make fresh water, and for the production of salt. Solar ovens were used for cooking, making perfume and as kilns for drying various materials. Another major solar application at this time was the use of solar reflectors. Steam, hot air, and various low-boiling temperature liquids were used to propel piston operated machinery by heating the liquids with a solar reflector to a vaporous state. In some applications the gaseous vapor would then be condensed and the process would begin again.

In 1868 an American engineer named John Ericsson wrote a paper stating that only through the development of solar power could a global fuel shortage be averted. Ericsson's words echo to us through the corridors of time.

Some of Ericsson's creations included a parabolic driven steam engine and a hot air driven engine. The hot air engine, heated the air inside a cylinder causing it to expand and force a piston down. When it reached the bottom of the stroke, cold air would rush in and the piston would return to the up position. Several heat sources, in addition to solar, were being used, such as wood and coal, allowing the engine to function anytime, anywhere, (William Church, 1980).

Low temperature solar pumps soon came into the picture. Using a low temperature heat box to vaporize liquids with a low-boiling point, such as ammonia hydrate (-28' F) and sulphur dioxide (14' F), solar pumps and other mechanisms were driven. Because these liquids vaporize quickly at low temperatures, the high cost of sophisticated curved reflectors was avoided. The heating process, for vaporization only, required a glass covered insulated box filled with three inches of water and lined with black tar paper. The pipes containing the low-boiling point liquid rested in the water. The vapor expanded to power the engine and then went through a condensing coil where it returned to a liquid state and back into the box to begin the process again.

Unfortunately, the preceding constructions, as well as many others, were constantly interrupted or stopped due to societal unrest, wars, economic conditions, the availability of less expensive fuels, and, frequently, the deaths of the solar pioneering explorers curtailed the experiments. Because most of the notes were written in such a way that the ideas could not be understood by anyone else, much of the research died as well.

With the discovery of inexpensive, easily transported oil, and the refinement of the internal combustion engine, the Industrial Revolution was in full swing. The use of fuel oil to produce electricity, heating, hot water heating, and transportation continued to gain prominence throughout the years, and alternative energy research and development were all but abandoned.

In the twentieth century, the non-renewable energy sources of oil, coal, synfuels and nuclear fission have been developed to fulfill our energy needs. Consequently, the use of renewable energy sources such as solar, wind, hydropower, geothermal and biomass were not being explored. International economic and national stability of many nations have been altered by increases in the cost of energy.

World events have been controlled by the United States and the U.S.S.R. since 1945. The response of the Third World nations to the controlling actions of these countries was resentment and despair. In an effort to break away from the control, several oil producing nations banded together. This alliance resulted in the emergence of a privileged Third World group of oil producing nations. For a short time they held the economic health and wealth of many countries in their hands and dictated their demands to the industrialized nations.

Unfortunately, the gap between the rich and the poor nations of the world has continued to widen. A fourth world of the very poor has emerged (Ethiopia, India, and a myriad of undeveloped countries in Africa and Asia), with little chance of upgrading their standard of living. They have been deprived of adequate education, housing, health-care and employment. One of the causes of their deprivation has been the rising cost of energy.

Renewable energy sources are an answer to many of their problems. The United States, having used much of the world's energy, has an obligation to develop and perpetuate the use of more renewable energy throughout the world and, in particular, in the fourth world nations.

The cost of energy has soared in the past years. In 1973 crude oil was two dollars a barrel. From 1973 to 1974 prices quadrupled to twelve dollars a barrel. These increases were mainly due to OPEC (Organization of Petroleum Export Countries) through their 1973-1974 embargo. They raised the cost of oil per barrel from three dollars to twelve dollars. In 1960 the United States population of one hundred and eighty million used forty-four quads of energy (a quad of energy is equal to eight billion gallons of gasoline and will produce one quadrillion BTU's), twenty-three of which was lost through the conversion of this energy. In 1979 the population of two hundred and twenty-one million used seventy-nine quads of energy and lost forty-five quads in the conversion. In 1970 we imported three billion dollars worth of oil, in 1978, forty-two billion. In

1979, sixty billion, and in 1980 eighty billion dollars in oil was imported (National Geographic, Feb. 1981). Even with conservation efforts and recession reductions, we continue to use more oil.

The following six tenets were adapted from the National Geographic Special Report on Energy, (February, 1981):

1. Our planet is not running out of energy producing fuels, and the United States still has far more than most other countries. The United States of America is the third largest oil producing country in the world. We are self sufficient in natural gas, we have the largest single share of coal reserves, and are one of the largest nuclear energy producing nations in the world. However, fossil fuels are finite and nuclear energy has its dangers.

Many countries have used other peoples' cheap, easily transportable and stored oil for many years. As several countries return to the use of coal as an energy source, hundreds of foreign freighters are taking on America's coal from the Virginias. Many of them lie at anchor off Cape Henry, sometimes waiting weeks for their cargo home.

2. Hydrocarbon fuels like coal, oil and gas are limited. Once a barrel of oil is burned, it is gone forever, unlike hydropower, wind power and solar energy. Will our ancestors look back on us of the twentieth century as being one of the countries that almost single handedly stripped the planet of its resources in just a few hundred years?

3. There is no quick fix. Shale oil, coal liquification or geothermal energy will not come into their own until the 1990's or later. In 1973 former President Nixon stated that by the end of the decade we will be self sufficient and meet our own energy needs without depending on any foreign energy sources. I think he may have had some idea of hundreds of nuclear power plants dotting the countryside - each power plant ticking away like a time bomb vulnerable to our own miscalculations, sabotage or a series

of accurately placed missiles resulting in total obliteration. Three times in the last twelve years war, revolution or political action has disrupted the flow of oil to the West. The Mid-East Arab embargo of 1973-74, the Iranian Revolution of 1979 and hostile oil producing nations like Lybia have contributed to the oil problem. Which Mid-East country or countries will be the aggressor of the future? The twentieth century Americans, Russians and Chinese look only at each other as being the possible life-threatening war machines of today and tomorrow. Nostradamus, sixteenth century French futurist, predicted that a fanatic equal to Hitler would rise out of the Mid-East during our lifetime. Annihilation of not only the major powers, but any country standing in their way could result.

4. These are warnings that should not go unheeded. There is no free lunch. Nuclear energy now provides one-tenth of the electricity in the United States of America.

However, the nuclear reactors' plutonium production might destroy us all. Pollutant products from coal combustion are doing their damage. Acid rain from the burning of coal is defacing buildings, destroying our lungs and killing numerous water creatures.
The accumulation of carbon dioxide in our atmosphere, from the burning of our fossil fuels is trapping the earth's heat. This could raise the average global temperature by two degrees celsius. The Polar temperature could be raised by as much as seven degrees. The effect would be catastrophic. Rainfall distribution would change and could turn fertile soil into deserts. In addition to the preceding, dump burning, automobile exhaust and other by-products of our present lifestyle will block out a great deal of the sun's solar penetration. The effects on the earth will be devastating.

5. The energy problem is global. What we do here in the United States affects everyone

else on this small planet in one way or another. How do humans feel when their decisions are made by someone else? When people lose their choice and, even worse, have little or no say toward the future of their world, rebellion may well follow. No wonder many countries in the world look at America with disfavor.

6. Energy efficiency and conservation are of greatest importance from now on, not next year-month-week, but today. The Department of Energy's goal in the U.S. is to produce twenty percent of its energy needs from renewable energy sources by the year 2000. The federal government has been spending some six hundred million dollars a year on nuclear fusion efforts which are likely to take forty years or more to perfect. Nuclear fusion may be an answer of the distant future. However, for today we must begin to use less in a more efficient way and explore ways to use more of our renewable energy sources to reach that future.

Throughout the development of civilization, communities, societies, states and countries have assumed the responsibility of providing energy for their citizens. The fulfillment of energy needs was delegated to various agencies to provide for individual survival and industrial development. History shows that from the early days of the Greeks, Chinese and Romans, energy needs were fulfilled primarily through the use of wood, sun, wind, water and other energy conserving practices. As civilizations developed, solar devices were implemented and refined to propel mechanical assemblies. The Industrial Revolution brought about a greater need for energy, calling upon machines to replace human-power. The discovery of inexpensive, easily transportable fossil fuels bridged the gap of fulfilling the energy needs of the newly emerging machines of this era. Consequently, previous practices of using renewable energy lost popularity.

Today, however, in 1985, our fossil fuels are being depleted at an exponential rate and are no longer inexpensive. Our highly technological society has transformed ancient alternative energy practices and devices into a highly efficient, viable means of energy production for today's world. As a wealthy, highly educated and privileged country, we have the obligation and challenge to create and foster a transition from non-renewable energy use to a greater use of alternative renewable energy sources throughout the world.

Alternative Energy

Alternative energy, for the purpose of this paper, will be energy converted from something other than a conventional fuel, or an energy source other than that which is supplied by a utility company resulting from conversion of fossil fuels or nuclear fission. Some examples of alternative energy are: nuclear fusion, solar, wind and water conversion. Included in alternative energy are renewable alternative energy sources used in these writings to relate to energy sources that are replenishable on a day-to-day basis. This section suggests the need for raising energy consciousness. It will not only include some of the conventional energy conserving practices of better insulating, double glazing, weather stripping and caulking, but also go beyond. The incorporation of passive design ideas in building, solar energy usage, and use of conservation practices that save energy and money, as well as preserve our living environment are emphasized.

Renewable energy sources are replenished on a day-to-day basis at verying levels depending upon which type we used. Among the renewable energy sources are the following:

1. Direct solar energy from the sun which can be captured efficiently in air, liquid or photovoltaic solar energy cells.

2. Heat from the thermalmass of the oceans which absorbs nearly seventy-five percent of the solar energy that strikes its surface.

3. Geothermalmass from the bowels of the earth is available in such forms as geysers and volcanic heat.

4. Ocean tides, hydroelectric river dams and winds can supply a large quantity of the world's energy needs. By driving turbines which then drive generators electrical energy is produced.

5. Biomass, which is living matter in any form, such as plants and animals, can produce energy in many ways from its consumption to its decomposition.

Energy is available in all of the preceeding forms, and many utility companies are doing more for conservation and conversion of energy with solar collectors, hydroelectric generators, and wind generators. Hopefully, this will continue and we will see numerous windmill farms, solar water heaters, solariums, greenhouses, and a change in the American lifestyle through a greater awareness of the need for conservation of energy and natural resources. As we move toward this scenario, we could see: solar collectors required in the construction of new homes; solariums attached to most homes; wind mills on top of existing towers and poles of various businesses dotting the countryside; and photovoltaic collectors on every rooftop. Retrofitting these towers/homes and tying them to the exisiting power grid could result in more jobs. As a result of the utility companies using more solar, hydroelectric, geothermal, wind and fussion technology, greater profits and a benign environment for the world could become a reality.

Although alternative energy concepts and practices have existed for thousands of years, solar and wind began to lose their prominence after the discovery of cheap fossil fuels. Yet fossil fuel continues to become more expensive and is finite. An alternative energy pioneer must be committed to the development of environmentally appropriate systems to protect future generations. Through a sound, common-sense approach, alternative energy practices can be a viable means for producing energy. Better building design and proper siting of structures for more solar penetration is needed. Using combinations of solar, photovoltaic cells and wind generation is essential today.

There are a number of ways to use alternate solar energy in the home today. Among them are various types of flatplate collectors, flatplate collecting greenhouses and solariums. Greenhouses can produce food. In addition to space heating and water heating, solar ovens, clothes dryers, wood kilns and pottery kilns and photovoltaics are all viable alternatives.

While there are many different types of heat trapping flat plate solar collectors, they all operate in fundamentally the same way. The glazing allows the ultraviolet rays (long-wave length) to enter the unit. As these rays pass through the glazing they are bent and changed to the infared wavelength (a shorter wave) which cannot pass back through the glazing and becomes trapped in the collector. The infared light waves then bounce back and forth between the aluminum collector surface and the inside of the glazing. As they bounce back and forth, they stimulate the movement of the photons on the surface of the painted metal collector plate which results in the production of heat. The collector absorbs this heat energy and transfers it to a transport medium. Because there is no effort made to concentrate the sun's energy (like a parabolic does) the highest operating temperature is usually around one hundred and fifty degrees farenheit (sixty-five degrees centigrade). A flat plate collector consists of a weather tight enclosure, insulation, glazing and a metal plate, spray painted flat black. A heat duct or tubing may be added to transport the heat transfer medium (air or liquid).

The preceding has been an explanation of how solar-light is changed into "heat" energy. The following section will describe how photovoltaics turn ultra-violet light into electrical energy.

Photovoltaics: Turning Solar Light into Electricity

Economically and environmentally, solar photovoltaics may be the ultimate electrical energy producing alternative. They are environmentally benign with no moving parts. The light sensitive cells convert sunlight, the earth's most abundant renewable energy source, into usable electricity. Phótovoltaic energy conversion is different from all other types of electricity generating processes and most closely resembles photosynthesis, the biochemical process that is the foundation of life on this planet.

The French scientist, Edmund Becquerel, discovered the photovoltaic effect in 1839. He noted that sunlight could produce electricity when it struck one of two electrodes immersed in a conductive field. Until this time, other experimentors, such as Augustin Mouchot, had unsuccessfully tried to generate a usable electric current with solar heat on dissimilar metals, thereby producing an elctrical current.

About fifty years later, Charles Fritts, an American, made the first solar cell. This cell was a thin wafer about the size of a quarter and made from selenium (an element derived from copper ore).

Albert Einstein, a twentieth century pioneer, observed that when tiny photons (particles of light) strike the electrons surrounding atoms, it causes a free stream of electrons, which is the basis of electricity (C. Flavin, 1982). Photovoltaic cells were then developed out of selenium. However, they proved to be ineffecent and expensive.

Photovoltaics were then put on the shelf until the Bell Laboratories tried to make the selenium cell more efficient in the early fifties. At the same time in 1954, another Bell research team developed an electronic device made of crystalline silicon and quite accidentally noted that the cell produced electricity when exposed to sunlight. However, the cost to produce crystalline silicon and the waste created when cutting the crystals into thin wafers were prohibitively expensive. The cost of oil at this time was only two dollars per barrel and prospectively inexpensive nuclear power was being developed. Consequently, photovoltaics were shelved. Then, in the 1960's, NASA (National Aeronautics and Space Administration) funded additional photovoltaic research and developed a lightweight, long-lasting twenty-four hour solid-state (no moving parts) renewable energy source for our satellites. The result was an economical power source that worked on light and not heat.

Currently, the main problem is the high cost involved in the production of crystalline silicon. One of the early processes for making crystal silicon semiconductors is called the Czochralski Process. The first step in this process is the separation of the silicon from the oxygen. The second step is the purification to a level where there is less than one nonsilicon atom per billion (C. Flavin, 1982). The purified silicon is then melted, doped with boron and formed into cylinders about fifteen centimeters in diameter and about one meter long. The cylinder is then sliced into thin wafers and phosphorous is added to one side of the wafer to react with the boron. A metal contact is placed on each side to channel the electric current to another cell. The cells are then tied together in panels one meter square and will optimally produce about one hundred watts of electricity at ten to twelve percent efficency.

In 1982 this panel cost fifteen hundred dollars

($15/watt). Further cost reductions are needed--the present goal is $.50/watt. Further developments in technology have focused on eliminating the waste from the cutting and the growing of cheaper, polycrystalline cells in flat sheets.

Other research and development programs for cost reduction have been initiated by countries that first began working with photovoltaics, such as the U.S.A, Japan, France, Italy, and West Germany. Countries with smaller research and development programs include Australia, Brazil, Canada, Belgium, England, India, Spain, Mexico, Sweden, The Netherlands, and the Soviet Union (Monegon, 1982).

The U.S. is doing much of the research and development followed by the Europeans and Japanese who are challenging for the lead. Together, in 1982, these countries spent one hundred and fifty million dollars on the exploration of solar cell technology, which made it the second most funded renewable energy technology behind solar heating and cooling (U.S. Congress, June 3, 1982). Consequently, the cost of producing polycrystaline cells has been cut in half since 1977.

Summary

We are on the threshold of being able to supply relatively inexpensive, highly durable, low maintenance, photovoltaic electricity producing panels. There is optimism that within the next five years, this will be a reality.

In spite of impending energy depletion, much of the world continues to waste natural resources. The many energy nibbling devices on the market make this waste even more evident. Among these are appliances such as: electric toothbrushes, electric knives, electric pencil sharpeners, can openers, and battery chargers (for the numerous battery operated toys).

The exhausting of the world's fossil fuels as a result of the present American lifestyle could be construed by many to be a crime against humanity. Yet deaf ears and blind eyes continue to be turned to the energy situation and almost appear to be searching for the straw to break the camel's back. A point will be reached where the oil bank will be empty. In one hundred and fifty years' time, America - with less than six percent of the world's population - used two trillion barrels of oil, which took three billion years to create (National Geographic, 1981).

CHAPTER III

Educational Strategies

Instructors assume many roles, such as: curriculum designers, instructional managers, facilitators, academic instructors, counselors, program evaluators, and student evaluators. One of the most important of these tasks is curriculum design. The creation of learning experiences for the students has frequently been interpreted to be the selection of the specific materials to be used by the learner. However, it is the writer's belief that it is more efficient to focus on the teaching strategies/models and specific learning styles of the students. Joyce, (1978) expresses a similiar belief in the following three assumptions:

1. There are many alternative approaches to teaching.
2. Teaching methods make a difference in what is learned and how well it is learned.
3. Students learn and react differently to different teaching methods and learning styles.

There have been over eighty teaching strategies identified which can be categorized into four major groups: social-interaction models, information processing models, personal models, and behavior modification/cybernetic models. Nonetheless, teachers seem to settle on one of the groups largely ignoring the rest. Joyce, (1978) believes the reason many teaching models are not more widely used is that few practioners have heard of or learned about them and that the theories have frequently not been made practical enough for use.

The specific teaching strategy used in the learning and growing process of education must be tailored to the learning outcomes desired. As the goals of learning change, the teaching strategy may also need to be changed. For example, self-awareness and strength of self-concept would best be learned through one type of experience; social values, human relations and social interaction might take a different approach; and mastery of a specific subject area might take another approach. Some strategies are very narrow in their focus and others quite broad. Some are extremely rigid and formal; others are casual and emergent, (Joyce, 1978).

Some of the more popular teaching strategies/models included in the preceding four categories are:

<u>Social Interaction Models</u> emphasize the relationships of the individual to society and other persons. They focus on the process by which an individual relates to others, engages in productive work within a society and develops the mind and self.

1. The Group Investigation Model, (Thelen, 1960 and Dewey, 1916). This model concentrates on the development of the interpersonal skills needed in a democratic society. Emphasis is placed on group interaction skills, academic inquiry skills and personal development.
2. The Laboratory Method, (Benne, Gibb and Bradford, 1964). This model focuses on the development of interpersonal and group skills with an emphasis on personal awareness and flexibility.
3. The Social Inquiry Model, (Massialas and Cox, 1966). This model is used primarily for social problem solving. It uses the skills of academic inquiry and logical reasoning.

4. The Jurisprudential Model, (Oliver and Shaver, 1966). This method was designed to teach the jurisprudential way of thinking to solve social issues.
5. The Role Playing Model, (Shaftel, 1967). This model was designed to develop personal and social values through the examination of one's own behavior and values.
6. The Social Simulation Model, (Boocock, 1968). In this model the students experience and examine their reactions to various social processes within specific situations (the students examine both their reactions and their fellow students' reactions).

The Information-Processing Models are oriented toward the information processing capability of students and the ways that they can best improve their ability to master information. How the student organizes the data, senses the problems, generates the concepts, and the manner in which the thinking is expressed both verbally and nonverbally are emphasized in these models.

1. The Inductive Thinking Model, (Taba, 1967).

This model is used primarily for the development of academic reasoning, inductive mental processing, and theory construction.

2. The Scientific Inquiry Model, (Schwab, 1963). This model was used extensively in the curriculum reform movement of the 1960's. It was designed to teach the research system of a discipline. It is also expected to have effects in other domains as well.
3. The Concept Attainment Model, (Bruner, 1967). This method focuses on the development of inductive reasoning, concept development, and analysis.
4. The Cognitive Growth Model, (Piaget, 1952; Sigel, 1969; and Sullivan, 1967). This model is used primarily to develop one's general intelligence and logical reasoning processes, and can also be applied to social and moral development as well (see Kolberg, 1966).
5. The Advance Organizer Model, (Ausubel, 1963). This model was designed to increase the efficiency of information processing.
6. The Memory Model, (Lucas, 1974). This model

was designed to increase the capacity to memorize.

Personal Models are oriented toward the individual and their personal and emotional life. The focus is to help the individuals to develop a productive relationship with their environment, to increase self-awareness of their capabilities, and to become more effective in information processing.

1. The Non-Directive Teaching Model, (Rogers, 1951). This model emphasizes personal development of self awareness, understanding autonomy, and positive self image.
2. Awareness Training, (Perls, 1977 and Schutz, 1967). This model focuses on the development of one's capacity for self-exploration and self-awareness, including interpersonal awareness and understanding, as well as sensory and body awareness.
3. Synetics, (Gordon, 1961). This model focuses on the development of creativity and creative problem solving.
4. The Conceptual Systems Model, (Hunt, 1970).

This model increases personal flexibility and complexity of the individual.

5. The Social-Problem Solving Model, (Glasser, 1969). This model helps to develop responsibility to self and society with increased self-awareness and self-understanding.

Behavior Modification and Cybernetics Models were developed to create efficient systems for sequential learning, shaping behavior, and are frequently referred to as behavior modification because they emphasize the visible changes in the behavior of the learner.

1. Programmed Instruction, (Skinner, 1956). This model emphasizes facts, concepts and skills needed for the development of personal goals and acceptable social behaviors to minimize social anxiety.
2. Anxiety Reduction, (Rinn, 1974). This model emphasizes the substitution of relaxation for anxiety in social situations.
4. Assertive Training, (Wolpe and Lazarus, 1966). This method emphasizes the expression of one's

true feelings in social situations.

5. Simulation, (Jrietzkow, 1963). This method focuses on the concepts and decision-making skills needed by an individual in day-to-day decision making.
6. Direct Training, (Glaser, 1965 and Lumsdaine, 1962). This method views pattern of behavior and the skills needed to interpret and change the individual's behavior.

From the above we see that there are many approaches to teaching. For the curriculum intervention program that the writer developed, the experiential education approach was selected. The experiential curriculum intervention developed is most similar to the social interaction models, but also includes some of the model characteristics found in the social simulation and personal models.

Experiential Education Literature

Experiential learning has had many names, but none for the all-inclusive category. Yale first adopted the name "laboratory sciences" in the 1830's, "applied studies" was coined during the Civil War era, "clinical experience," "cooperative education," "studio arts" and "field studies" have all been used at one time or another. The newest term used is "experiential learning", (Keeton and Tate, 1978). Therefore, a review of some of the literature supporting experiential learning is in order.

John Dewey is considered to be a father of modern thinking in education, a noted American philosopher who has been most influential in directing the world toward the fundamental ideals of a liberal civilization. Dewey, born in New England in 1859, is the author of such significant works as How We Think, Reconstruction in Philosophy, Experience and Nature, The Theory of Inquiry and Experience and Education, all of which provide a foundation upon which to build a rationale for the use of experiential learning.

Dewey was one of the forerunners in the development of progressive schooling. He shared his ideas on the needs and problems facing education--and possible approaches to educating--throughout his career. He supported progressivism and experiential learning. Dewey and his followers emphasized experience, experimentation, purposeful learning, freedom and other such concepts. Dewey stated that principles by themselves are abstract, and they only become concrete when they are experienced by putting them into practice in the school and the home, (Dewey, Experience and Education, 1938).

Jerome Bruner (1962) discusses creativity and experiences for learning. He refers to such situations as, "the unexpected that strikes with wonder and astonishment", "a placing of things in new perspectives", and "the sensory intensity presently being experienced." Situations such as these imply that a more positive effect on learning and retention will result through an experiential approach where the act produces an effective suprise. The lasting impression, created through surprise, is learning that can be carried through into one's future to be recalled in any given situation.

Morris T. Keeton (1977) researched and studied the experiential learning movement. In his book, Experiential Learning, he addresses the rationale, characteristics and assessments of this approach. He states that the traditional educational practices do not fulfill our needs, that they inadequately represent current understanding of knowledge because concepts without percepts are empty and percepts without concepts are blind. In other words, without the percept - an impression of an object obtained by the use of senses (Webster, 1981) - the concepts are incomplete. One needs to experience the information given in a complete manner for the learning to become complete. Both the concepts and the percepts must be present for learning to take place. Experiential content is essential to genuine experiential knowledge (Keeton, 1977).

Through the senses of sight and sound one can integrate the concepts of an area of study into thoughts within the mind. This knowledge then can be reinforced through experience, making the knowledge more useful. One may say that reading is an experience, but it is only an experience of reading, not the experience of doing what is being read about. For example, I recently earned a private pilot's license. I could have learned about flying by reading about it, but I could not have gotten into an airplane and flown it away with only the knowledge of the concepts gained through reading. Experiences on a simulator, actual flying time with an instructor and without an instructor, and practice were essential for the learning to be complete. The experiential approach is currently being used in outdoor education programs, Outward Bound Programs, Project Adventure Programs, vocational training, and is included in many science education programs.

Of note in the science programs is the ESTPP (Earth Science Teacher Preparation Project) which, in the 1970's noticed that teachers following a less structured curriculum in the ESCP (Earth Science Curriculum Project) showed greater successes. In the Earth Science Curriculum Newsletter (September 1, 1970) they reported the following:

On the Positive Side

1. The ESCP worked very well in many schools and the interest was high.

2. Teachers who allowed their students to work on activities in a leisurely fashion had far more success with their classes.

3. Students who were allowed alternatives to choose among, rather than having to follow an externally imposed linear path through the ESCP or any other materials, appeared

to have a very positive attitude toward earth science.

4. Teachers who provided their students with many materials besides those created by ESCP saw great values in the ESCP materials themselves, but experienced even greater success in classes not based entirely on any single packaged curriculum.

5. Low-ability students thrived on ESCP materials when truly open modes of inquiry were substituted for the strict guided modes of inquiry adopted by many ESCP teachers. Dependence on the book put low-ability students at a disadvantage.

6. Nonauthoritarian teachers, in general, had great success with ESCP materials.

<u>On the Negative Side</u>

1. Students who were too rigidly confined by their teachers to the schedules proposed by the ESCP were not enjoying their study of earth science.

2. Problems with reading and math levels occurred in many book oriented classrooms.

3. Some students became bored with the repetitous nature of laboratory activities. This was less true of ESCP than of most other programs, but it still occurred.
4. Students subjected to a strict ESCP pattern questioned the relevance of many things that they were expected to learn.
5. Many ESCP teachers were still far more concerned about subject matter than children.
6. Grading pressures were high, in general, and much of the emphasis was still on retention of factual information or solving of trivial problems. The ESCP unit tests were guilty of perpetrating this emphasis. The evaluation effort was related to the book rather than to the laboratory exercises.
7. Authoritarian teachers had just as poor a response from students in ESCP-based classes as in non-ESCP-based classes.

Experiential education has existed in one form or another for many years. It has an established foundation, has proven itself to be effective in many situations, and is considered by many to be essential for learning to be complete. The experiential approach to education is the primary mode employed in this project.

Learning Styles

In addition to teaching method/strategy, an instructor must consider the learning styles of his/her students. Combinations of student attitude, aptitude, interpersonal skills and past achievements all affect the student's learning style. Consequently, no two people will react in the same way to any one teaching model/strategy.

Learning styles may be categorized as either generic or model specific, (Joyce, 1978 and Hunt, 1970). The generic styles are important in that they provide guidelines for adapting and tailoring the teaching models to fit the student's personality. An example of the generic style is a model which involves conceptual flexibility as opposed to rigidity, (Hunt, 1970). The model specific style is more rigid, and these students prefer models of high structure which provide clear cut guidelines for expected behavior and performance. Very few students, if any, can profit from one teaching model or one learning style. What is important to keep in mind, is that some students will be more productive in one environment than in another.

The student's individual learning style is a combination of different elements resulting from four basic stimuli: the environment, the emotional elements, the sociological elements, and the physical elements. The interaction of these elements will have a significant effect on the learner's ability to absorb and retain knowledge. Combinations and variations of these four elements suggest that few people will learn in exactly the same way or think in the same way, (Dunn and Dunn, 1975).

The first category includes the environmental elements. They include sound, light, temperature and design (general surroundings). Surrounding noises may be distracting to some students, while others can block them out. Some students can adjust well to selected sounds, but most appear to require complete silence when the learning requires concentration or is difficult for them to comprehend. Another group may well require sound by needing a discussion of the materials before they can be learned. Lighting at one level may be considered excessive by some, but insufficient to others. The effect of temperature differences on concentration is easily observed. Some require a warm environment before they can study, where others find the same temperature too warm and uncomfortable. The design of the environment will also produce different levels of achievement. Some students require a formal study area, like a library or a study room with a chair, table or desk. Other students might find it difficult to sit in a traditional setting for any length of time and need a more relaxed setting in order to work for long intervals.

When the elements are incorrect for an individual, his/her concentration will be interrupted by either over-stimulation or under-stimulation. The key then, to a good learning experience, would be to adapt the teaching method to the student's individual learning style. The adaptability, creativity, motivation, intelligence, immediate environment, emotionality, sociological needs, physical requirements, and overall personality of the student will have a more powerful affect on learning than any one specific teaching method or learning style. The task of the instructor then, is to match the learning experience to the student's learning style.

The second category includes the emotional elements. These include the student's motivation, persistence, responsibility, and need for structure or flexibility. Historically, teachers address each group or class as a whole. Those students who want to learn can be more independent and learn at their own pace. However, the unmotivated, non-persistent, irresponsible learner needs to be more closely supervised, given short assignments, and given frequent praise.

The third category addresses the sociological elements. Students react differently to their peers, other adults, and the learning process itself. Some prefer to study alone because they feel intimidated by an "authority figure". These students can learn more easily by working with a friend or in a small group situation. With this type of student, independent or peer-group studies should be emphasized when designing the teaching strategy. Other students may require more direction and sometimes continual interaction with an authority figure, whether s/he be an outside resource, an expert, a teacher or a para-professional.

The fourth group includes the physical elements/needs. Some people learn best through an auditory approach like a lecture, a discussion or a recording. Others are more inclined to visual strategies, "a picture is worth a thousand words", and tactual or kinesthetic involvement may be more beneficial for other students. Frequent eating, drinking, gum chewing, or biting on objects while engaging in the learning process may be needed by others. The time of day is another factor that needs to be considered. Some students are more alert in the morning, afternoon or evening and will best be able to absorb the learning at that time. Lastly, is the physical need for mobility. Some students find it extremely difficult to sit still for long periods of time in a restricted environment. These students find it impossible to function in a traditional teaching setting. Conversely, others who are at ease in one position for hours on end find that the frequent movement that occurs in informal programs breaks their concentration.

In conclusion, the use of a multi-sensory approach to teaching can often overcome many of the perceptual problems that students experience in traditional programs. Individual differences/learning style profiles and teaching methods/strategies should be matched when designing a program of learning. Traditional programs frequently make this impossible, but an experiential approach to teaching would lend itself to a more perscriptive approach to teaching and learning.

Energy Education Literature

In a recent accounting of consumer energy conservation research, some six hundred studies were completed since the 1973 oil embargo. However, most of the studies tend to be intuitive and atheoretical. Many of them simply describe attitudes and assume predictive relationships between attitudes and actual energy conservation behavior, (MacDougall, Claxton, Ritchie and Anderson, 1981).

Conservation of energy by individuals, who have been given rapid informational feedback on the energy they are using and could save is indicative of a greater change in attitude and energy consumption, (McLeod and Glynn, 1983).

Consequently, many utility companies, state agencies and special interest groups have sponsored free energy audits and consultations for the procurement and installation of energy efficient windows, doors, and other energy conservation products at low or no cost to the consumer.

The burden of energy conservation falls more heavily on the poor and less educated. Misuse by the rich has little or no direct penalty for wasting energy. Tienda and Aborampah (1981) noted that low-income families can only absorb the increases in energy costs through a "collective household strategy to allocate scarce resources against potentially competing demands." Therefore, they need information about low or no-cost solutions for more efficient use of energy in their specific living situations. However, studies tend to show that they are the least informed. It appears that upper-class Americans tend to support conservation practices, but it is the middle-class American groups that put their support into practice. One may extrapolate from this: poor people pay more, both in financial output and personal sacrifice for energy. Middle and upper class Americans tend to be reached more effectively through the media. Low status groups may be less exposed to energy information or less likely to integrate the contents of the media's message into their lives, but if educated effectively, would be more likely to introduce it into their living situations.

In the 1980's there have been a variety of approaches taken to address the problems related to energy education. There have been numerous workshops, computer software packages, energy audits designed for existing educational structures, various written materials from the government, numerous magazine articles and many educational packets developed for various grade levels centering around the theme of energy, among which are the following.

Mitchell Thomashow's Know Nukes: A Model for Teaching Controversial Issues, (1984) summarizes a nuclear power workshop that presented techniques useful in controversial issues of education. Carolyn J. Tzitz' Resource Conservation Software Competition in

California, (1984) describes a statewide computer competition involving young programmers who developed software packages on energy and water conservation. Edward C. Hall, Jr.'s Energy Enriched Microcomputer Curriculum Project, (1984) describes software packages on energy topics such as personal energy inventories and home energy savings for grades seven through twelve. Ted Clark's Monitoring and Conserving Energy Usage in Existing Educational Buildings, (1984) describes past efforts to conserve energy in schools and advocates that all school capital improvements contain as many conservation components as financially possible. C. Dickinson Schwarzbach's and J. Philbin's How to Motivate Staff and Students to Save Energy, (1984) is a publication which describes techniques and approaches that many California school districts have used successfuly involving staff and students in energy reduction efforts. Dennis Garrahy's Energy Theme, (1982) designed a social studies unit to develop the reading and writing skills of low achievers with the student activity focus on the theme of energy. Gerald C. Saunders' Climate Change and the Classroom, (1983) is a teaching aid to understanding the orbital variations producing equable or extreme climatic conditions.

In addition to the preceding, there are numerous science studies skills programs and energy management courses. Many of these programs are based on an experiential approach where the students become more involved in the project. Science programs, in particular, offer a wide range of experiences in building and using various alternative energy devices. Among the programs available are: Department of Energy, Science Activities in Energy Series: Solar Energy, (1977) which is a packet of twelve simple experiments demonstrating the properties of solar energy; Halacy's Solar Science Projects, (1974) which consists of seven solar projects including the plans for constructing a solar cooker, an over, a water heater, a distiller, and a furnace; Halacy's Experiements with Solar Energy, (1969) is a collection of forty inexpensive solar energy experiments including hands-on construction/operation of several solar devices; Metos, Exploring With Solar Energy, (1978) covers some history of solar energy usage and model building; Solar-Education Corporation's, Handbook of Energy Lesson Plans, (1977) is a collection of solar experiments for elementary, secondary and college students; Cummings' Make Your Own Alternative Energy, (1979) is a guide including instructions and diagrams for constructing solar collector models, a solar greenhouse, a water wheel, a wind gauge, a sawdust stove, and a tabletop methane digester; Barling, Solar Fun Book: Eighteen Projects for the Weekend Builder, (1979) is a collection of step-by-step building instructions for solar cookers, a solar greenhouse, and swimming pool heater, among others; Davis, Solar Energy Laboratory Manual (1979) is a collection of seventeen laboratory and outdoor science experiments which teach the fundamentals of solar energy uses, solar radiation, heat transfer, and the collection and storage of flat plate solar systems; Stewart, How To Make Your Own Solar Electricity (1979) covers the design, construction and economics of photovoltaics, including details on solar arrays, concentration cells, photosensors, battery and other types of storage systems.

There are many vocational school courses specifically developed around alternative energy. The vocational and technical school programs concentrate on hands-on construction and maintenance of alternative energy devices in great detail and devote several weeks or months to a specific project. Some of the programs are: Bergen County Vocational Technical Schools' Solar Troubleshooting and Maintenance, Energy Conservation for Residential Dwellings, Photovoltaics and Wind Power Systems, and Solar Systems and Energy Management Controls, (1983) developed by Bergen County Vocational Technical Schools in Trenton, New Jersey. Maine Audubon Society's Vocational and Industrial Arts Package (1977) is a thorough manual of activities on solar concentrators, collectors, wood fuel, heat loss, bio-gas, wind energy, radiant energy, photo cells, heat storage, and ocean thermal energy, and their Vocational Region 10 Solar Greenhouse Resource Booklet describes how students built a solar greenhouse. Minnesota Instructional Materials Center's Energy Activities for Industrial Education (1977) is a collection of twenty-one hands-on activities/experiments including insulation efficiency tests, automotive efficiency tests, collecting/storing energy techniques, and the hands-on construction of several collectors including a hydroelectric generator and wind generator. Beyond the above programs for vocational and technical education, there are readings available on home efficiency/maintenance such as Joint Venture Incorporated's Solar Heating for Multi-Family Housing (1981) which is a step by step description of solar mechanical systems for the conversion of energy and its use in multi-family dwellings. Another is Adams' Your Energy Efficient House-Building and Remodeling Your Home (1975) which is a work that covers uses of the sun, wind, landscaping, climate factors, insulating, and heating/cooling techniques.

As can be seen from the preceding literature, there are many formal alternative energy education programs available. If one chooses to pursue alternative energy education, there are several two and four year schools that offer energy related programs of study and/or degrees in solar technology. Among the two year schools in Massachusetts are: Blue Hills Regional Technical Institute, Canton; Cape Cod Community College, West Barnstable; Franklin Institute of Boston, Boston; Massasoit Community College, Brockton; and Springfield Technical Community College, Springfield. Among the four year schools in Massachusetts are: Amherst College, Amherst; Boston College, Boston; Boston University, Boston; Clark University, Worcester; Harvard University, Cambridge; University of Lowell, Lowell; University of Massachusetts, Amherst; Massachusetts Insitute of Technology, Cambridge; North Adams State College, North Adams; Northeast Institute of Technology, Boston; Northeastern University, Boston; North Shore Community College; Wentworth Institute of Technology, Boston; Worcester Polytechnic Institute, Worcester; and Williams College, Williamstown.

In Massachusetts alone, there are many formal institutions offering educational opportunities for energy education. However, programs offered outside of the formal educational setting are few. Of note are the Do-It-Yourself House Design Courses offered by the Heartwood School in Washington, Massachusetts; the Shelter Institute in Bath, Maine; and Corner Stones in Brunswick, Maine. These experiential education groups provide a basic practical education, developing hands-on skills in carpentry, while building inexpensive collectors and remodeling and designing alternative energy homes.

Attitudes in Education

The field of psychology has emphasized the effects of attitude and success on learning. Attitudes were first experimented with by Miller and Schumann in 1889. These experiments had been mainly concerned with the repression of learning, but have been more recently concerned with success, attitudes and beliefs in relation to the learning experience.

Edwards (1941) delivered a speech to a class of students using an equal number of favorable and unfavorable statements about F.D. Roosevelt's New Deal proposal. Edwards found that most of the arguments remembered supported the individual's preferred views regarding the New Deal proposal; those that were in favor of it remembered more of the favorable statements and those that opposed it showed a similar tendency to recall the unfavorable statements. Thistle and Thwaite (1950), in a similar experiment, found that his respondents tended to select conclusions consistent with their attitudes, but not necessarily in agreement with the previous arguments. Manis (1961) suggested that if the message receivers or learners felt pressured to change their beliefs when they heard them attacked, they would resist the change. The greater the divergence, the greater the message block with less probability of change in attitude.

Karl Jung (1971) stated that attitude is a readiness of the mind to act or react in a certain way. He writes about both conscious and unconscious attitudes, citing that feelings may swallow up thinking and sensation, or thinking may overrun everything else, depending upon the attitude. As a teacher, it is important to keep this perspective, for attitudes will affect both the acceptance of the learning experience and predict the likelihood of using the knowledge gained in the learner's future life situations.

Students construct their own understanding from what is presented to them in any given learning experience. Traditional curricula have promoted the idea that rote memorization or mirroring of the information presented was the best indication of the knowledge learned. I.Q. tests, S.A.T. scores, G.R.E. scores and other such proficiency tests tend to substantiate that these are still deemed to be the primary indicators of one's present knowledge from which future predictions are made.

It is the writer's belief that a solid attitudinal foundation is needed for learning to be complete. Although behavior and knowledge may be temporarily changed and/or retained, the integration of the learning is not complete without an attitudinal affect. The attitude toward the information learned will determine whether the change and knowledge will have permanence.

Through this project's experiential curriculum intervention, it is hoped that an attitudinal change will result in a greater understanding of and appreciation for the use of alternative energy and the practices of conserving our natural resources.

C H A P T E R IV

Seminar Part I

The alternative energy seminars and research were conducted with two groups of thirty-two participants each. One group, the control group, had the project explained to them, and completed a twenty-four item questionnaire (see Appendix F) on two separate occasions--total time commitment, two hours. The second group, the experimental group, completed the same questionnaire prior to attending the seminar, attended a two-day seminar, completed the pre/seminar questionnaire at the end of the seminar, and responded to a follow-up telephone interview (see Appendix G).

The experiential curriculum intervention strategy seminars included: discussion sessions, demonstrations, and hands-on activities designed to help the participants understand and use their twenty-four page hand-out (see Appendix D).

The time commitment invested by the participants was:

Questionnaire completions---two hours

Seminar attendance---two days

Telephone interview---forty-five minutes

Home energy audit---two hours (if requested)

The seminars were designed to be experiential in setting and activities. They incorporated a multi-sensory stimulation with four focal themes:

1. To develop and/or reinforce a positive attitude toward energy conservation while showing that energy conservation need not be an expensive proposition--in fact, it can save money as well as natural resources;

2. To develop an awareness and understanding of the energy options, conservation practices, and construction techniques available for their use;

3. To encourage them to incorporate the use of conservation practices into their lives, develop hands-on skills for energy conservation and maintenance of their homes, and ultimately, encourage the construction of alternative energy

devices and energy efficient homes;

4. To share this knowledge with their friends and neighbors, so that many people could benefit from their experiences at the seminar.

The seminars began with a tour of the alternative energy house, followed by discussion sessions on the beach and a few demonstrations. In order to reflect some of the writer's narrative content of the seminar, portions of this chapter will include direct quotes from the writer's seminar presentations.

"You may or may not feel that you have the talent to work on your home or apartment. Hopefully, as a result of the seminar information, you will feel more comfortable in evaluating your home's efficiency and attempting some of the seminar suggestions for energy conservation.

"Today we are able to identify and diagnose through thermograms the areas where most of our heating energy is lost. A thermogram is a special photograph which shows the infared heat radiated from various areas of a person, building, town, city or even the world, depending upon your perspective. Plymouth, Michigan, with Federal funds, used thermograms of their buildings to heighten the homeowners' awareness of the need for energy conservation, and to provide tips for building. The pictures were taken in early evening hours, on two cold March nights, from a van with an infared scanner mounted on its roof. They recorded the visible temperature imprints and electronically transferred them onto film, in the form of various colors. The spectrum ranged from white, to red, orange, green, light blue, dark blue, pink, magenta, and black. The various levels of heat radiated were recorded with white being the most heat radiated, and black the least. The scale from white to magenta spans about fifteen degrees fahrenheit. Consequently, a precise picture was revealed. The greatest amount of heat was radiated from windows and doors. Large display windows in businesses were most obvious in heat transfer. The heat from parked cars on the street--that could help heat a garage--were quite visible in the thermograms. The waste of energy from power plants in converting fuel to energy was also vividly displayed. Heat escaping through sky lights, chimneys, and other roof and ceiling openings was also evident.

"One of the simplest concepts to understand is that hot air rises. Therefore, through the use of more insulation in the ceiling areas, insulated curtains, thermal shutters and plastic coverings around doors and windows, heat will be kept from escaping. As a result of these efforts a large drop in energy consumption could be noticed."

At this point the seminar participants discussed what they felt could be done to conserve energy in their homes. Following this discussion, the participants completed an energy audit. The students then assessed the present level of energy efficiency of the alternative energy home being constructed. Through this awareness they could then begin to develop the simple skills necessary to "button-up" their homes and augment their present heating systems.

The following Energy Audit charts, which were compiled and adapted from Northeast Utility brochures, were used for the audit (They are available by writing: NU 80s/90s Northeast Utilities, P.O. Box 270, Hartford, Connecticut 06101). This part of the seminar was presented in the following manner.

"Let us begin with the following 100+ energy audit. This do-it-yourself audit is easy to do and we will complete one here today. Upon completion of a do-it-yourself audit, if you feel a more professional audit would be helpful, there are several groups that will conduct an audit at minimal cost. For further information on these groups, contact your local electric, gas or oil companies. Many of these companies offer free literature and some will even subsidize a professional energy audit. In Massachusetts you can request a professional energy audit from: Mass-Save, Inc., 131 State Street, Suite 1050, Boston, MA 02109, telephone (617) 720-2590."

In order to understand and complete the energy audit, the following definitions for R-value, U-value, and Vapor barriers were presented and discussed:

> "The R-value of a material is the measurement of that material's ability to resist heat loss. The higher the R-value, the more heat saved.
>
> U-value is the measurement of a

material's ability to conduct heat. The lower the U-value, the more heat saved.

A Vapor barrier is a thin covering of paper, foil or plastic film that protects insulation and wood from moisture damage. The vapor barrier should face the heated area to avoid condensation in the walls of a structure and will stop wind infiltration."

After the preceding introduction, the following do-it-yourself energy audit was discussed and completed.

NU 80s/90s "100 Plus"
Do-It-Yourself
Energy-efficient Home Checklist

Assigned Rating Points	Minimum R-Value Recommended for New Construction	Points Date	Points Date
Ceiling insulation			
R-57........40 points	R-38		
R-38........30 points			
R-30........26 points			
R-19........20 points			
Exterior wall insulation			
R-25........26 points	R-19		
R-18........22 points			
R-11........18 points			
Interior Walls			
Between separately heated units			
R-11.........5 points			
Floor insulation			
Over vented crawl spaces			
R-19.........6 points	R-19		
Over unheated basement			
R-19.........6 points	R-19*		
R-11.........4 points			
Between separately heated units			
R-11.........5 points	R-11		
Slab insulation			
R-8..........4 points			
R-6..........3 points	R-6		
R-4..........2 points			
Windows			
Triple glazed....24 points			
Double glazed....20 points	Double glazed**		
Exterior doors			
Standard door with weather stripped storm door OR Insulated doors R-3...4 points	Either method		

Assigned Rating Points	Minimum R-Value Recommended for New Construction	Points Date	Points Date
Weather stripping All weatherstripping and caulking....13 points OR, for new construction or window replacement: Windows with infiltration rate of less than .5 CFM/FT of operable sash (specified by the manufacturer...13 points	Either method		

*or R-4 basement wall insulation
**Triple glazing required in over-7000 degree day areas for 24 points. Call your local weather bureau office for information on the degree day rating for your area.

Attic ventilation
Gable vents with insulation vapor barrier, 1 sq. ft. inlet and 1 sq. ft. outlet for each 600 sq. ft. of ceiling area......4 points
Gable vents without insulation vapor barrier, 1 sq. ft. outlet and 1 sq. ft. inlet for each 300 sq. ft. of ceiling area..........4 points
Eave and gable vents, 1 sq. ft. inlet and 1 sq. ft. outlet for each 600 sq. ft. of ceiling area..........................4 points

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Exhaust fan (outside vented)
Kitchen range.........................5 points
Bathroom (all full baths).............5 points
Dryer.................................5 points

Air conditioning ducting/piping
If not in conditioned space and not insulated to R-7........................deduct 3 points

---

Hot water piping
If not in conditioned space and not insulated to R-7........................deduct 3 points

---

Assigned Rating Points	Minimum R-Value Recommended for New Construction	Points Date	Date
Controls and appliances			
If central air conditioner does not have EER of 7 or higher................deduct 3 points			
Water heater			
-Insulated wrapper..................10 points			
-Thermostat setting 140 or lower......5 points			
Solar assist equipment (includes wind powered)............................15 points			
Automatic night setback for heating...5 points			
Fireplace if no positive damper or glass door on fireplace............deduct 10 points			
Showerhead flow control limit to 2-1/2 GPM....................5 points			
Outlets and switches in outside walls gasketed.............................5 points			
Heating equipment***			
Oil burner with flame retention head burner or automatic vent damper or equivalent (ask your oil company representative).....10 points			
Natural gas fired with automatic vent damper or equivalent........................10 points			
Heat pump with seasonal performance factor rating of 1.5 or greater at your location............................10 points			
TOTAL:			

***Specifications apply to the primary heating system only - maximum of 10 points per home. Equivalent listings are available from NU's Energy Management Services (EMS) Department.

Some of the questions discussed during this particular phase of the session were: What is the R-value for various types of insulation? What types of insulation are available? What are some of the advantages and disadvantages of each?

In the chart that follows, several types of insulation, pros and cons of its usage, and the R-value for each (per/inch) were explained. The participants then calculated the R-value of different types of insulation by measuring the thickness and multiplying it times the appropriate one inch factor from the following chart.

MATERIAL	R-VALUE/INCH	BENEFITS	DRAWBACKS
Batts/ Blankets Fiberglass Rock Wool	 3.2 3.4	They are easy to install, widely available fire & moisture resistant. Least expensive	Fiberglass may cause skin and/ or lung irritation. (Full body clothing with gloves & mask should be worn during installation
Loose Fill* Fiberglass Rock Wool Cellulose Vermiculite	 4.7 3.7 3.7 3.0	These are easy to install & fill spaces thoroughly. Moderately priced.	The chemicals in cellulose may reduce the R-value or cause pipe corrosion
Rigid Board Rigid Plastic Foam Polystyrene Polyurthane Polyiso- cyanurate	 5.0 6.2 7.2	They are light-weight and have a higher R-value per/inch. Most expensive	Needs fireproofing because the vapors from burning may cause death.

*Depends on Density

Door and window insulation was then discussed with the U-value rather than R-value focused on. (Unlike the R-value, the lower the U-value, the better the insulation value.) Both flexible and rigid plastic--which may be chosen from several types of clear plastic materials and have a good insulation value when properly installed--were discussed and experiemented with. The participants then donned protective clothing--rubber surgical gloves, a surgical mask and protective glasses. The participants then installed some insulation and plastic sheeting, which they measured, cut and stapled into place. Many of the students were surprised at the ease with which these products could be installed. Insulated drapes, thermal shades and thermal shutters were then covered with a discussion of their effectiveness. Now that the participants had developed an understanding of insulation, the seminar focused on weather stripping, caulking and the determining of which type to use.

"Windows and doors are where most energy is lost; they lose more heat per/square inch than any other part of the house. Loosely fitting windows and doors lose up to five times more heat than closely fitting ones. Weather stripping, caulking, use of plastic and thermal curtains are inexpensive and can give you a pay-back within the first year.

"How do you check for heat loss? On a windy day, feel the doors and outside walls and see how well they are insulated. Feeling for a draft by hand or using a piece of cellophane taped to a pencil and moving it around the outside of the window or door opening will give an indication of any draft. Another method for findng leaks at night, is shining a flashlight around the edge of the doors and windows while someone is outside marking where the light can be seen for caulking or covering on the following day. Condensation build-up on the inside of a storm window is an indication of the inside window leaking. If doors do not shut with slight resistance, the hinges may need adjusting. If there are gaps, they can be sealed with various types of weather stripping or door sweeps. The caulking and weather stripping that has been previously installed may need adjustment or replacement. These should be checked annually. All doors, windows, basement and attic access openings that are between heated and unheated areas should also be checked. Other places to check for caulking are: exterior joints where door and window frames meet the siding, where storm windows meet the window frames, the corners of the house, and window and foundation sills. In addition, you should check where porches join the main part of the house, any exterior openings where pipes or electric wires enter the house, ceiling lights, electrical outlets, and wall switches mounted on the outside walls. Your chimney is another area that needs to be checked. Check where the chimney meets the siding, and how well the damper seals. An inside covering for the fireplace opening, and kitchen or bathroom fan openings should be used when not in use.

"The choice of weather stripping and caulking should be appropriate to the specific needs. Cost, durability, the period of time expected to occupy that space, ease of installation, whether it can be painted, expandability, and the best use for a specific type of weather stripping should all be carefully considered."

After giving the participants the preceding introduction, they discussed the following chart and worked with the installation of different types of weather stripping and caulking. The charts show the type, the benefits, draw-backs, best use and cost for common types of weather stripping and caulking.

Common Types of Weather Stripping

TYPE	BENEFITS	DRAWBACKS	BEST USE	COST
Thin Spring Metal	Very durable & almost invisible when installed	Hard to install	In channel of window	Expensive
Rolled Vinyl	Durable & easy to install	Visible when installed & destroved by fire	In middle of double hung windows	Medium priced
Foam rubber with adhesive backing	Easy to install & invisible when installed	Breaks down quickly, can not be used where friction occurs: it is less effective than metal strips or rolled vinyl	Use on window tops and bottoms	Lowest
Rolled vinyl with aluminum channel backing	Durable & easy to install	Visible when installed	Sides & tops of doors	Expensive
Door shoes	Very durable	Difficult to install	On a wooden threshold that is not worn	Medium-priced
Door sweeps	Inexpensive	Not very durable & may drag on rug	On a flat threshold	Lowest-cost

TYPE	BENEFITS	DRAWBACKS	BEST USE	COST
Spring metal	Easy to install, invisible when installed & extremely durable	Door cannot bind at any point prior to installation	Sides & tops of doors	Expensive

Do-it-Yourself Guide To Caulking

TYPES OF CAULKING	BENEFITS	DRAWBACKS	COSTS
Oil or resin base	Can be painted	Least durable and needs replacement every two years	Lowest cost
Latex, Butyl & polyvinyl base	More durable	Limited ability to expand	Medium-priced
Silicones	Most durable	Cannot be painted	Most expensive

After having acquainted the students with areas where most energy is lost, and instructing them in "tightening-up" their homes, the next question that was posed was: do you know how much electricity, water, gas, and/or oil is used in your home?

In order to monitor energy usage, it is necessary to become acquainted with the different types of meters and the reading of them. The following meter reading demonstration was carried out with the seminar participants.

Meter Reading

- Monitor your electric, gas and water meters!

- Try some of the conservation practices listed in the following pages of this chapter.

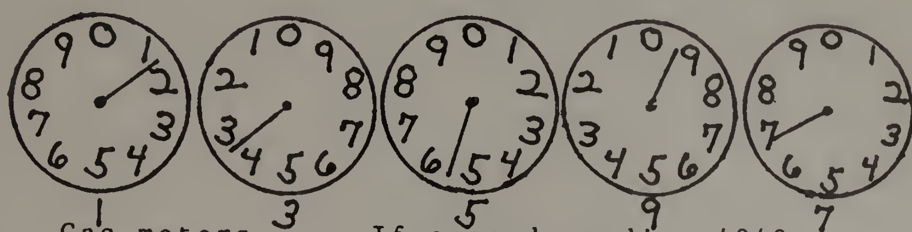
- Record any changes and calculate what the savings would be in a year's time.

The following information will help you to read your meters.

Read the dial starting from the right (units, tenths, hundredths etc.) noticing that some dials go clockwise while others go counterclockwise. If a pointer is between two numbers, record the lower of the two numbers.

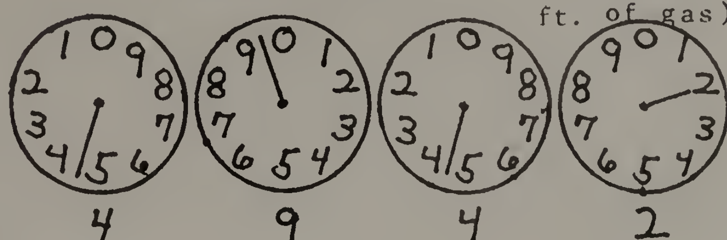
Electric meters

If	second reading	13597
	First reading	13487
	Amount used	110



Gas meters

If second reading	4942
First reading	4842
Amount used	100 (cubic ft. of gas)



Water Meters

If second reading	112800
First reading	107700
Amount used	5100

(cubic ft. of water)

First Reading	Second Reading
107700	112800

Energy Conservation Practices

This portion of the seminar was followed by a presentation of energy conservation tips and a discussion of energy usage in cooking.

"In an effort to live better on less, let us look at a few energy conservation tips that could be used in our daily lives. (Compiled from brochures published by: The Connecticut Light and Power Company, Western Massachusetts Electric Company, Holyoke Water Power Company, Northeast Utility Nuclear Energy Company, and the Northeast Utilities Service Company).

"Cooking uses a great deal of energy, and with some thought, one could save both energy and money. Some efforts to help the air flow in an oven are:

1. Cookie pans should be staggered.
2. The racks should not be lined with foil.
3. The oven should be preheated not more than eight or ten minutes.
4. Use glass or ceramic pans - as a result, the oven temperature can be turned down 25% or more.
5. Meat thermometers and timers can be used to avoid overcooking; double portions should

be cooked, half of which can be frozen.

"Here is an energy comparison for meatloaf preparation. Note the appliances, the temperature, the time, the energy used, and the cost for the various appliances.

APPLIANCE	TEMPERATURE	TIME	ENERGY	COST
Electric oven	350	1 hr.	1.5 KWh	.12
Gas oven	350	1 hr.	.112 Ccf	.078
Toaster oven	450	50 min.	.4KWh	.032
Fry pan	420	1 hr.	.44KWh	.035
Microwave	---	12 min.	.31KWh	.025
Crockpot	200	7 hrs.	.52KWh	.042
Pressure Cooker	Low	10 mins.	.23KWh	.019
	High	3 mins.	.005KWh	.019

Assumes .08 per/KWh (kilowatt hour)

Assumes .70 per/Ccf (100 cubic feet of gas)

"When using a self cleaning oven, use the cleaning feature after cooking while the oven is already hot. Burner reflector surfaces should be kept clean and shiny so as to reflect more heat into the food being cooked instead of absorbing it into the appliance. This will make cooking more efficient; the smaller the area heated, the better. The smaller of two ovens should be used when possible. Toaster ovens are quite efficient, as noted in the previous chart. Pressure cookers and flat-bottom cookware that fit the burner are also more efficient. Turning the burner or the oven off a little before the end of the cooking time will take advantage of the heat radiating from the burner and its surroundings. When using gas appliances, the flame should burn blue, if not, the burner should be cleaned and adjusted. Also, turn the pilots off, matches are far less expensive than gas.

"Regarding the refrigerator: Defrosting food in the refrigerator before cooking will help keep the refrigerator cold and save cooking time. If a freezer has two pieces of plastic taped inside the door with staggered slits to reach through, it would help to keep the cool air in when the door is open. In addition, the location of the refrigerator should be away from any heat source, sunlight included, and the door should be opened as seldom as possible. For example, after shopping, separate all the perishables and put them all away at one time. After school snacks could be prepared before the children get home. A list of foods in your freezer and refrigerator could be taped to the outside of the door--to avoid keeping it open to inventory what is there. Try to plan ahead for meals, removing all the food needed at one time. Keep the freezer full and defrost it whenever there is one-fourth inch of frost. When doing this the frozen foods should be taken from the freezer and put into the refrigerator. This will help keep the refrigerator cold. Vacuum the condenser coils of the refrigerator every three months. If the refrigerator has a butter softener, set it on hard--many have a heater. The gasket around the refrigerator and freezer doors can be checked by closing them on a piece of paper. The paper should be set in several positions around the door. If the paper can be pulled out easily, the door catch should be adjusted or the gasket replaced. Washing the gasket occasionally will keep it soft and afford better seal. When storing liquids in the refrigerator, always keep them covered; the vapors given off from open cans will cause the compressor to work harder. These efforts will help to keep the refirgerator from running excessively.

"When purchasing appliances, look for the most efficient ones. Some may have energy saving devices, such as power saving switches and all should have an energy usage guide--as of May, 1980, the Federal Law requires that all major appliances display a black and yellow energy guide tage. The advantages of one unit should be compared to another. The size that best suits your needs should be purchased, too large or too small will only waste energy.

"Hot water is another area of high energy waste. Although solar alternatives will be discussed later, there are several things that can be done to make present systems, as well as alternative energy systems, more efficient. An insulation jacket around your hot water heater is a must--some electric and gas companies will install these free of charge on their rental heaters. Usually the hot water heater is in the basement or other cool area which draws heat out of the unit. If possible, the heater should be installed in a well insulated hot spot--near your furnace, wood stove, sauna, etc. The pipes coming off the hot water tank should also be wrapped with insulation; otherwise the area around them is heated each time you draw hot water (this is not a very efficient way to heat a basement). There are usually two thermostats on a hot water heater.

Both thermostats should not be set any higher than one hundred and twenty degrees fahrenheit and the bottom heating element can be set lower. In addition, low-flow shower heads and water restricting sink devices should be used."

Constructing Alternative Energy Collectors

The seminar participants spent several hours working with, and developing skills to construct a flat plate collector. Measuring, cutting, cleaning and soldering of copper pipe; using rigid insulation; glazing and caulking were among the hands-on experiences encountered. The knowledge base that they worked from included the following information presented by the writer.

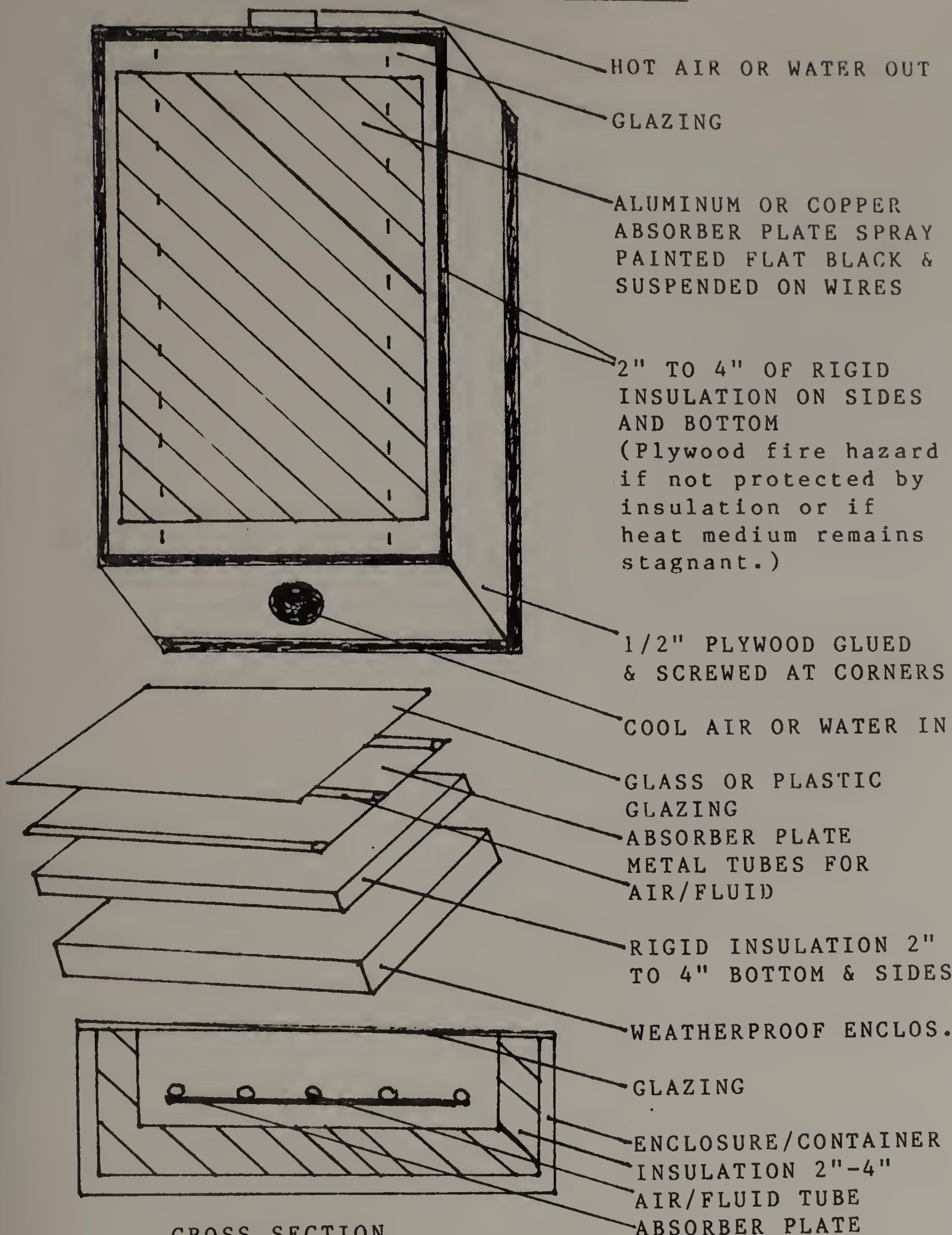
"After constructing an insulated collector box with an inlet and outlet, a metal collector surface must be installed. The collector surface itself should be composed of thin copper or aluminum sheets, due to the fact that these materials have a higher rate of conductivity, more heat can be captured from them. The difference in conductivity between copper and aluminum is slight, but the cost difference is significant. Therefore, aluminum is the better choice. Most newspaper and lithograph companies have used or flawed aluminum sheets. These can be purchased for scrap aluminum prices and, when cleaned, are quite usable. Next, spray paint one side of the sheet with flat black paint and suspend the sheets in the insulated collector box.

"Several types of glazing can be used in the construction of a solar collector--the glazing is the transparent covering that allows the sun's ultraviolet rays to enter the unit. Low lead glass is the most durable. Clear mylar, various transparent plastics and even clear polyethylene can be used to different degrees of efficiency. At a later time the less efficient lower cost glazing could be replaced.

"After the assembly is complete, with a compass, orient the collector to within twelve degrees to either side of true south (taking into consideration the isogenic magnetic correction for your area of the world). Secondly, set the collect angle from the ground equal to the site's lattitude plus or minus twenty degrees. (An inexpensive angle finder from Sears works nicely.) Once the unit is installed, the heat can be distributed inexpensively and efficiently through the use of thermal convection and/or small fans."

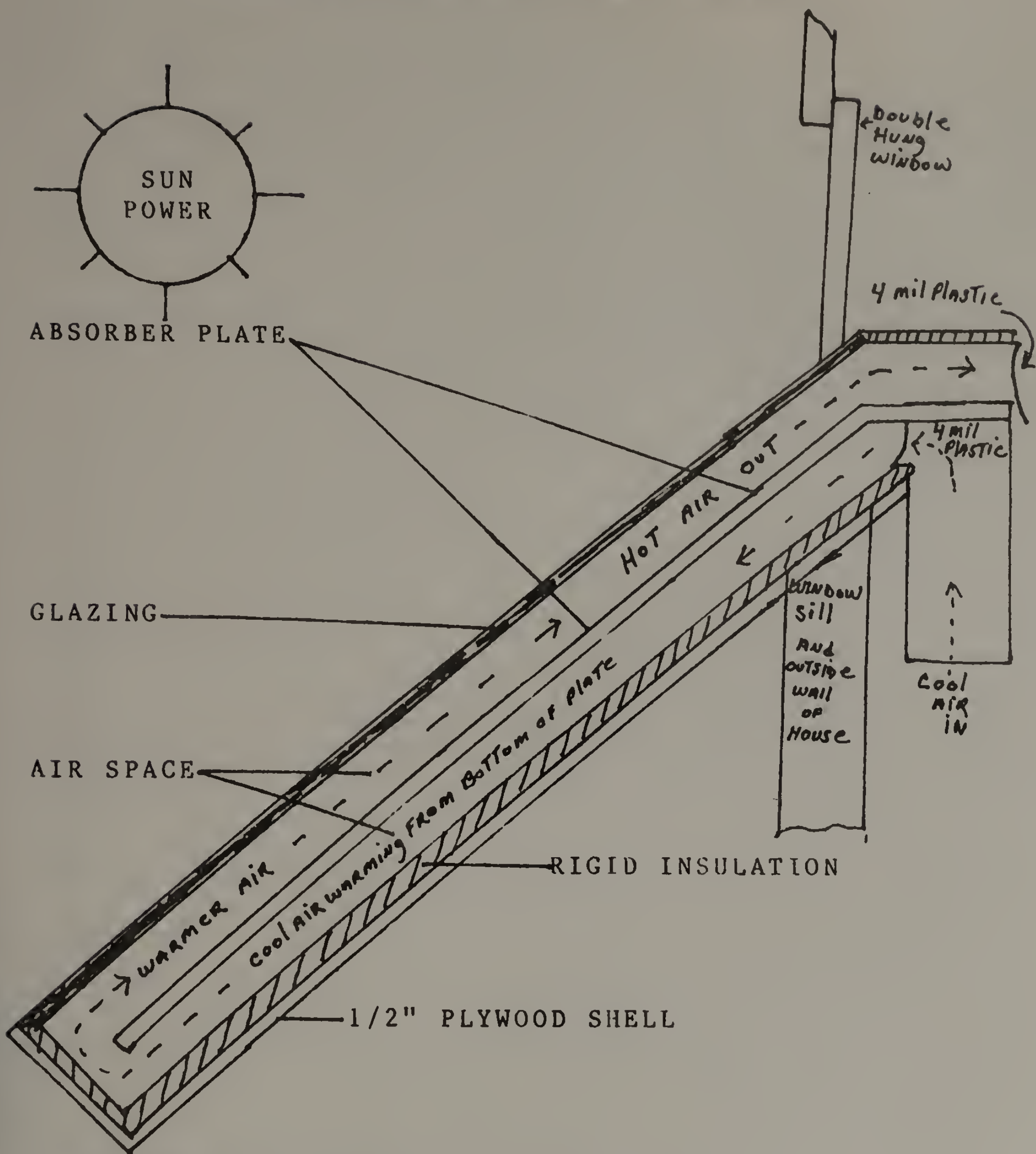
The following diagrams and charts were used as visual aids during this phase of the seminar, along with a demonstration of a parabolic reflector in use.

Anatomy of a Flat Plate Collector



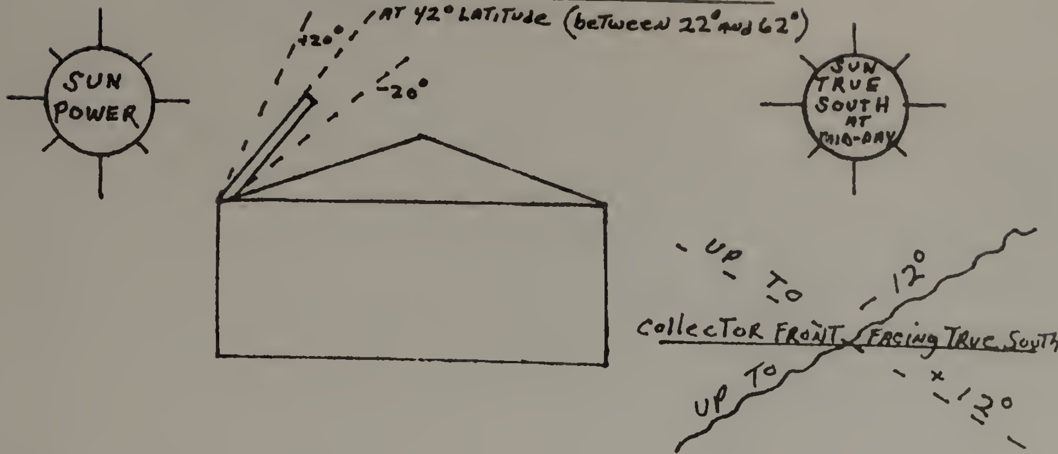
CROSS SECTION

Passive Solar Window Box Collector



(CAUTION: Fire hazard to plywood shell:
1. If not properly protected by insulation;
2. If heat medium is allowed to remain stagnant.)

Collector Tilt and Orientation



The optimum collector tilt is usually equal to your site lattitude. A variation +/-20 will not cause any major difference in performance, for year round, +20 for winter use is better

Twelve degrees to either side of true south is acceptable. Local climate and collector type mayinfluence the choice between east or west deviations.

A parabolic reflector changes the sun's light energy into heat energy. By reflecting the sun's rays off the mirror-like surface to a focal point where nearly all the rays come together, heat is produced. On a calm day the cpncentration of the sun's rays can produce four hundred degrees fahrenheit and higher. This is a difficult unit to construct and should not be a beginning project.

Seminar Review Session

The morning of the second day was spent in a review of what had been learned, while making a second tour of the alternative energy home. Questions, answers and demonstrations were used to point out the specific alternative energy designs and conservation practices that had been considered and used in the construction of the house.

The thirty-five foot, five-sided glass tower that faced true south was now able to be viewed as a giant solar collecting box. The wood fired sauna-furnace room located in the southwestern corner of the basement, could now be seen as similar to the designs used in the ancient Roman, Greek and Chinese civilizations. Here too, the main living area is above the heat storage area in the southwest corner of the house and heated by thermal convection. The north-facing eight-foot dead air buffer zones--created by the forty-four foot enclosed porch and storage areas, and appropriate landscaping, among other designs and practices--all held new meaning for the participants.

CHAPTER V

Seminar - Part II

Project Description: The Writer's Experiential Processes

From the Purchasing of Land to the Construction of the Alternative Energy Home

During the final session of the seminar--embellished with a barbeque near the pond behind the project construction--the writer related his experiences with the project to the participants. Further, the steps one might take, from the procurement of land to the construction of an alternative energy home, were discussed in detail, as outlined in this chapter. Participants' questions, answers, and individual future scenarios were also explored and considered.

It was shown that the construction process becomes complicated when the intention of a builder is the use of alternative building practices. The political processes that have to be followed are laced with one obstacle after another. At many steps along the way, one is coerced into dealing with a variety of professionals and para-professionals in order to acquire the necessary permits and approvals established by the power structure. The following illustrates some of the obstacles encountered and surmounted by the writer, from the procurement of land through the construction of the alternative energy demonstration house. As part of the writer's experiential learning intervention, over 90% of all the related tasks were completed personally.

The writer began his experiential learning intervention while searching for an appropriate piece of land for the project construction. The type of land which was desired needed to have: a southern exposure on a hillside: a body of fresh water: a good deciduous tree population; and be located on high ground near the ocean. The southern exposure affords the opportunity to capture the maximum energy available from the sun. Being on a hill allows three sides of the basement--heat storage area--to be earth-covered. The body of fresh water serves two purposes: 1. through the use of a heat exchanger submerged in the pond, the pond water could be used to help heat the structure in the winter and cool it in the summer; 2. through the use of a simple pump, the water could be used for irrigation and be available in case of an emergency--fire or draught. The deciduous trees help cool the house in the summer, allow good solar penetration in the winter, and are available as fuel for heating if necessary. Lastly, being located on high ground near the ocean, there is: the availability of wind energy; greater sun availability due to a less obstructed horizon; the promise of milder winters; and the availability of seafood, salt and solar desalinized water provide possibilities for future use.

The search covered both the Massachusetts and Rhode Island coasts. Various realtors were engaged, although a private sale was also sought. The realtors and many of the associated professionals continuously advised the spending of more money for lawyers, engineers, and surveyors, and discouraged the individual from doing the work of such professionals. A private sale was found at a savings of more than 10%, avoiding, at least, the realtor's fees.

Another step in the process, clarified for the seminar participants, was the title search. It was undertaken and a deed drawn up by the writer, using past deeds as guides, rather than using a lawyer. Providing money from another source is used to finance the land, rather than a bank mortgage on the land, a lawyer is not required to search the title, to draw up the deed, or to be involved in the closing (a savings of over five hundred dollars). If the title search is questionable, for a small fee, title insurance could be purchased. Additionally, owning the land mortgage free will allow it to be used as collateral for the construction of the house.

Further, it was shown that the buyer can change the names on the various permits gained by the previous owner, and complete them, rather than pay a professional twenty-five to fifty dollars per permit. Simply, the original permit is just copied, changing the names and the dates. Forms needed for this construction included some from the Department of Environmental Management (D.E.M.) Septic Division, D.E.M. Wetlands Division, for the County Conservation Commission, and the Building Inspector.

The next phase included surveying for bench-marks and boundary lines, and the designing of a septic system--to be approved by the Department of Environmental Management. All of this work had to be completed by a certified engineer with copies accompanying the various forms to the Department of Environmental Management. Because of the community ties of the building inspector, electrical inspector, plumbing inspector, water department officials, fire chief, civil engineers, septic system installers, general contractors, etc., one is coerced, and in some cases, forced to use their services. The PERC test, a test to determine whether the land will drain well enough for the installation of a septic system, must be done by an engineer. The engineer has to design and evaluate not only the proper system for specific use but also determine whether wetland or other environmental balances will be affected. The Department of Environmental Management, the building inspector, and the health inspectors insist on the above and require that the septic system be installed by a certified, septic installer in order to be passed by them.

The next step delineated was the designing of the house and the drawing of blueprints. If there are problems with the design, the building inspector will not hesitate to point them out. Also, if you or the building inspector feel there is a need for an engineer to check and certify the building plans, then it can be done for a nominal fee. In reviewing different house-design books and alternative energy books, many energy conservation ideas can be found and incorporated into the design plans. The result can be a more structurally sound and energy efficient home. In addition to the above materials necessary to obtain the building permit, other applications for the plumbing and electric work were required, as well as a schematic of each system, and the approximate cost for materials and installation of each. All permit fees are calculated on what it would cost to have the system professionally installed.

Taking all the preceeding into account, one may still experience unforeseen problems. For example: because of the water on the property, a variance for the septic system was required from the state. After all of the state requirments had been fulfilled and the system had been installed, it was revealed--by the new town building inspector--that the town regulations differed from the state regulations. The State of Rhode Island requires that a septic system be a minimum of one-hundred feet from a body of water. The town requires that a septic system be a minimum of one-hundred and fifty feet from a designated wetland area. However, the building site had not been designated as part of a wetland area! Nevertheless, if the building inspector feels that it might be a wetland, then it is the responsibility of the owner to prove that it is not. One would think that it is up to the state or town to prove that it is. Unfortunately, more forms had to be completed by the writer for the Department of Environmental Management - Wetlands Division, requesting that they determine whether or not the area in question was a wetland area. This should have been the responsibility of the engineer who designed the original septic system for the previous owner (at a cost of $525.00). When a site is determined to be part of a wetland area--even though the state requirement of a minimum distance of one-hundred feet had been satisfied--the town's requirement of one hundred and fifty feet takes precedance. A variance must then be sought from the town's Zoning Board of Appeals, and notification of the meetings sent to all of the property owners within two- hundred feet of the property in question.

The pond on the construction site was evaluated and declared a wetland area. A variance was requested and the writer researched all of the land ownership within two-hundred feet of the prospective building lot. The writer then sent registered letters, with return receipt requested, to announce the meetings with the Board of Appeals and the Town Environmental Management Committee. A presentation and explanation of the rationale for what would be done, and how it would be done was then made at a series of six meetings. The meetings included two meetings with each of the following groups: the Environmental Management Committee, the Rhode Island Department of Environmental Management and the local Board of Appeals. These obstacles took over a year's time to surmount, required numerous letters and meetings throughout the state of Rhode Island, before the variances were granted and the building permits were issued. The approximate cost for professional assistance in this process would have been more than two-thousand dollars.

The building permits were ultimately issued, subject to restrictions of water consumption, the use of various wetlands contamination precautions, and a relocation of the septic system. Unfortunately, the spetic system had to be moved twenty feet, at an addditional cost of $1,200--even though the previous installation had been approved by the State Department of Environmental Management.

With the necessary permits in hand, a little more than an acre of land on a dead-end road, encompassed by a pond with an island, the writer cleared the land and finalized the designs for an energy efficient house. An energy efficient house must incorporate positive energy conservation design ideas and renewable alternative energy usage in its design, construction and subsequent use.

The location, configuration, orientation to the sun and wind, building layout, method of construction and specific design details need to be carefully considered in both new and renovated homes. After choosing an appropriate site that afforded the opportunity to conserve energy by capturing and converting the sun's energy, the foundation had to be located accordingly. The siting (or orientation) of the foundation should have the main living area facing true south. The south wall must then provide sufficient glass area to allow an ample amount of solar radiation to enter the structure.

A guide to the minimum amount of glass needed is: one-quarter to one-fifth of the floor area in a temperate climate and one-third to one-fourth of the floor area in colder climates (J. W. Morrison, 1979).

The heat energy must then be captured and stored. A rule of thumb for storage mass is a one-to-one ratio of floor area to storage area. Insulated curtains and thermal shutters are also of great value in helping to retain the heat as long as possible. By using these guidelines as much as fifty percent of the building's heating requirements can be provided (J.W. Morrison, 1979). Heat can be stored in the floors, walls, masonary slabs, fireplaces, chimneys, rock/sand/water containers, waterbeds and other furnishings. Once the means to capture the heat in the home is established, one has to be able to let it in when needed, keep it in as long as necessary, and keep it out or vent it as desired.

If a home is not to be hot during the summer, methods for shading and cooling need to be incorporated into the design. Cooling may be accomplished by the use of window shades, blinds, awnings and overhangs of at least two feet on the southern wall. Both the overhang and awnings will keep out the high summer sun, and will also allow the windows to be kept open during rain showers, thereby providing additional cooling during these periods. For additional shading, the planting of deciduous trees on the southern side of the house will help block out the summer sun, while allowing the lower winter sun's rays to penetrate the structure.

Well planned ventilation is also important. This can be accomplished by the arrangement of windows and doors so as to capture the prevailing summer breezes (this information can be obtained from the local weather bureau). For additional natural ventilation, when near a body of water, it should be noted that the breezes will usually move from the water to the land during the day and flow in the reverse at night. When on a south facing hillside, the breezes tend to move uphill during the day and downhill at night. In addition to the above suggestions, one should also attempt to draw the cooler cellar air up through the structure while venting the hot air out through the roof.

When the purchasing of building materials became imminent, and the quantity appeared to be substantial, a construction business was created. The writer set up a business checking account with a local bank. This was done by adding two initials to the word enterprises--W.J. Enterprises. For all intended purposes a business had begun and the writer was the president. As a result of researching the jargon of the contruction field, the writer was able to speak knowledgeably with representatives of the cement companies, the lumber companies, sub-contractors, and other professionals for supplies and services, at a savings of up to 25%. As the president of a company, one need not know everything there is to know about building, and the business can employ help and sub-contract as needed at a substantial savings. The role of the building entrepreneur and executive was not that difficult to play and well worth the effort.

With the final plans approved by a civil engineer and the building inspector, the cellar hole was excavated. The writer then formed the footings and poured them along with the cellar walls. This was followed by the constructing of the first floor, outside walls, and temporary roof. A few windows were then installed and the entire structure covered with tar paper for the first winter. Simultaneously, the septic system and water service were installed. To save additional money, a temporary electric service was installed and the electric company brought their electric service to the temporary arrangement at no cost.

Additional research was then conducted to assist in the final design and installation of the electric and plumbing systems. Upon completion of this research, the writer installed the complete plumbing and electric services throughout the structure during the winter months. With Spring approaching, six truck-loads of loam were delivered, spread, raked and seeded. Following this, sixty trees and fifteen shrubs were planted for protection against erosion and wind infiltration. The construction continued and six experiential curriculum intervention seminars were then completed during the following summer.

Although the dissertation has been finished, the constructions and experiential curriculum intervention seminars will continue. The experience has opened up new horizons for the writer and may become the foundation of a new career. To date, the educational process has included four years of research and experiential learning for the writer, the development and instruction of six experiential currciculum intervention seminars, and numerous individualized instruction of scores of people that have been exposed to the project at various times.

The writer, seminar participants, neighbors, environmental management comittee members, board of appeals members, various town and state inspectors, building supply company employees, friends and acquaintances continually drop by to check on the progress, ask questions and experience the building process. Consequently, their experiential learning intervention continues.

As a result of their exposure to alternative energy building techniques, various alternative energy practices, and a sharing of knowledge, these people became aware of the many options available to them that could be of significant value in their present and future living situations. Through the use of this knowledge, skill development and exposure, they can save both money and energy--ultimately, becoming a little less dependent on foreign and domestic energy sources.

It is this writer's hope that the alternative energy house, the educational seminars, and these writings will be food for thought and a guide to begin to convert these thoughts into action by all who are exposed to them.

CHAPTER VI

A Pilot Study: Description of Results

All of the participants in the experimental group received and completed the following consent form and pre/post questionnaire one week prior to their seminar attendance. At the completion of the seminar, the pre/post questionnaire was filled out a second time. The control group also completed the same questionnaire on two separate occasions.

Consent Form--Program Abstract

For Seminar Participants

I am a doctoral student at the University of Massachusetts in the School of Education. I am conducting an alternative energy program and research of current knowledge and attitudes about energy. My proposed research will involve two groups of about thirty human subjects. One group, the control group, will have the project explained to them and they will complete a twenty-four item questionnaire. This questionnaire will be filled out on two separate occasions (total time commitment about two hours). The questionnaire is designed to measure attitudes and knowledge of energy.

The second group, the experimental group, will complete the same questionnaire, participate in a two day seminar, and a follow-up telephone interview. The seminar, an experiential curriculum intervention strategy, will include discussion sessions, demonstrations, hands-on activities, and a review of the enclosed energy packet. Each participant will be given the energy education packet, lodging, free instruction, and a free home energy audit consultation upon request.

My research will involve the above described program, and requires the following responsibilities (with approximate time commitments) of the participants:

1. Questionnaire completions (1 hour each)
2. Attendance at a 2 day seminar (in Rhode Island)
3. Telephone interview (45 minutes)
4. Provision of own transportation to and from the seminar site
5. Home energy audit consultation (2 hours) (If requested by the participant)

Additional energy related information will be available through:

W.J. Landry, Jr.
University of Massachusetts
School of Education
Future Studies Program
Instructional Leadership Division
Amherst, MA 01003

The participants' anonymity will be assured by the assignment of a letter code to each participant upon the completion of the initial questionnaire. Subsequent questionnaires, interviews, data recording and reporting will use the participants' codes rather than names. The results of my research will be used in my dissertation, shared with colleagues and published. However, the names of the participants will not be used.

It is my intent that through involvement with the program you will:

1. Gain a better understanding of the energy options and conservation practices available to you today;
2. Develop and/or reinforce a positive attitude toward the use of alternative energy devices and conservation practices;
3. Experience various hands-on construction techniques;

4. Not only use the knowledge within your living situation, but share it with friends and neighbors so that many people can benefit from your experiences in the program.

If at any time, there are questions or concerns about the program, my research or any other requests, please feel free to ask. In addition, if you wish to discontinue participation in the program at any time, you are free to do so without prejudice toward you.

In the unlikely event of injury occurring to and from the seminar site, or during participation in the program, the U.S. Department of Health and Welfare requires that I inform you that the University of Massachusetts will not be held responsible for any medical treatment and/or compensation in any form should injury occur.

Thank you for your assistance in this program.

Program Director________________________
W. J. Landry, Jr.

I/we agree to participation as stated in the above program:

Date________________ Participant______________

Date________________ Guardian_________________

NOTE: Things to bring along; Money for food, sleeping bag, pillow, pencils, two towels, bathing suit, tooth brush, and other personal items as needed.

QUESTIONNAIRE

Target Population

Overall Group	Sub Group
I. Teenagers - 75%	People who have had the project explained to them
II. Adults over age 20 - 25%	People who have participated in the experiential education intervention sessions

A computer analysis will be made of the energy inventory questions to conclude the mean differences in attitudes and knowledge between the control and experimental groups. The analysis will compare the pre-intervention questionnaire answers of the two groups, and the post-intervention questionnaire answers of the two groups. In addition, there will be a demographic breakdown of the groups according to age, sex and education. The telephone interview of the program participants will be used as additional data for my qualitative conclusions.

The questions and above analysis method have been reviewed and approved by Jane Rogers of the Research Consulting Services (Room 149A, Hills South).

DEMOGRAPHIC DATA

NAME:
AGE:
SEX:
OCCUPATION:
EDUCATION (years completed):
ADDRESS:
TELEPHONE:

ENERGY INVENTORY QUESTIONNAIRE

The following questions are designed to inventory your attitudes and knowledge of energy.

For the attitude questions, circle A if you agree or D if you disagree. For the knowledge questions, circle Y if you agree and N if you disagree.

A D 1. People need to become more aware of available alternative energy devices/practices in order to conserve energy and save money.

Y N 2. Do you know how a solar collector works?

Y N 3. There are few, if any, alternative energy devices that I could construct and/or install.

Y N 4. There are many inexpensive alternative energy conservation practices that I could adopt which would save money as well as energy.

Y N 5. There are some inexpensive alternative energy devices that I could construct and use to save money.

Y N 6. Alternative energy installations would not be cost effective for me.

A D 7. Solar, wind and water power are viable alternatives for the production of energy in today's world.

A D 8. The world's present nuclear fission programs should be expanded.

A D 9. The use of alternative energy devices and practices could be financially beneficial to me.

A D 10. It is everyone's responsibility to conserve energy.

Y N 11. Without oil we could not produce any plastics or synthetic fibers.

A D 12. Science will find an answer before the energy problem gets too bad.

A D 13. We should relax our environmental standards in order to increase our energy production.

A D 14. People who can afford it should buy and use as much energy as they want.

Y N 15. It is worth the extra expense to me to keep the thermostat above sixty-five degrees in cold weather.

Y N 16. Have you read anything about alternative energy in the last six months?

Y N 17. Have you ever done an energy audit where you live?

Y N 18. Have you ever monitored your utility usage?

Y N 19. Have you been exposed to any alternative energy programs?

PLEASE CIRCLE ALL CHOICES THAT YOU AGREE WITH IN EACH QUESTION:

20. Alternative energy is:
a. Nuclear b. Solar c. Coal d. Renewable e. Oil
f. Wind

21. Renewable energy is power from:
a. Nuclear fission b. Solar c. Nuclear fusion
d. Fossil fuels e. Hydroelectric facilities f. Wind

22. Fossil fuels are:
a. Gas b. Oil c. Coal d. Wood e. Geothermal
f. Nuclear

23. The country that produces the most oil annually is:
a. U.S.A. b. Saudi Arabia c. Mexico d. U.S.S.R.
e. Iran f. Libya

Would you be interested in receiving any additional energy information?

Research Group Composition

Experimental Group	- 16 males	- 16 females	= 32
Control group	- 16 males	- 16 females	= 32
		Total:	N = 64

Ages of Participants

Age	Absolute Frequency	Relative Percent
14	2	3.1
15	3	4.7
16	14	21.9
17	15	23.4
18	14	21.9
22	2	3.1
24	2	3.1
26	2	3.1
29	1	1.6
32	1	1.6
34	2	3.1
38	1	1.6
39	1	1.6
51	1	1.6
54	1	1.6
58	1	1.6
59	1	1.6
TOTAL	64	100.0

Participants' Years of Education

Years of Education	Absolute Frequency	Relative Percent
8	2	3.1
9	3	4.7
10	4	6.3
11	22	34.4
12	22	34.4
13	1	1.6
14	2	3.1
15	1	1.6
16	3	4.7
18	4	6.3
TOTAL:	64	100.0

A computer analysis was made of both groups' responses. The results of the CYBER ANALYSIS are found on the following pages for the reader's review.

The charts that follow show the results of a three-way interaction of the groups, their sexes, and their ages. The results tend to indicate that the seminar experiences caused the change in answers and neither sex nor age were significant factors.

*These results tend to show that the seminar participants' experience resulted in a significant change in their pre/post questionnaire answers--significance levels of .018 and .017 are noted (a signiificance of .050 or lower is significant, and a significance of .010 or lower is highly significant).

**These results show that the sex of the participants was not a determining factor--.272/.290 (both are greater than .050).

***These results show that the age of the participants was not a determining factor--.513 is not significant.

AN ANALYSIS OF VARIANCES (ANOVA)

ANOVA TABLE BY GROUP (EXPERIENTIAL AND CONTROL) AND SEX

SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	SIGNIFICANCE OF F
Group	7.563	1	7.563	5.951	.018*
Sex	1.563	1	1.563	1.230	.272**
2-way interactions					
Group	.063	1	.063	.049	.825
Sex	.063	1	.063	.049	.825

ANOVA TABLE BY GROUPS (CONTROL AND EXPERIMENTAL)

SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	SIGNIFICANCE OF F
Group	7.563	1	7.563	6.021	.017*

ANOVA TABLE BY AGE, GROUP AND SEX

SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	SIGNIFICANCE OF F
Age	.556	1	.556	.433	.513***
Group	7.551	1	7.551	.877	.018*
Sex	1.464	1	1.464	1.139	.290**

CHI Square Analysis of Pre/Post Questionnaire Responses

N=64 total (32 experimental group-32 control group)
*Denotes items with a significance level of .05 or lower
**Denotes items with a significance level of .01 or lower

Q-1. People need to become more aware of available energy devices/practices in order to conserve energy and save money.

	Experimental Group			Control Group		
	Pre Test	Post Test	Change	Pre Test	Post Test	Change
Agree	32	32	0	32	32	0
Group %	100.0	100.0		100.0	100.0	
Total %	50.0	50.0		50.0	50.0	
Disagree	0	0	0	0	0	0
Group %	0	0		0	0	
Total %	0	0		0	0	

All participants agreed with this statement on both tests. No change was anticipated or recorded.

**Q-2. Do you know how a solar collector works?

	Experimental Group			Control Group		
	Pre Test	Post Test	Change	Pre Test	Post Test	Change
Agree	14	31	+17	12	13	+1
Group %	43.8	96.9		37.5	40.6	
Total %	21.9	48.4		18.8	20.3	
Disagree	18	1	-17	20	19	-1
Group %	56.3	3.1		62.5	59.4	
Total %	28.1	1.6		31.3	29.7	

Corrected CHI square with 1 degree of freedom=21.01818
**Significance=.0000

+17 (+53.1%) of the experimental group changed. This indicates that the seminar participants developed a greater understanding of how solar collectors operate. The control group had a change of only +1 (+3.1%).

**Q-3. There are few, if any, alternative energy devices that I could construct and/or install.

	Experimental Group Pre Test	Post Test	Change	Control Group Pre Test	Post Test	Change
Agree	21	4	-17	19	18	-1
Group %	65.6	12.5		59.4	56.3	
Total %	32.8	6.3		29.7	28.1	
Disagree	11	28	+17	13	14	+1
Group %	34.4	87.5		40.6	43.8	
Total %	17.2	43.8		20.3	21.9	

Corrected CHI square with 1 degree of freedom=11.70563
**Significance=.0006

+17 (+53.1%) of the experimental group changed. This indicates that the post/seminar participants felt more competent in the construction and/or installation of alternative energy devices. (87.5% felt they now had this ability.) The control group had a change of only +1 (+3.1%).

Q-4. There are many inexpensive alternative energy conservation practices that I could adopt which would save money as well as energy.

	Experimental Group Pre Test	Post Test	Change	Control Group Pre Test	Post Test	Change
Agree	31	32	+1	27	27	0
Group %	96.9	100.0		84.4	84.4	
Total %	48.4	50.0		42.2	42.2	
Disagree	1	0	-1	5	5	0
Group %	3.1	0		15.6	15.6	
Total %	1.6	0		7.8	7.8	

Corrected CHI square with 1 degree of freedom=3.47119
Significance=.0624

Most of the sample were aware, in the pre-test, that there are many conservation practices that could be used to save money and energy. Specific practices were reinforced during the seminar.

**Q-5. There are some inexpensive alternative energy devices that I could construct and use to save money.

	Experimental Group			Control Group		
	Pre Test	Post Test	Change	Pre Test	Post Test	Change
Agree	13	30	+17	15	13	-2
Group %	40.6	93.8		46.9	40.6	
Total %	20.3	46.9		27.4	20.3	
Disagree	19	2	-17	17	19	+2
Group %	59.4	6.3		53.1	59.4	
Total %	29.7	3.1		26.6	29.7	

Corrected CHI square with 1 degree of freedom=18.14396
**Significance=.0000

This question further substantiates the results of question 3. An increase of +17 (+53.1%) of the experimental group participants felt they had the ability to construct some alternative energy devices.

**Q-6. Alternative energy installations would not be cost effective for me.

	Experimental Group			Control Group		
	Pre Test	Post Test	Change	Pre Test	Post Test	Change
Agree	12	1	-11	13	14	+1
Group %	37.5	3.1		40.6	43.8	
Total %	18.8	1.6		20.3	21.9	
Disagree	20	31	+11	19	18	-1
Group %	62.5	96.9		59.4	56.3	
Total %	31.3	48.4		29.7	28.1	

Corrected CHI square with 1 degree of freedom=12.53878
**Significance=.0004

+11 (+34.4%) of the experimental group changed to total 96.9% of the experimental group feeling that they could save money by installing alternative energy devices. The control group was negatively affected by -1 (-3.2%).

Q-7. Solar, wind and water power are viable alternatives for the production of energy in today's world.

	Experimental Group			Control Group		
	Pre Test	Post Test	Change	Pre Test	Post Test	Change
Agree	32	32	0	32	32	0
Group %	100.0	100.0		100.0	100.0	
Total %	50.0	50.0		50.0	50.0	
Disagree	0	0	0	0	0	0
Group %	0	0		0	0	
Total %	0	0		0	0	

No change was observed. Both groups continued to agree that solar, wind and water power are viable alternatives for the production of energy. This attitude was further reinforced throughout the seminar.

Q-8. The world's present nuclear fission program should be expanded.

	Experimental Group			Control Group		
	Pre Test	Post Test	Change	Pre Test	Post Test	Change
Agree	16	15	-1	14	15	+1
Group %	50.0	46.9		43.8	46.9	
Total %	25.0	23.4		21.9	23.4	
Disagree	16	17	+1	18	17	-1
Group %	50.0	53.1		56.3	53.1	
Total %	25.0	26.6		28.1	26.6	

Corrected CHI square with 1 degree of freedom=0
Significance=1.0000

The sample was unchanged in their attitude toward nuclear energy. The seminar did not address the nuclear issue in depth, but rather concentrated on the positive usage of renewable energy.

Q-9. The use of alternative energy devices and practices could be financially beneficial to me.

	Experimental Group			Control Group		
	Pre Test	Post Test	Change	Pre Test	Post Test	Change
Agree	27	29	+2	27	25	-2
Group %	84.4	90.6		84.4	78.1	
Total %	42.2	45.3		42.2	39.1	
Disagree	5	3	-2	5	7	+2
Group %	15.6	9.4		15.6	21.9	
Total %	7.8	4.7		7.8	10.9	

Corrected CHI square with 1 degree of freedom=1.06667
Significance=.3017

+2 (+6.2%) of the experimental group changed to total 90.6% of the experimental group feeling that the use of alternative energy practices and devices could save them money. The control group had a reverse effect of -2 (-6.2%).

Q-10. It is everyone's responsibility to save energy.

	Experimental Group			Control Group		
	Pre Test	Post Test	Change	Pre Test	Post Test	Change
Agree	32	32	0	31	30	-1
Group %	100.0	100.0		96.9	96.8	
Total %	50.0	50.0		48.4	47.6	
Disagree	0	0	0	1	2	+1
Group %	0	0		3.1	6.2	
Total %	0	0		1.6	3.2	

Corrected CHI square with 1 degree of freedom=.00026
Significance=.9872

Almost everyone involved in the research agreed with this statement before and after their involvement.

**Q-11. Without oil we could not produce any plastics or synthetic fibers.

	Experimental Group			Control Group		
	Pre Test	Post Test	Change	Pre Test	Post Test	Change
Agree	16	6	-10	15	15	0
Group %	50.0	18.8		46.9	46.9	
Total %	25.0	9.4		23.4	23.4	
Disagree	16	26	+10	17	17	0
Group %	50.0	81.3		53.1	53.1	
Total %	25.0	40.6		26.6	26.6	

Corrected CHI square with 1 degree of freedom=4.53599
**Significance=.0332

+10 (+31.3%) of the experimental group changed to show a total of 81.3% of the experimental group were aware that oil was not necessary for the production of plastic or synthetic fibers. The control group was unchanged.

Q-12. Science will find an answer before the energy problem gets too bad.

	Experimental Group			Control Group		
	Pre Test	Post Test	Change	Pre Test	Post Test	Change
Agree	19	16	-3	18	21	+3
Group %	59.4	50.0		56.3	65.6	
Total %	29.7	25.0		28.1	52.8	
Disagree	13	16	+3	14	11	-3
Group %	40.6	50.0		43.8	34.4	
Total %	20.3	25.0		21.9	17.2	

Corrected CHI square with 1 degree of freedom=1.02503
Significance=.3113

In this question there is an inverse relationship between the change in answers of the control group and experimental group. The experimental group became less optimistic, -3 (-9.4%), in their belief that science would find the answers to our energy problems. The control group became more optimistic, +3 (+9.4%).

Q-13. We should relax our environmental standards in order to increase our energy production.

	Experimental Group			Control Group		
	Pre Test	Post Test	Change	Pre Test	Post Test	Change
Agree	11	6	-5	10	9	-1
Group %	34.4	18.8		31.3	28.1	
Total %	17.2	9.4		15.6	14.1	
Disagree	21	26	+5	22	23	+1
Group %	65.6	81.3		68.8	71.9	
Total %	32.8	40.6		34.4	35.9	

Corrected CHI square with 1 degree of freedom=.34830
Significance=.5551

+5 (+15.7%) of the experimental group felt that environmental standards should not be relaxed in order to provide more energy. The control group had a change of +1 (+3.1%) totaling 71.9% who felt the standards should not be relaxed.

Q-14. People who can afford it should buy and use as much energy as they want.

	Experimental Group			Control Group		
	Pre Test	Post Test	Change	Pre Test	Post Test	Change
Agree	1	1	0	1	0	-1
Group %	3.1	3.1		3.1	0	
Total %	1.6	1.6		1.6	0	
Disagree	31	31	0	31	32	+1
Group %	96.9	96.9		96.9	100.0	
Total %	48.4	48.4		48.4	50.0	

Corrected CHI square with 1 degree of freedom=1.000
Significance=.3135

No significant change. Almost all of the research participants agreed that conservation of energy, and not money availability, was most important.

Q-15. It is worth the extra expense to me to keep the thermostat above sixty-five degrees in cold weather.

	Experimental Group			Control Group		
	Pre Test	Post Test	Change	Pre Test	Post Test	Change
Agree	11	10	-1	12	12	0
Group %	34.4	31.3		37.5	37.5	
Total %	17.2	15.6		18.8	18.8	
Disagree	21	22	+1	20	20	0
Group %	65.6	68.8		62.5	62.5	
Total %	32.8	34.4		31.5	31.3	

Corrected CHI square with 1 degree of freedom=.06926
Significance=.7924

No significant change. The majority of the sample felt that the thermostat should not be kept above 65 degrees.

**Q-16. Have you read anything about alternative energy in the last six months?

	Experimental Group			Control Group		
	Pre Test	Post Test	Change	Pre Test	Post Test	Change
Agree	7	27	+20	8	11	+3
Group %	21.9	84.4		25.0	34.4	
Total %	10.9	42.2		12.5	17.2	
Disagree	25	5	-20	24	21	-3
Group %	78.1	15.6		75.0	65.6	
Total %	39.1	17.8		37.5	32.8	

Corrected CHI square with 1 degree of freedom=14.57490
**Significance=.0001

A change of +20 (+62.5%) of the post/seminar experimental group were motivated to engage in additional alternative energy reading. The control group change was only +3 (+4.8%).

Q-17. Have you ever done an energy audit where you live?

	Experimental Group Pre Test	Post Test	Change	Control Group Pre Test	Post Test	Change
Agree	5	5	0	1	2	+1
Group %	15.6	15.6		3.1	6.3	
Total %	7.8	7.8		1.6	3.1	
Disagree	27	27	0	31	30	-1
Group %	84.4	84.4		96.9	93.8	
Total %	42.2	42.2		48.4	46.9	

Corrected CHI square with 1 degree of freedom=.64160
Significance=.4231

No significant change upon seminar completion. However, the telephone follow-up showed that 18 out of the 32 experimental group participants had done some type of energy audit where they lived.

Q-18. Have you ever monitored your utility usage?

	Experimental Group Pre Test	Post Test	Change	Control Group Pre Test	Post Test	Change
Agree	11	11	0	8	8	0
Group %	34.4	34.4		25.0	25.0	
Total %	17.2	17.2		12.5	12.5	
Disagree	21	21	0	24	24	0
Group %	65.6	65.6		75.0	75.0	
Total %	32.8	32.8		37.5	37.5	

Corrected CHI square with 1 degree of freedom=.29942
Significance=.5843

No change upon seminar completion. However, the telephone follow-up showed that 20 out of 32 of the experimental group had done some utility monitoring where they lived.

**Q-19. Have you been exposed to any alternative energy programs?

	Experimental Group			Control Group		
	Pre Test	Post Test	Change	Pre Test	Post Test	Change
Agree	11	26	+15	9	9	0
Group %	34.4	81.3		28.1	28.1	
Total %	17.2	40.6		14.1	14.1	
Disagree	21	6	-15	23	23	0
Group %	65.6	18.8		71.9	71.9	
Total %	32.8	9.4		35.9	35.9	

Corrected CHI square with 1 degree of freedom=16.14187
**Significance=.0001

The control group was unchanged. However, the experimental groups' agreement with this statement was increased by +15 participants, a change of +46.9%. The interest level of the participants was raised, and resulted in their participation in other energy related programs.

Q-20A. Alternative energy is - Nuclear.

	Experimental Group			Control Group		
	Pre Test	Post Test	Change	Pre Test	Post Test	Change
Agree	13	9	-4	13	14	+1
Group %	40.6	28.1		40.6	43.8	
Total %	20.3	14.1		20.3	21.9	
Disagree	19	23	+4	19	18	-1
Group %	59.4	71.9		59.4	56.3	
Total %	29.7	35.9		29.7	28.1	

Corrected CHI square with 1 degree of freedom=1.08590
Significance=.2974

+4 (+12.5%) of the experimental group changed, to total 71.9% of this group that felt nuclear energy was not a good alternative energy source.

Q-20B. Alternative energy is - Solar.

	Experimental Group			Control Group		
	Pre Test	Post Test	Change	Pre Test	Post Test	Change
Agree	30	32	+2	26	28	+2
Group %	93.8	100.0		81.3	87.5	
Total %	46.9	50.0		40.6	43.8	
Disagree	2	0	-2	6	4	-2
Group %	6.3	0		18.8	12.5	
Total %	3.1	0		9.4	6.3	

Corrected CHI square with 1 degree of freedom=2.40000
Significance=.1213

+2 (+6.2%) of the experimental group changed, to total 100% of the experimental group feeling that solar energy was a good alternative energy source. The control group was also a +2 (+6.2%) to a total of 87.5% in agreement.

Q-20C. Alternative energy is - Coal.

	Experimental Group			Control Group		
	Pre Test	Post Test	Change	Pre Test	Post Test	Change
Agree	11	11	0	7	9	+2
Group %	34.4	34.4		21.9	28.1	
Total %	17.2	17.2		10.9	14.1	
Disagree	21	21	0	25	23	-2
Group %	65.6	65.6		78.1	71.9	
Total %	32.8	32.8		39.1	35.9	

Corrected CHI square with 1 degree of freedom=.07273
Significance=.7874

No significant change. The majority of the sample felt that coal was a good alternative energy source.

**Q-20D Alternative energy is - renewable.

	Experimental Group			Control Group		
	Pre Test	Post Test	Change	Pre Test	Post Test	Change
Agree	17	24	+7	11	12	+1
Group %	53.1	75.0		34.4	37.5	
Total %	26.6	37.5		17.2	18.8	
Disagree	15	8	-7	21	20	-1
Group %	46.9	25.0		65.6	62.5	
Total %	23.4	12.0		32.8	31.3	

Corrected CHI square with 1 degree of freedom=7.68254
**Significance=.0056

+7 (+21.9%) of the experimental group changed, with a total of 75% of this group feeling that alternative energy is renewable. The control group change was +1 (+3.1%).

Q-20E. Alternative energy is - oil.

	Experimental Group			Control Group		
	Pre Test	Post Test	Change	Pre Test	Post Test	Change
Agree	2	1	-1	8	4	-4
Group %	6.3	3.1		25.0	12.5	
Total %	3.1	1.6		12.5	6.3	
Disagree	30	31	+1	24	28	+4
Group %	93.8	96.9		75.0	87.5	
Total %	46.9	48.4		37.5	43.8	

Corrected CHI square with 1 degree of freedom=.86780
Significance=.3516

96.9% of the post/seminar experimental group and 87.5% of the control group did not consider oil to be an alternative energy source.

Q-20F. Alternative energy is - wind.

	Experimental Group			Control Group		
	Pre Test	Post Test	Change	Pre Test	Post Test	Change
Agree	25	29	+4	24	25	+1
Group %	78.1	90.6		75.0	78.1	
Total %	39.1	45.3		37.5	39.1	
Disagree	7	3	-4	8	7	-1
Group %	21.9	9.4		25.0	21.9	
Total %	10.9	4.7		12.5	10.9	

Corrected CHI square with 1 degree of freedom=1.06667
Significance=.3017

+4 (+12.5%) of the experimental group changed, to total 90.6% that realized wind was among the renewable energy sources. The control group change was +1 (+3.1%).

**Q-21A. Renewable energy is power from - Nuclear Fission.

	Experimental Group			Control Group		
	Pre Test	Post Test	Change	Pre Test	Post Test	Change
Agree	4	0	-4	8	7	-1
Group %	12.5	0		25.0	21.9	
Total %	6.3	0		12.5	10.9	
Disagree	28	32	+4	24	25	+1
Group %	87.5	100.0		75.0	78.1	
Total %	43.8	50.0		37.5	39.1	

Corrected CHI square with 1 degree of freedom=5.77444
**Significance=.0163

+4 (+12.5%) of the experimental group changed, to total 100% that realized that nuclear fission was not a renewable energy source. The control group change was +1 (+3.1%).

**Q-21B. Renewable energy is power from - Solar.

	Experimental Group			Control Group		
	Pre Test	Post Test	Change	Pre Test	Post Test	Change
Agree	20	32	+12	23	24	+1
Group %	62.5	100.0		71.9	75.0	
Total %	31.3	50.0		35.9	37.5	
Disagree	12	0	-12	9	8	-1
Group %	37.5	0		28.1	25.0	
Total %	18.8	0		14.1	12.5	

Corrected CHI square with 1 degree of freedom=7.0000
**Significance=.0082

+12 (+37.5%) of the experimental group changed, to total 100% that recognized solar as a renewable energy source. The control group change was +1 (+3.1%).

Q-21C. Renewable energy is power from - Nuclear Fusion.

	Experimental Group			Control Group		
	Pre Test	Post Test	Change	Pre Test	Post Test	Change
Agree	5	9	+4	5	7	+3
Group %	15.6	28.1		15.6	21.9	
Total %	7.8	14.1		7.8	10.9	
Disagree	27	23	-4	27	25	-3
Group %	84.4	71.9		84.4	78.1	
Total %	42.2	35.9		42.2	39.1	

Corrected CHI square with 1 degree of freedom=.08333
Significance=.7728

+4 (+12.5%) of the experimental group changed and +3 (+6.3%) of the control group changed. Each group seems to see fusion as a renewable energy source of the future--71.9% and 78.1% respectively.

**Q-21D. Renewable energy is power from - Fossil Fuels.

	Experimental Group			Control Group		
	Pre Test	Post Test	Change	Pre Test	Post Test	Change
Agree	10	0	-10	11	12	+1
Group %	31.3	0		34.4	37.5	
Total %	15.6	0		17.2	18.8	
Disagree	22	32	+10	21	20	-1
Group %	68.8	100.0		65.6	62.5	
Total %	34.4	50.0		32.8	31.3	

Corrected CHI square with 1 degree of freedom=12.41026
**Significance=.0004

+10 (+30.2%) of the experimental group changed, to total 100% that realized fossil fuels are not renewable. The control group change was +1 (+3.1%).

**Q-21E. Renewable energy is power from - Hydroelectric Facilities.

	Experimental Group			Control Group		
	Pre Test	Post Test	Change	Pre Test	Post Test	Change
Agree	16	30	+14	12	12	0
Group %	50.0	93.8		37.5	37.5	
Total %	25.0	46.9		18.8	18.8	
Disagree	16	2	-14	20	20	0
Group %	50.0	6.2		62.5	62.5	
Total %	25.0	3.1		31.3	31.3	

Corrected CHI square with 1 degree of freedom=20.01732
**Significance=.0000

+14 (+43.8%) of the experimental group changed, to total 93.8% that recognized the renewable energy potential from hydroelectric facilities. The control group was unchanged.

**Q-21F. Renewable energy is power from - Wind.

	Experimental Group			Control Group		
	Pre Test	Post Test	Change	Pre Test	Post Test	Change
Agree	17	32	+15	17	19	+2
Group %	53.1	100.0		53.1	59.4	
Total %	26.6	50.0		26.6	29.7	
Disagree	15	0	-15	15	13	-2
Group %	46.9	0		46.9	40.6	
Total %	23.4	0		23.4	20.3	

Corrected CHI square with 1 degree of freedom=13.90045
**Significance=.0002

+15 (46.9%) of the experimental group changed, to total 100% that recognized wind as a renewable energy source. The control group change was +2 (+6.3%).

**Q-22A. Fossil fuels are - Gas.

	Experimental Group			Control Group		
	Pre Test	Post Test	Change	Pre Test	Post Test	Change
Agree	20	30	+10	11	11	0
Group %	62.5	93.8		34.4	34.4	
Total %	31.3	46.9		17.2	17.2	
Disagree	12	2	-10	21	21	0
Group %	37.5	6.3		65.6	65.6	
Total %	18.8	3.1		32.8	32.8	

Corrected CHI square with 1 degree of freedom=21.98940
**Significance=.0000

+10 (+31.3%) of the experimental group changed; to total 93.8% that recognized gas was a fossil fuel. The control group was unchanged.

**Q-22B. Fossil fuels are - Oil.

	Experimental Group			Control Group		
	Pre Test	Post Test	Change	Pre Test	Post Test	Change
Agree	25	32	+7	25	26	+1
Group %	78.1	100.0		78.1	81.2	
Total %	39.1	50.0		39.1	40.6	
Disagree	7	0	-7	7	6	-1
Group %	21.9	0		21.9	18.8	
Total %	10.9	0		10.9	9.4	

Corrected CHI square with 1 degree of freedom=4.59770
**Significance=.0320

+7 (+21.9%) of the experimental group changed, to total 100% that recognized oil as a fossil fuel. The control group change was +1 (+3.1%).

Q-22C. Fossil fuels are - Coal.

	Experimental Group			Control Group		
	Pre Test	Post Test	Change	Pre Test	Post Test	Change
Agree	29	32	+3	30	30	0
Group %	90.6	100.0		93.8	93.8	
Total %	45.3	50.0		46.9	46.9	
Disagree	3	0	-3	2	2	0
Group %	9.4	0		6.3	6.3	
Total %	4.7	0		3.1	3.1	

Corrected CHI square with 1 degree of freedom=.51613
Significance=.4725

+3 (+9.4%) of the experimental group changed, to total 100% that recognized coal as a fossil fuel. The control group was unchanged.

**Q-22D. Fossil fuels are - Wood.

	Experimental Group			Control Group		
	Pre Test	Post Test	Change	Pre Test	Post Test	Change
Agree	11	2	-9	15	12	-3
Group %	34.4	6.3		46.9	37.5	
Total %	17.2	3.1		23.4	18.8	
Disagree	21	30	+9	17	20	+3
Group %	65.6	93.8		53.1	62.5	
Total %	32.8	46.9		26.6	31.3	

Corrected CHI square with 1 degree of freedom=7.40571
**Significance=.0065

+9 (+28.2%) of the experimental group changed, to total 93.8% that recognized wood was not a fossil fuel. The control group change was +3 (+9.4%).

Q-22E. Fossil fuels are - Geothermal.

	Experimental Group			Control Group		
	Pre Test	Post Test	Change	Pre Test	Post Test	Change
Agree	2	0	-2	4	4	0
Group %	6.3	0		12.5	12.5	
Total %	3.1	0		6.3	6.3	
Disagree	30	32	+2	28	28	0
Group %	93.8	100.0		87.5	87.5	
Total %	46.9	50.0		43.8	43.8	

Corrected CHI square with 1 degree of freedom=2.40000
Significance=.1213

+2 (+6.4%) of the experimental group changed, to total 100% that recognized geothermal was not a fossil fuel. The control group was unchanged.

Q-22F. Fossil fuels are - Nuclear.

	Experimental Group			Control Group		
	Pre Test	Post Test	Change	Pre Test	Post Test	Change
Agree	0	0	0	2	3	+3
Group %	0	0		6.3	9.4	
Total %	0	0		3.1	4.7	
Disagree	32	32	0	30	29	-3
Group %	100.0	100.0		93.8	90.6	
Total %	50.0	50.0		46.9	45.3	

Corrected CHI square with 1 degree of freedom=1.39891
Significance=.2369

100% of the experimental group and 90.6% of the control group recognized that nuclear energy was not a fossil fuel.

**Q-23. The country that produces the most oil annually is:

	Experimental Group			Control Group		
	Pre Test	Post Test	Change	Pre Test	Post Test	Change
(A) U.S.A.						
Agree	8	0	-8	8	5	-3
Group %	25.0	0		25.0	15.6	
Total %	12.5	0		12.5	7.8	
(B) Saudi Arabia						
Agree	17	6	-11	19	22	+3
Group %	53.1	18.8		59.4	68.8	
Total %	56.6	9.4		29.7	34.4	
(C) Mexico						
Agree	1	0	-1	1	0	-1
Group %	3.1	0		3.1	0	
Total %	1.6	0		1.6	0	
(D) U.S.S.R.						
Agree %	5	26	+21	3	4	+1
Group %	15.6	81.3		9.4	12.5	
Total %	7.8	40.6		4.7	6.3	
(E) Iran						
Agree	1	0	-1	1	1	0
Group %	3.1	0		3.1	3.1	
Total %	1.6	0		1.6	1.6	
(F) Libya						
Agree	0	0	0	0	0	0
Group %	0	0		0	0	
Total %	0	0		0	0	

Corrected CHI square with 1 degree of freedom=31.27619
**Significance=.0000

21 Experimental group changes, from 15.6% to 81.3% recognition that the U.S.S.R. produces more oil annually than any other country--the control group had 1 change from 9.4% to 12.5% recognition.

The following telephone interviews were conducted with the thirty-two post/seminar participants approximately one month after their experiential intervention.

EXPERIMENTAL GROUP

TELEPHONE INTERVIEW QUESTIONS

AND RESPONSES

1. What are some renewable energy sources that you can think of?

-Thirty two out of thirty two were able to speak of four or more renewable sources.

2. Have you noticed any alternative energy devices/installations in your area? If so, how many different ones?

-Twenty out of thirty-two noticed flat plate collectors;

-Eight out of thirty-two noticed wind generators;

-Five out of thirty-two noticed greenhouses and/or solariums;

-Three out of thirty-two noticed reflector-type collectors.

3. Do you feel that you have a better understanding of how to use alternative energy devices and practices after having been exposed to the project?

-Thirty-two out of thirty-two felt that they do have a better understanding.

4. In what ways have your thoughts changed in regard to the use of alternative energy devices and practices?

-Thirty-two out of thirty-two felt that energy conservation practices should be used;

-Twenty out of thirty-two believed that they could build, renovate, or maintain their homes;

-Eighteen out of thirty-two felt that

cost was not a prohibitive factor
for constructions.

5. What alternative energy devices could you use in your living situation?

-Thirty out of thirty-two believed
flat plate water heating units
could be used;
-Fifteen out of thirty-two believed
a greenhouse/sunroom could help
heat their homes;
-Eight out of thirty-two showed
interest in wind generators;
Five out of thirty-two showed
interest in photovoltaics, but
felt they were still too expensive.

6. What are some of the alternative energy practices that you could use in your living situation?
-Thirty-two out of thirty-two were
able to speak on six or more practices.

7. At what temperature do you usually keep your thermostat in the winter?

Day when away: Average of all - 65

Evening at home: Average of all - 70

Night (asleep): Average of all - 65

8. What, if anything, have you done to conserve energy and save money?

-Thirty-two out of thirty-two had begun observing various energy conservation practices;

-Twenty out of thirty-two had monitored their utility usage, in an effort to reduce their overall usage;

-Eighteen out of thirty-two had done an energy audit and performed some type of "buttoning-up" of their homes.

9. Do you know how a solar collector works?

-Thirty-two out of thirty-two responded positively.

10. Have you read anything about alternative energy since the program?

-Twenty-nine out of thirty-two had recently read energy related material;

-Two out of thirty-two had attended another energy related program.

11. Have you done an energy audit of your home since the program?

-Eighteen out of thirty-two did some type of energy audit where they live.

12. Have you monitored your utility usage since the program?

-Twenty out of thirty-two had monitored their energy usage.

13. How has the program been helpful to you?

-Thirty-two out of thirty-two felt that their knowledge, attitude and skill awareness/development had been positively effected.

14. Would you be interested in any additional alternative energy information? If so, what kinds of information would you be most interested in?

-Thirty-two out of thirty-two requested additional information;
-Twenty out of thirty-two were interested in space and water heating information;
-Twelve out of thirty-two were interested in wind generation;
-Nine out of thirty-two were interested in photovoltaics.

Summary

As indicated by the analysis of the pre/post questionnaire responses from the previous charts and the telephone interview responses--the seminar participants tended to show a greater understanding of alternative energy devices, construction practices, and the economics involved in constructing and retrofitting alternative energy structures.

Self assurance, with regard to individual construction skills, increased with the seminar participants, and an energy awareness of the need for greater use of conservation practices and/or alternative energy devices seems to have been reinforced.

The majority of the sample (both experimental and control) were not in favor of expanding the present nuclear fission program but believed that science would find the answers to our energy problems. However, they were not in favor of relaxing our environmental standards to produce more energy.

The experimental group indicated a greater understanding of energy in general, various alternative energy sources and their applications.

CHAPTER VII

Summary and Conclusions

The Problem

Our world's energy needs are continuously escalating. Energy availability, energy costs, and environmental pollutants have become a major concern of the day. As a result of the world opting to use oil and nuclear fission as primary sources of energy, the present energy problems have developed.

Oil, which was easy to transport and relatively inexpensive in the past, has become exhorbitant, in both financial output and personal compromise. In spite of our past oil conservation efforts and recesssion reductions, America continues to consume more than two-hundred and fifty million dollars worth of oil each day. Fossil fuels like oil, gas and coal are finite. Once these limited hydrocarbon fuels are used, they are gone forever. Will the legacy today's societies leave their descendents be a planet stripped of the majority of its resources by a few major powers, or will it be a world with a myriad of highly efficient renewable energy systems that its inhabitants could reuse indefinitely?

There are numerous viable, inexpensive alternative energy devices and practices available for use today. Through greater use of these renewable energy sources and energy conservation practices, the world's dependency on, and depletion of, fossil fuels could be significantly reduced. The major powers of the world, having already used much of the world's energy resources, have an obligation to develop and perpetuate the use of renewable energy sources and energy conservation practices. Therefore, the people of these countries need to assume a greater responsibility for providing and conserving energy for their own individual needs. Individuals can convert solar, wind and water energy sources into electricity and heat for use in their homes and places of work. Individuals can use less energy by using more efficient building designs, insulation techniques and other such energy conservation practices. The collective results of millions of individuals modifying their energy practices to conserve energy could have a profound effect on energy availability for the future.

To begin this transition, people need to be exposed to various energy education programs. The writer proposes that this energy education must be developed today, and should be focused on the individuals' energy requirements in their homes and work places. Consequently, the information learned will be more meaningful, immediately useful, more likely to be put into practice, and, through that practice retained longer.

The Purpose of this Study

The purpose of this study was to develop and support an experiential curriculum intervention strategy that would:

1. Develop a better understanding of the energy options and conservation practices available today;
2. Develop and/or reinforce a positive attitude toward the use of alternative energy devices and practices;
3. Teach various hands-on construction

techniques;

4. Foster a sharing of knowledge between the writer, seminar participants, neighbors and friends of everyone involved.

Methodology

The study was based on the use of an experiential approach to learning. The experiential education mode of instruction is, in this writer's opinion, one of the most effective approaches for the education of people. This planned learning, which usually occurs outside the traditional classroom, combines the perceptive impressions of the learner with the written and verbal curriculum traditionally presented. The results of these experiential impressions may be: unexpected wonderment or astonishment; a sensory intensity which leads to new perspectives; a reinforcing of concepts and knowledge.

The experiential approach is currently being used in vocational education, physical education, outdoor education programs, Outward Bound, Project Adventure, various science programs, and is even seen as the foundation of some higher education degree programs.

Armed with the belief that an experiential curriculum would be a most effective mode of instruction, the writer embarked on the construction of an alternative energy model home and the development of an experiential curriculum intervention program. (see appendix D.) The program was then presented to twelve groups. The participants were evaluated by a pre/post test questionnaire (see Appendix F) and a follow-up telephone inteview (see Appendix G)--the results are presented in chapter six and Appendix I.

Results and Conclusions

The results of the testing showed that the control group had little or no change in knowledge or attitude about alternative energy. The experimental group, as a result of their exposure to the experiential curriculum intervention program, did increase their knowledge and awareness of various alternative energy practices and devices available to them today; did reinforce a positive attitude toward the use of alternative energy practices and devices; did tend to show that the participants' knowledge about energy in general was increased.

It is the writer's belief that a solid attitudinal foundation is necessary for learning to be complete. One's attitude toward the information learned will determine whether the learning will be used and the degree of permanance of any behavioral changes. The program participants learned, retained and used the information gained from the seminars. This is substantiated by the pre- to post- questionnaire responses and the follow-up telephone interview responses reported in chapter six.

Attitudes toward the use of nuclear energy were unchanged, and the majority of the sample felt that science would find the answers to the world's energy problems. However, the majority was not in favor of relaxing the environmental standards in order to produce more energy (see Appendix I).

The realization of skills and abilities posessed by the seminar participants became particularly evident to them as they completed the hands-on activities during the course of the seminars. Through the use of various hands-on learning experiences, the participants left the seminars with a clearer understanding of--"how to", and a recognition that they "can do"--much of the construction necessary to effect changes in their home and work environments.

In conclusion, through this curriculum's multi-sensory stimulation in a non-traditional learning environment, the students appeared to learn more quickly, retain their learning, and use their acquired knowledge in their day-to-day lives.

Recommendations

Realizing that this is only a pilot study, there is a need for additional research. As a foundation for future studies, this pilot study is encouraging. Through the use of an experiential curriculum intervention program, the enthusiasm and exchange of knowledge of teacher and student can be increased. As a teacher/student one should experiment with the experiential approach for both the teaching and reinforcement of learning. Educators must search out the appropriate experiential programs available that could augment and reinforce the subject matter they are imparting. The practicing of the specific learning should be done in such a way that it appeals to and affects multi-sensory stimulation. In short, by implementing a multi-sensory stimulation of the student, education will be more effective; every sensory input possible should be used to increase the educational transfer. Through the development and use of experiential curriculum programs, educators can promote increased learning, longer retention, and greater usage. Through the use of this approach in education one can begin to recognize the values of both knowledge and experience, individually and together, as each will continuously complement the other.

Future

As one relects upon the accomplishments of humankind from the beginning of time, one begins to comprehend the magnitudinous growth, development and knowldege acquisition that has come forth in such a short time. The future, then, holds boundless opportunities for additional growth and understanding. We, the pioneers of today, are the architects of our future. How will we choose to construct that future? Where will we choose to put our emphasis? Where will the world's research and development be concentrated? Will war or peace prevail? Will we use or abuse our space exploration? The effectiveness of the education of our people and the areas of education that are emphasized will contribute to the answering of these questions and ultimately to the development of future civilizations.

The writer holds an optimistic vision for the earth's future. Foreseen are numerous space stations throughout the galaxies; artificial and satellite reflecting suns orbiting various planets; mineral exploration and extraction from the lunar surface to planets in galaxies yet unknown; solar, fusion and other forms of thermal-nuclear conversion--in and outside of our atmosphere--will provide more energy than can be used; crystal technology for healing and energy conversion will open up new dimemsions for health care, travel, and future engineering design and construction.

The key to this and similar scenarios is education. To facilitate student learning and self-actualization, the educational processes need to foster a learning environment that produces an exciting, stimulating educational experience for both the teacher and the student. With this focus, educators can plant and nurture the seeds necessary to produce a positive future designed and constructed by the educators/students of today and tomorrow.

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Appendix A

Glossary of Terms

<u>Barrel</u> - A liquid measure of oil, usually crude oil, equal to 42 gallons or about 306 pounds.

<u>Barrel of oil equivalent</u> - Energy equal to a barrel of crude oil - 5.8 million Btu's.

<u>Biomass</u> - Living matter, plant and animal, in any form.

<u>Btu</u> - British thermal unit, the amount of heat necessary to raise the temperature of one pound of water one degree fahrenheit or about a quarter of a calorie.

<u>Carcenogen</u> - A substance or agent producing or inciting cancerous growth.

<u>Cogeneration</u> - The production of two useful forms of energy from the same process. In a factory, for instance, steam needed for industrial processes.

<u>EER</u> - Energy efficiency ratio, A common measurement of the energy efficiency of home appliances.

<u>Efficiency</u> - The ratio of useful work or energy output to the total work or energy input.

<u>Fossil Fuels</u> - Fuels such as coal, crude oil or natural gas formed from remains of animals.

<u>Gasahol</u> - In the U.S., this is a mixture of ninety percent unleaded gasoline and ten percent ethyl alcohol.

<u>Geopressured Gas</u> - Natural gas that is dissolved in hot brine and trapped under great pressure deep within the earth.

<u>Glazed Windows</u> - Windows which have more than one pane of glass between inside and outside. A double-glazed window has two panes, a triple glazed window has three panes. The dead air spaces between the panes act as insulation.

Greenhouse Effect - The warming effect of carbon dioxide and water vapor in the atmosphere. These molecules are transparent to incoming sunlight (long waves) but hold in infared (short waves - heat) radiation escaping from the earth.

Megawatt - A unit of power equal to 1000 kilowatts, or one million watts. A gigawatt is a billion watts.

OPEC - The Organization of Petroleum Exporting Countries, thirteen nations that aim at developing common oil-marketing policies.

Operable Sash - The moveable part of a window in which the panes of glass are set.

Photovaltaics - The process by which radiant (solar) energy is converted directly into electrical energy through the use of a solar cell.

Quad - A quadrillion Btu's. The energy contained in eight billion gallons of gasoline, a year's supply ten million automobiles.

Renewable Energy Source - One that is constantly or cyclically replenished, including direct solar energy and indriect sources such as biomass and wind power.

Reserve - That portion of a resource that has been discovered but not yet exploited and which at present is technically and economically extractable.

R-Value - The measurement of an insulation material's ability to resist heat loss. The higher the R-value, the more heat you save. R-Values are usually printed on the insulation covering.

Seasonal Performance Factor - This is a measurement of a heat pump's efficiency over a heating season compared to electric heat.

Shower Head Flow - This is measured by Gallons Per Minute (GPM). Collect water for 15 seconds, measure the amount and multiply by 4 to get the GPM.

Synfuels - Fuels synthesized from sources other than crude oil or natural gas and used in place of them or their derivations, primarily for transportation and the heating of boilers.

Slab Insulation - This should be found on homes built on concrete slabs. It prevents heat from leaking through the slab.

Vapor Barriers - These are thin coverings of paper foil or plastic film that protect insulation and wood from moisture damage. They face the area to be heated.

Appendix B

Addresses for Energy

Information and Materials

American Petroleum Institute
2101 L Street, N.W.
Washington, D.C. 20037

Center for Renewable Resources
1001 Connecticut Ave. N.W.
Washington, D.C. 20036

Channing L. Bete, Co., Inc.
Federal Street
Greenfield, MA 01301

Christina Peterson, Coordinator
Food Energy & You
c/o Shoreline School Distruct
158th St. & 20th Ave. N.E.
Seattle, WA 98155

DOE
Technical Information Ctr.
P.O. Box 62
Oak Ridge, TN 37830

EARS-Environmental Action
Reprint Service
2239 East Colfax
Denver, CO 80206

Energy Challenge
P.O. Box 14306
Dayton, Ohio 45414

ERDA Film Library
P.O. Box 62
Oak Ridge, TN 37830

ERIC Center for
Mathematics &
Environmental
Education (ERIC/SMEAC)
Ohio State University
1200 Chambers Rd.
Columbus, Ohio 43212

Federal Energy 45
Off. of Communication &
Public Affairs
Washington, D.C. 20461

Field Enterprises Educ.
Corporation
Merchandise Mart Plaza
Chicago, IL 60654

Florida State Univ.
David E. LaHart
Environ. Educ. Project
Tallahassee, FL 32304

Friends of the Earth
124 Spear Street
San Francisco, CA 94105

Global Develop. Studies
Inst.
Millbrook School
Millbrook, NY 12545

Energy Management Center
P.O. Box 190
Port Richey, FL 33568

Environ. Action Coalition
156 Third Ave.
New York, NY 10010

Hubbard
P.O. Box 104
Northbrook, IL 60062

Library of Congress
Reference Section
Science & Technology Div.
10 First St., S.E.
Washington, D.C. 20540

Maine Audubon Society
118 Route 1
Falmouth, ME 04105

Marine Studies Center
1800 University Ave.
Madison, Wl 53706

Mass. Audubon Society
H.E.E.I.
Lincoln, MA 01773

Minnesota Environmental
Sciences Foundation
5400 Glenwood Ave.
Minneapolis, MN 55422

Natnl. Recreation & Park Assn.
Park Project on Energy Interp.
1601 North Kent Street
Arlington, VA 22209

Harcourt Brace
Jovanovich, Inc.
757 Third Avenue
New York, NY 10017

Houghton Mifflin Co.
Educational Division
1 Beacon St.
Boston, MA 02108

Project Quesst
Educ. Resources Center
855 Broadway
Boulder, CO 80302

Rodale Books
33 E. Minor St.
Emmaus, PA 18049

Scholastic
904 Sylvan Avenue
Englewood Cliffs, NJ
07632

Scribner's, Charles
Sons
597 Fifth Avenue
New York, NY 10017

Solar Action Office
Rm. 1414-1 Ashburton
Boston, MA 02108

Solar Services Corp.
Cherry Hill, NJ 08003

South Carolina Dept.
of Education
Environ. Education
803 Rutledge Bldg.
Columbia, SC 29201

Natnl. Solar Heating &
Cooling Information Ctr.
P.O. Box 1607
Rockville, MD 20850
(Toll free: 800-523-2929)

National Wildlife Federation
1412 16th. Street, NW
Washington, D.C. 20036

Project Ecology
Highline Public Schools
Dept. of Instruction
P.O. Box 66100
Seattle, WA 98166

State of Indiana Dept.
of Public Instruction
Rm. 229 State House
Indianapolis, ID 46204

Thomas Alva Edison
Foundation
Cambridge Office Plaza
Suite 143
18280 W. Ten Mile Rd.
Southfield, MI 48075

Washinton State:
see Christina Peterson

World Book:
see Field Enterprises

Appendix C

Energy Materials

Materials available at the Hitchcock Center's Environmental Education Resource Library.

Award Winning Energy Education Activities, DOE, 1977, Free. Ten winning activities covering elementary and secondary levels. Likely starting points. K-12.

The Best Present of All, Ranger Rick reprint, National Wildlife Federation. Free. A story, touching on all the sources of energy that can be readily dramatized. It would make a great assembly program to touch off a school-wide energy project. Elementary.

Catch a Sunbeam: A Book of Solar Experiments, Florence Adams, Harcourt, 1978. Thoughtful, clearly stated information and experiments. Grades 4-7.

Energy Environment Booklets, Channing Bete, 1974. 21 scriptographic booklets provide a fresh approach to presenting factual background. Jr. high to adult.

Consuming Energy: The U.S. vs. The World, Project QUESST, Boulder, CO. One unit module for teaching high school students about energy consumption patterns with the aid of quantitative concepts. High School.

Curious Naturalist Vol. XIV, 1974-75. Mass. Audubon Society Each issue in this volume on energy contains background information and several projects based on the particular theme of the issue. Teachers' guides are also available. Available as an "Energy Packet" which includes background readings. Grades 3 and up.

Energy Access: A Guide to Activities & Resources for Educators, Maine Audubon, 1979. Developed largely by Maine teachers This booklet serves as a guide to developing interdisciplinary energy curriculum. Excellent K-12.

Energy Activities for the Classroom, Herbert L. Coon, ERIC/ SMEAC, 1976. Graded, multidisciplinary investigation, K-12.

Energy Activities with Energy Ant, DOE, 1975. Coloring book and activities such as scrambled words, dot-to-dot pictures, riddles and matching words to pictures. Elementary.

Energy Activity Guide, National Recreation & Park Association, Newspaper format, many lively ideas. Might spark a class journalism project.

Energy & Order: A High School Teaching Sequence, Mark Terry and Paul Witt, Firends of the Earth, 1976. Highly recommended. High school.

Energy & Society--Investigations in Decision Making, Biological Sciences Curriculum Study, Hubbard, 1977. May be used as a discrete 9 week course or as part of a semester in environmental studies. High school.

Energy & the Environment Vols. I & II, Florida State University, 1976-77. These energy units were developed by classroom teachers in social studies, science, and home economics. The lengthy list of energy education concepts is very useful. Grades K-12.

The Energy Book, South Carolina Department of Education. This document lists interdisciplinary ideas grouped by grade levels. There are suggestions for individual, small group, and entire class activities.

The Energy Challenge, FEA, 1977, Free. 24 spirit duplicating activity masters developed for grades 5-8 with a teacher's guide. Multidisciplinary emphasis. Grades 5-8.

Energy Conservation Experiments You Can Do. Nuclear Experiments You Can Do, Thomas Alva Edison Foundation. Simple epxeriemnts. Middle school.

Energy Conservation in the Home, University of Tennessee, 1977. This is directed to secondary Home Economics teachers, but it can be valuable in all curriculum areas and at the elementary level as well as the secondary.

Energy Education Curriculum Project, State of Indiana, 1979. Three volumes, one each for Gr. K-1, 2-3, & 4-6, of energy activities and assessment instruments. Thoughtfully planned well organized, multidisciplinary. Each volume suggests ways of adapting the activities to the other grade levels. Gr. K-6.

Energy Education for the Fourth Grade, Energy Management Center, 1977. Activity-centered, hands-on. Three modules: Let's Learn About Energy; Nature's Energy; Man and Energy, for students' use, and a lengthy teacher's guide. Adaptable to other grade levels.

The Energy Environment Game, Mass. Electric. An educational simulation that deals with society's demand for increasing amounts of energy and the problems that result. Biased but useful. Junior & Senior high.

Energy-Environment Mini-unit Guide, National Science Teachers, 1975. This guide is a collection of detailed interdisciplinary mini-units. They are grouped by grade levels: K-3, 3-6, 5-8, 6-9, 9-12.

Energy, Food & You - Elementary, Washington State, 1978. An interdisciplinary curriculum guide for elementary school which includes ideas and activities on: the sources and uses of energy; global food and energy problems; energy resources and U.S. food system; energy efficiency and good nutrition; gardens and other ways to use energy efficiently. Excellent.

Energy for Today and Tomorrow, San Diego City/County Schools, 1976. Each activity is designed for student action in the classroom, at home or in the community. The November 1976 issue of Science and Children contains a brief article on this guide and a copy of the "Energy Land" game. K-6.

Energy Futures, Project Ecology, Highline Public Schools, Seattle, Washington. Eleven lessons that could provide a framework for a four or five week unit in Junior high.

Energy History of the United States 1776-1976 (Chart). So What's New, "User's Manual" to accompany the Energy History chart, ERDA, 1976. Likely source for research projects.

Energy in an Interdependent World, Global Development Studies Institute, 1979. A case study of the global energy issue that can be incorporated in science or social studies as well as a global studies course. Includes selected short readings from energy experts and different countries amd a lengthy annotated bibliography. Gr. 11-14.

Energy: Knowledge and Attitudes, National Assessment of Educational Progress, 1978. The results of a poll on energy-related knowledge of adults 26-35 which uncovered a lack of public knowledge on the energy issue. Use it to convince parents and administrators of the need for energy education.

The Energy Problem: A Learning Guide, World Book, Field Enterprises. Many suggestions for independent study topics that will lead students to a variety of resources, not just the World Book. Gr. 4-8.

Energy--Who's Doing What? National Recreation & Park Association. Descriptions of approximately 200 citizens' groups, companies, and non-profit agencies involved in some type of energy project which has educational value.

The Household Energy Game, Marine Studies Center, University of Wisconsin-Madison, 1974. The game is divided into two parts. In the first part you can put together your own energy budget. The second part is devoted to ways in which you can modify your budget to conserve energy--and save money. Secondary.

Human Issues in Science--Energy, Scholastic Magazine. The four filmstrips, with cassettes, are designed to show how science and society interact. The titles are Energy & the Land; Energy & the Sea; Using Energy; The Future of Energy. Jr. high and up.

The Hydrocarbon Civilization--Energy Materials, Minnesota Environmental Sciences Foundation. A series of eight lessons containing short, flexible activities requiring 1 - 3 class periods to complete. Multidisciplinary. High school level.

Industrial Arts Manual to the Construction of Miniaturized Alternative Energy Source Equipment, Energy Management Center, 1979. Industrial arts students or vocational students will learn to read blueprints, follow simple building instructions, and interpret photos. Guides are provided for teachers of 4th and 9th grades to use these models.

It's Your Environment: Things to Think About, Things to Do, Scribner's, 1976. Written for children, but teachers will find many possibilites for classroom activities. Elementary.

Less Power to the People, Environmental Action Coalition, 1976. A compilation of energy activities with teachers' guides drawn from past issues of "Eco News", a young people's newsletter. Elementary.

Living With Our Means: Energy and Society, State University of New York, 1974. Provides environmental activities which are keyed both to broad environmental understandings and to most disciplines at all grade levels. Well-developed procedures for environmentalizing the curriculum. Gr. K-6, & 7-12.

Massachusetts Solar Energy Education Directory, Solar Energy Research Institute, 1977, free. This directory lists solar-related courses, programs and curricula offered at post-secondary educational institutions. Order from National Solar Heating Information Center.

Professional Energy Careers, D.O.E., 1979, free. This booklet gives a brief outline of professional energy careers, including high school emphasis, college training, adult education and sources of information. Grades 6 and up.

Project for an Energy-Enriched Curriculum (PEEC), N.S.T.A., 1974-1979. Teams of teachers have written the units for this K-12 energy curriculum. All are available free from D.O.E. K-12.

Recycle Used Motor Oil: A Model Program, American Petroleum Institute, 1979, free. This manual outlines a detailed program for the collection and recycling of used motor oil generated by the motorist who drains his or her own engine oil. Could be basis for high school/community project.

Science Activities in Energy, D.O.E. Each unit in the series forms a coherent program of instruction on single topic: solar energy; electricity; conservation, chemical energy; wind energy. (Well organized, hands-on activities.) K-6. Solar Energy II was developed for secondary classes.

Solar Energy Education Packet for Elementary & Secondary Students, Center for Renewable Resources, third ed., 1979. A compilation of "Sun Facts" and activities drawn from many sources, plus a lengthy annotated bibliography. Gr. K-12.

Solar Energy Experiements, Thomas Norton, Rodale, 1977. Presents 18 self-explanatory solar energy experiments and classroom activities suitable for individual student analysis. High school level.

Tilly's Catch a Sunbeam Coloring Book: The Story of Solar Heat Even Grown-ups Can Understand, Service Corp., 1975. Humorous, appealing and educational. K-8 and up.

Was There an Energy Crisis in 1980? Old Sturbridge Village. This thematic guide to the village is the basis for an unusual field trip. It could also be applied to your own town--a great research project. Use in conjunction with ERDA chart "Energy History of the U.S." Grades 3 and up.

You and the Environment: An Investigative Approach, Education Reearch Council of America, Houghton-Mifflin,

1976. The section on energy in this junior high text contains a simulation on a nuclear power plant controversy that could easily be adapted to a local issue. Junior High.

Your Energy World, D.O.E., 1978. Your Energy World, a multi-disciplinary program for intermediate grades, consists of four units: Energy Overview; Transportation, the Energy Eater; Energy Use in Homes and Stores; Schools Can Conserve Too. The 18 activity masters can be adapted to on-going curricula. Intermediate level.

Appendix D

Introduction

You may or may not feel that you have the talent to work on your home or apartment. Hopefully, as a result of the following information, you will feel more comfortable in attempting some of the suggestions. Some of the things covered will be: an energy-efficient home checklist, some general maintenance procedures, construction of some simple solar collectors.

Do-It-Yourself

The first step is to assess the present level of energy efficiency of your home. Through this awareness you can then begin to develop the simple skills necessary to button-up your home and augment your present heating systems.

The following charts have been compiled and adapted from NU brochures. They are available by writing: NU 80s/90s Northeast Utilities, P.O. Box 270, Hartford, Connecticut 06101.

Let us begin with the following "100+" checklist. This do-it-yourself audit is easy to do. Upon completion, if you feel a more professional audit is needed, there are several groups that will conduct an audit at minimal cost. For further information on these groups, contact your local electric, gas or oil companies.

You may be asking yourself, how do I know what the R-value is for various types of insulation? What types of insulation are available and what are the advantages or disadvantages of each? In the chart that follows, several types of insulation, pros and cons of its usage, and the R-value (per inch) is shown. To find the R-value of your specific type of insulation, measure the thickness and multiply it times the appropriate one inch factor.

MATERIAL	R-VALUE/INCH	BENEFITS	DRAWBACKS
Batts/ Blankets Fiberglass Rock Wool	 3.2 3.4	They are easy to install, widely available fire & moisture resistant. Least expensive	Fiberglass may cause skin and/ or lung irritation. (Full body clothing with gloves & mask should be worn during installation
Loose Fill* Fiberglass Rock Wool Cellulose Vermiculite	 4.7 3.7 3.7 3.0	These are easy to install & fill spaces thoroughly. Moderately priced.	The chemicals in cellulose may reduce the R-value or cause pipe corrosion
Rigid Board Rigid Plastic Foam Polystyrene Polyurthane Polyiso-cyanurate	 5.0 6.2 7.2	They are light-weight and have a higher R-value per/inch. Most expensive	Needs fireproofing because the vapors from burning may cause death.

*Depends on Density

NU 80s/90s "100 Plus"
Do-It-Yourself
Energy-efficient Home Checklist

Assigned Rating Points	Minimum R-Value Recommended for New Construction	Points Date	Points Date
Ceiling insulation			
R-57........40 points	R-38		
R-38........30 points			
R-30........26 points			
R-19........20 points			
Exterior wall insulation			
R-25........26 points	R-19		
R-18........22 points			
R-11........18 points			
Interior Walls			
Between separately heated units			
R-11.........5 points			
Floor insulation			
Over vented crawl spaces			
R-19.........6 points	R-19		
Over unheated basement			
R-19.........6 points	R-19*		
R-11.........4 points			
Between separately heated units			
R-11.........5 points	R-11		
Slab insulation			
R-8..........4 points			
R-6..........3 points	R-6		
R-4..........2 points			
Windows			
Triple glazed....24 points			
Double glazed....20 points	Double glazed**		
Exterior doors			
Standard door with weather stripped storm door OR Insulated doors R-3...4 points	Either method		

Assigned Rating Points	Minimum R-Value Recommended for New Construction	Points Date	Date
Weather stripping All weatherstripping and caulking....13 points OR, for new construction or window replacement: Windows with infiltration rate of less than .5 CFM/FT of operable sash (specified by the manufacturer...13 points	Either method		
*or R-4 basement wall insulation **Triple glazing required in over-7000 degree day areas for 24 points. Call your local weather bureau office for information on the degree day rating for your area.			
Attic ventilation Gable vents with insulation vapor barrier, 1 sq. ft. inlet and 1 sq. ft. outlet for each 600 sq. ft. of ceiling area......4 points Gable vents without insulation vapor barrier, 1 sq. ft. outlet and 1 sq. ft. inlet for each 300 sq. ft. of ceiling area..........4 points Eave and gable vents, 1 sq. ft. inlet and 1 sq. ft. outlet for each 600 sq. ft. of ceiling area.........................4 points			
Exhaust fan (outside vented) Kitchen range.........................5 points Bathroom (all full baths).............5 points Dryer.................................5 points			
Air conditioning ducting/piping If not in conditioned space and not insulated to R-7.........................deduct 3 points			
Hot water piping If not in conditioned space and not insulated to R-7.........................deduct 3 points			

Assigned Rating Points	Minimum R-Value Recommended for New Construction	Points Date	Date
Controls and appliances			
If central air conditioner does not have EER of 7 or higher..................deduct 3 points			
Water heater			
-Insulated wrapper...................10 points			
-Thermostat setting 140 or lower......5 points			
Solar assist equipment (includes wind powered)............................15 points			
Automatic night setback for heating...5 points			
Fireplace if no positive damper or glass door on fireplace............deduct 10 points			
Showerhead flow control limit to 2-1/2 GPM....................5 points			
Outlets and switches in outside walls gasketed.............................5 points			
Heating equipment* **			
Oil burner with flame retention head burner or automatic vent damper or equivalent (ask your oil company representative).....10 points			
Natural gas fired with automatic vent damper or equivalent.......................10 points			
Heat pump with seasonal performance factor rating of 1.5 or greater at your location..............................10 points			
	TOTAL:		

***Specifications apply to the primary heating system only - maximum of 10 points per home. Equivalent listings are available from NU's Energy Management Services (EMS) Department.

Door and window insulation is concerned with the U-value, rather than the R-value, as just discussed. The U-value is the common measurement of a material's ability to conduct heat. Unlike the R-value, the lower the U-value, the better the insulation value. Rigid plastic, which may be chosen from several types of clear plastic material, has a good insulation value when properly installed. Plastic sheeting, which can be cut with scissors and installed easily, is very effective on a year-to-year basis. Insulated drapes, thermal shades and thermal shutters are also quite effective. Now that we know a little bit about insulation, we will discuss weather stripping and caulking and how to determine which to use. Windows and doors are where the most energy is lost. They lose more heat per square inch than any other part of the house. Loosely fitting windows and doors lose up to five times more heat than closely fitting ones. Weather stripping, caulking and use of plastic and thermal curtains are inexpensive and can give you payback within the first year.

How do you check for heat loss? On a windy day, feel the doors and outside walls and see how well they are insulated. Feeling for drafts by hand or, using a piece of cellophane taped to a pencil and moving it around the outside of a window or door opening, will give an indication of any draft. Another method for finding leaks at night is shining a flashlight around the edge of doors and windows while someone is on the other side marking wherever the light can be seen for caulking or covering the following day. Condensation build-up on the inside window indicates a leak from the outside window, condensation on the outside window is an indication of the inside window leaking. If doors do not shut with slight resistance, the hinges may need adjusting. If there are gaps, they can be sealed with various types of weather stripping or door sweeps. The caulking and weather stripping that has been previously installed may need adjustment or replacement. These should be checked annually. All doors, windows, basement and attic access openings that are between heated and unheated areas should be checked. Other places to check for caulking would be exterior joints where door and window frames meet the siding, where storm windows meet the window frames, any corners of the house, and window and foundation sills. You should also check where porches join the main part of the house, any exterior openings where pipes or electric wires enter the house, ceiling lights, electric outlets and wall switches mounted on outside walls. Your chimney is another area that needs to be checked. Check where the chimney meets the siding. Also check the damper and how well it seals. An inside covering for the fireplace opening, and kitchen or bathroom fan openings should be used when not in use.

Your choice of weather stripping and caulking should be most appropriate for your specific needs. Cost, durability, the period of time that you expect to be living in that space, ease of installation, whether it can be painted, expandability, and the best use for that specific type of weather stripping should all be carefully considered.

Common Types of Weather Stripping

TYPE	BENEFITS	DRAWBACKS	BEST USE	COST
Thin Spring Metal	Very durable & almost invisible when installed	Hard to install	In channel of window	Expensive
Rolled Vinyl	Durable & easy to install	Visible when in- installed & des- troyed by fire	In middle of double hung windows	Medium priced
Foam rubber with adhe- sive backing	Easy to install & invisible when installed	Breaks down quickly, can not be used where friction occurs; it is less effective than metal strips or rolled vinyl	Use on window tops and bottoms	Lowest
Rolled vinyl with aluminum channel backing	Durable & easy to install	Visible when installed	Sides & tops of doors	Expensive
Door shoes	Very durable	Difficult to install	On a wooden threshold that is not worn	Medium- priced
Door sweeps	Inexpensive	Not very durable & may drag on rug	On a flat threshold	Lowest- cost

TYPE	BENEFITS	DRAWBACKS	BEST USE	COST
Spring metal	Easy to install, invisible when installed & extremely durable	Door cannot bind at any point prior to installation	Sides & tops of doors	Expensive

Do-it-Yourself Guide To Caulking

TYPES OF CAULKING	BENEFITS	DRAWBACKS	COSTS
Oil or resin base	Can be painted	Least durable and needs replacement every two years	Lowest cost
Latex, Butyl & polyvinyl base	More durable	Limited ability to expand	Medium-priced
Silicones	Most durable	Cannot be painted	Most expensive

There are a number of ways to use alternate solar energy in the home today. Among them are parabolic reflectors, various types of flatplate collectors, flatplate collecting greenhouses and solariums. In addition to space heating and water heating, the greenhouses can produce food. Solar ovens, clothes dryers, food dryers, wood kilns and pottery kilns are all viable alternatives. In the following pages, some of these units will be diagrammed which could easily be constructed.

In the construction of these units there are several types of glazing that can be used. Glazing is the transparent covering that allows the sun's ultraviolet rays to enter the unit. Low lead glass is the most durable. Clear mylar, various transparent plastics and even clear polyethylene can be used to different degrees of efficiency. At a later time the less efficient lower cost glazing could be replaced.

The collective surface itself should be a thin aluminum sheet. Most newspaper and lithograph companies will have used or flawed sheets. These can be purchased for scrap aluminum prices and when cleaned are quite usable. Now, spray paint one side of the sheet with flat black paint. Next, with a compass orient it to within twelve degrees to either side of true south at an angle equal to the site's latitude plus or minus twenty degrees. (an inexpensive angle finder from Sears works nicely.) Through thermal convection and/or a small fan, you can now tap the sun's energy and distribute it inexpensively and efficiently.

The materials used in flat plat collector construction are listed on the following pages. There are many different types of flat plate solar collectors. Basically, the collector absorbs the energy that hits it and transfers it to a transport medium. Because there is no effort made to concentrate the sun's energy (like a parabolic does), the operating temperature is usually around one-hundred and fifty degrees fahrenheit (sixty-five degrees centigrade). A flat plate collector consists of a weather tight enclosure, insulation, glazing and a metal plate spray-painted flat black. A heat duct or tubing may be added to transport the heat transfer medium (air or liquid).

Materials used in Flat Plate Collector Construction

COMPONENT	MATERIALS USED	COMMENTS
CONTAINER:	Metal (aluminum or galvanized steel)	Lightweight, durable
	Fiberglass	
	Plastic	Many plastics deteriorate rapidly on exposure to ultraviolet radiation
	Wood	May deteriorate because of high stagnation temperature (350) and moisture condensation

(There is no standardized size for single units: a 4x8 ft. unit is difficult for two persons to handle: 4x4 ft. units are often used. 2x3 ft. units may be used to take advantage of local availability of this size sheet metal.)

COMPONENT	MATERIALS USED	COMMENTS
INSULATION:	Fiberglass (glass wool)	Has relatively high insulating value, stable.
	Polyurethane foam	Expensive, deforms over 160 F.
	Styrofoam	Flammable

(Two to four inches of fiberglass insulation should be used.)

COMPONENT	MATERIALS USED	COMMENTS
GLAZING:	Glass (Many types available)	Probably best, but costly and breakable.
	Low iron glass (looks blue on edge)	.88 transmittance, costly.
	Water white crystal (ASG)	.92 transmittance, costly.

(Glass thickness should be 1/8" or 3/16"; double glazing with one inch air space needed in colder regions or if temperature over 160 F. is desired.)

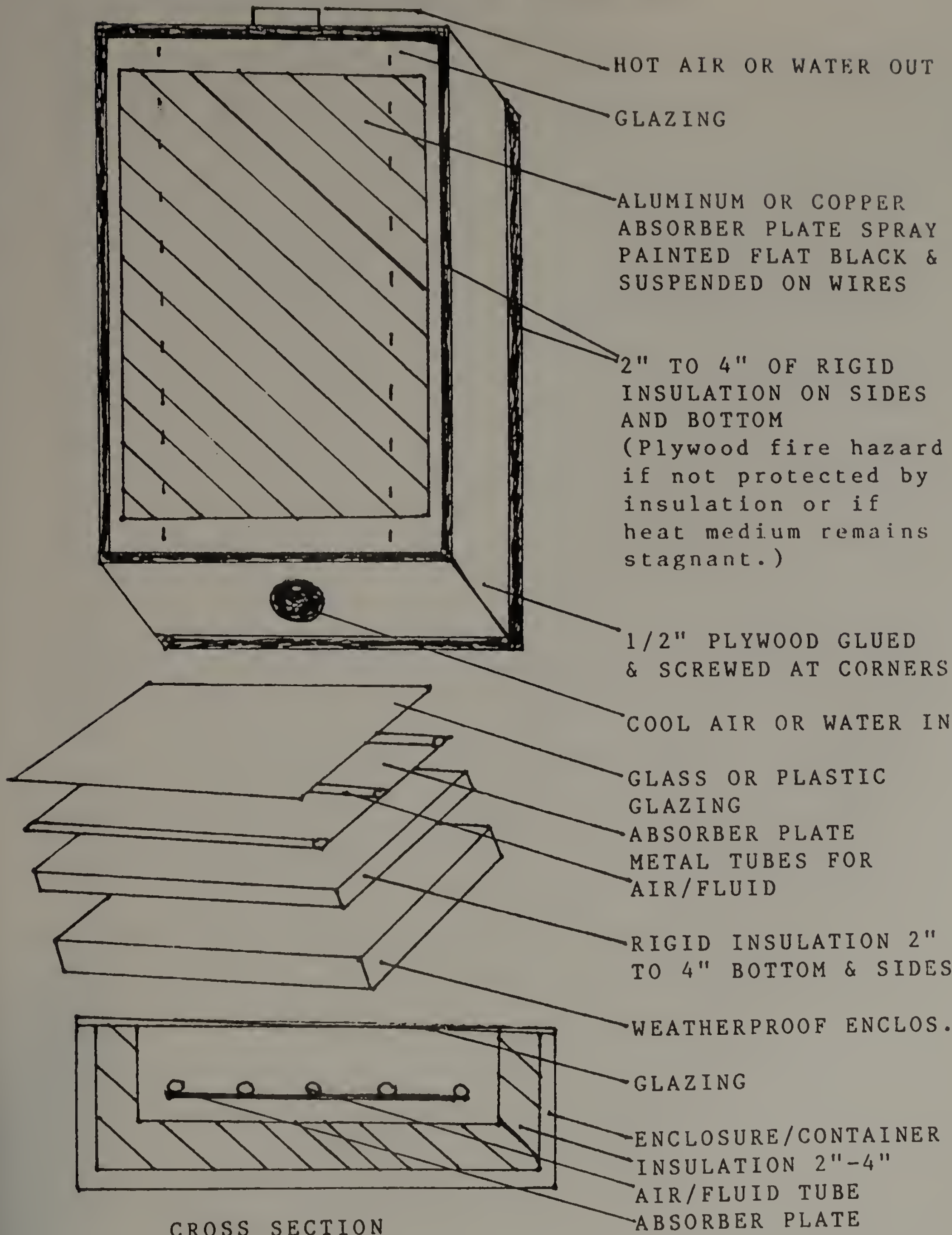
COMPONENT	MATERIALS USED	COMMENTS
GLAZING:	Fiberglass ("filon", "kawall")	Good, but some loss of transmittance with ultraviolet aging (special ultraviolet resistant types available at higher cost.
	Polycarbonates ("lexan")	Good, but very expensive.
	"Mylar", "Tedlar" sheeting	Reradiate infared; mylar undergoes ultraviolet degradation.
	Polyethylene Film	Poor, short life (1/2 yr.) Transmits up to 70% infared (this represents a heat loss).
FLAT PLATE:	Copper	Probably best.
	Aluminum	Corrosion problems if contact with other metals.
	Steel, galvanized	Poorer heat conduction, may rust eventually.
TUBING:	Copper	Best.
	Aluminum	Possible corrosion problems.
	Plastic	Poor heat transfer, low temp. use.
PAINT:	3M "Nextal" or "Black Velvet"	.98 absorptivity with 93. emissivity, expensive.
	Flat Black	Should stand 400 F.

COMPONENT	MATERIAL USED	COMMENTS
SELECTIVE COATING:	Black chrome	Best, durable, .90 absorptivity and .15 to .35 emissivity, but very expensive.
	Nickel Black Black Copper Oxide	

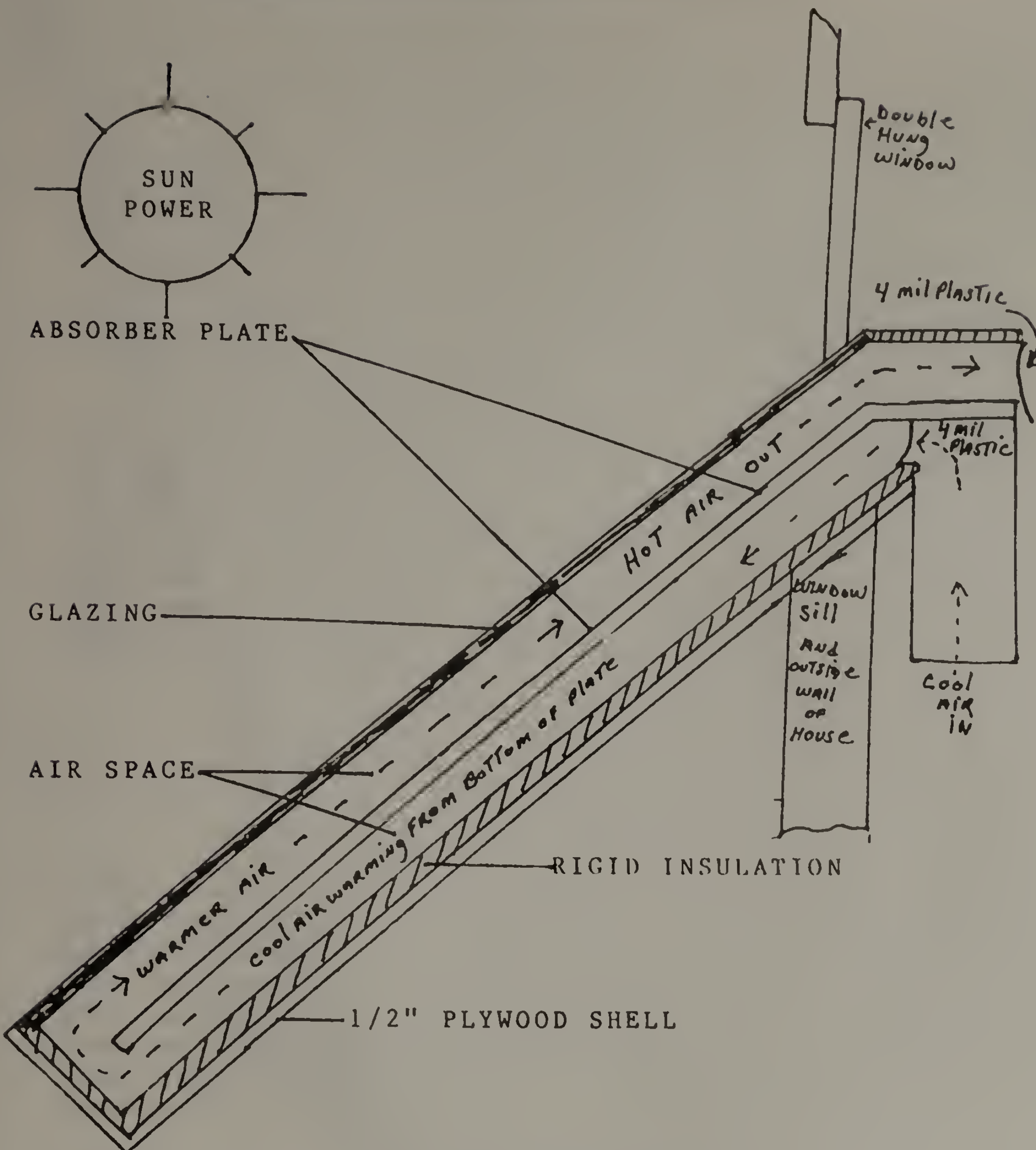
(Selective coatings increase efficiency dramatically when there is a large temperature difference between the collector plate and outside air. For low temperature collectors the extra cost is probably not warranted.)

If the heat transfer medium is air instead of liquid, then no tubing is required and just the flat or corrugated sheet, with or without baffles, is used.

Anatomy of a Flat Plate Collector

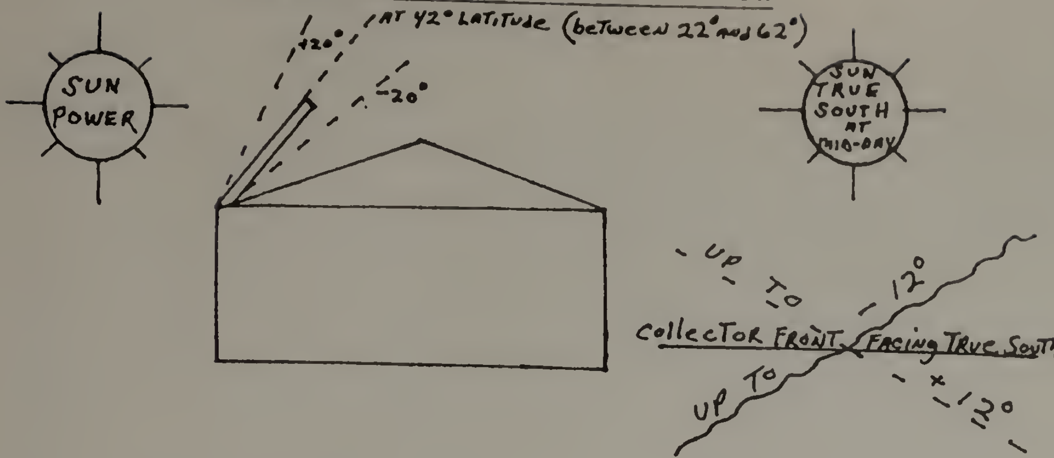


Passive Solar Window Box Collector



(CAUTION: Fire hazard to plywood shell:
1. If not properly protected by insulation;
2. If heat medium is allowed to remain stagnant.)

Collector Tilt and Orientation

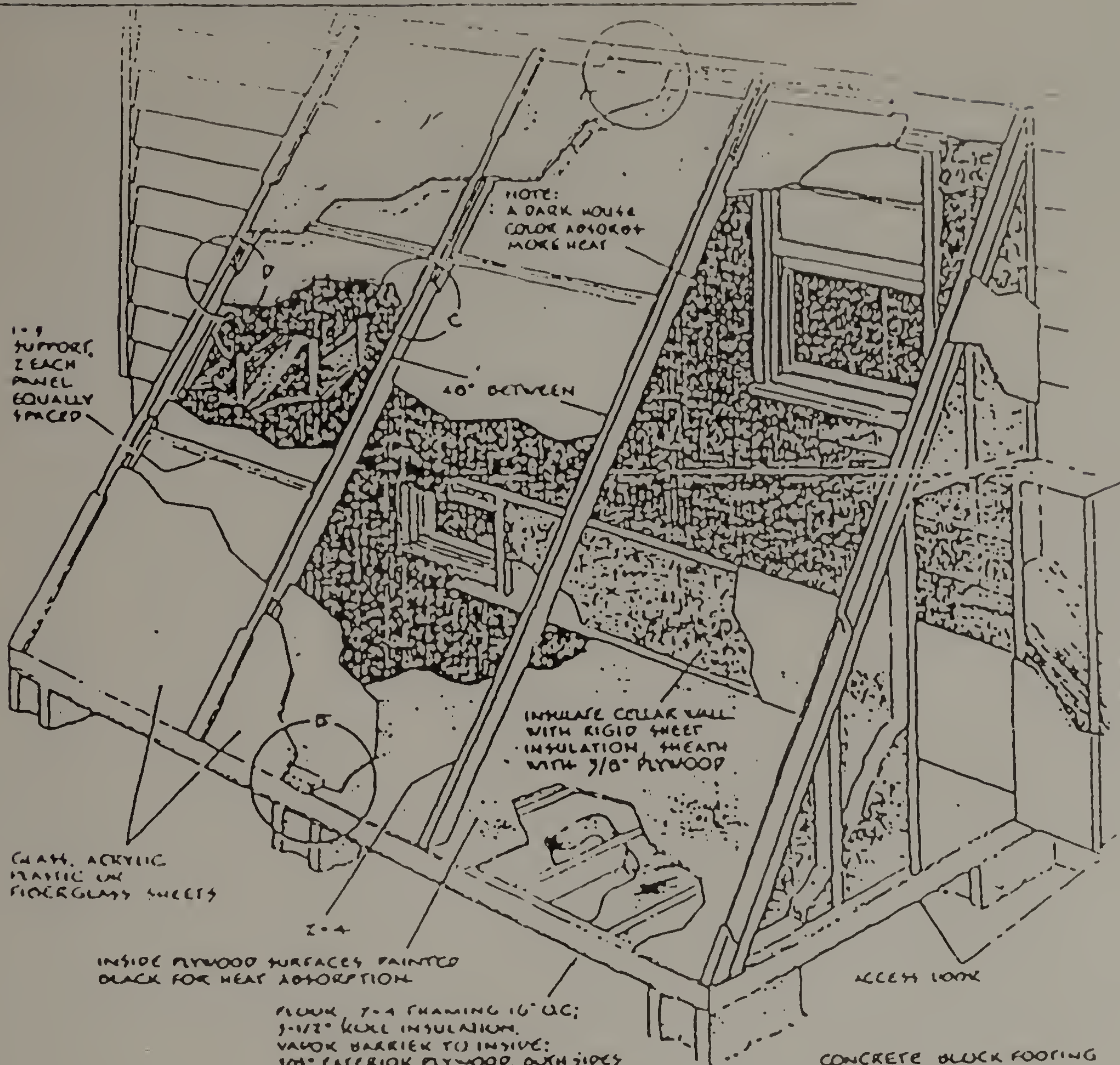


The optimum collector <u>tilt</u> is usually equal to your site lattitude. A variation +/-20 will not cause any <u>major</u> difference in performance, for year round, +20 for winter use is better

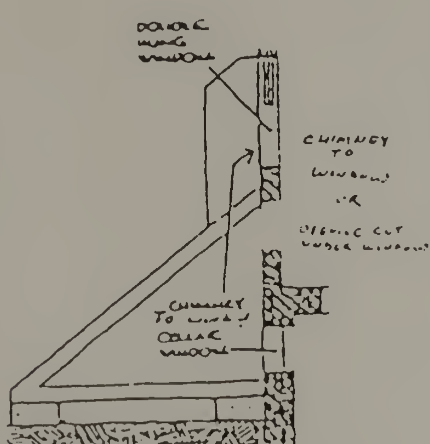
Twelve degrees to either side of true south is acceptable. Local climate and collector type mayinfluence the choice between east or west deviations.

A parabolic reflector changes the sun's light energy into heat energy. By reflecting the sun's rays off the mirror-like surface to a focal point where nearly all the rays come together, heat is produced. On a calm day the cpncentration of the sun's rays can produce four hundred degrees fahrenheit and higher. This is a difficult unit to construct and should not be a beginning project.

A PASSIVE SOLAR COLLECTOR THAT ALMOST ANYONE CAN BUILD

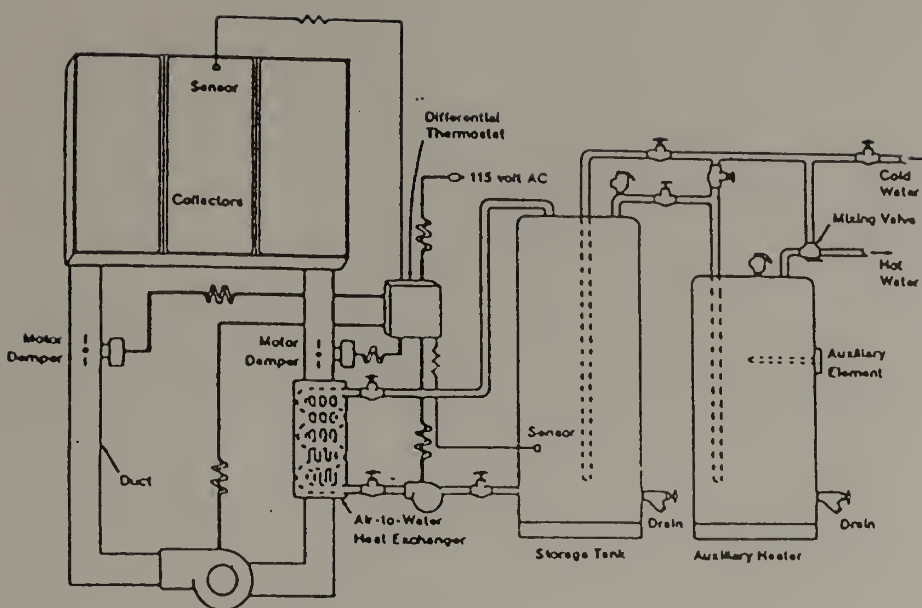


FOR STEP BY STEP PLANS
SEND A SELF ADDRESED/STAMPED
ENVELOPE TO THE SOURCE:
JOSEPH R. PROVEY
WORCESTER POLYTECHNIC INST.
PUBLIC RELATIONS DEPT.
WORCESTER, MA. 01609

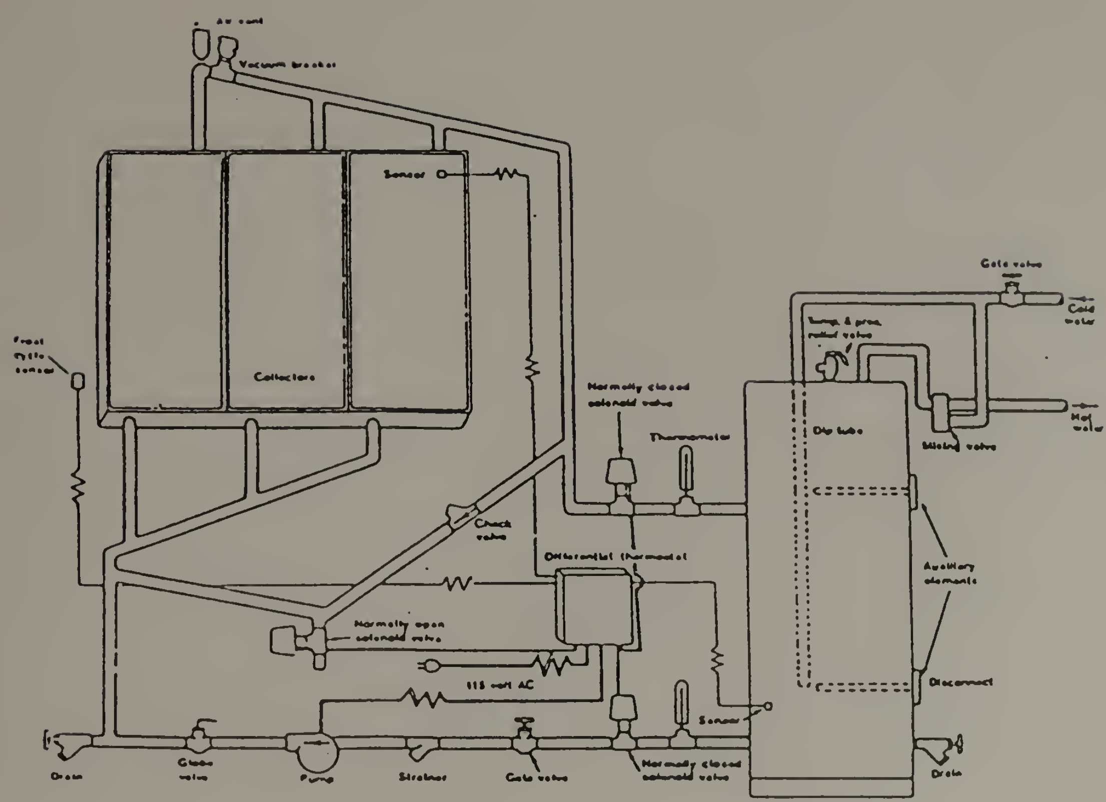


ALTERNATE CONSTRUCTION METHODS

AIR SYSTEM


Sensor
Collectors
Differential Thermostat
115 volt AC
Motor Damper
Motor Damper
Duct
Sensor
Air-to-Water Heat Exchanger
Storage Tank
Drain
Auxiliary Heater
Drain
Auxiliary Element
Cold Water
Mixing Valve
Hot Water

DRAINDOWN SYSTEM



Meter Reading

- Monitor your electric, gas, and water meters!

- Try some of the conservation practices listed in the following pages of this hand-out.

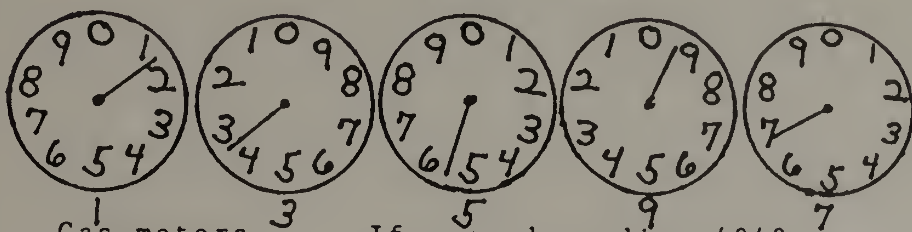
- Record any changes and calculate what the savings would be in a year's time.

The following information will help you to read your meters:

Read the dial starting from the right (units, tenths, hundredths etc.) noticing that some dials go clockwise while others go counterclockwise. If a pointer is between two numbers, record the lower of the two numbers.

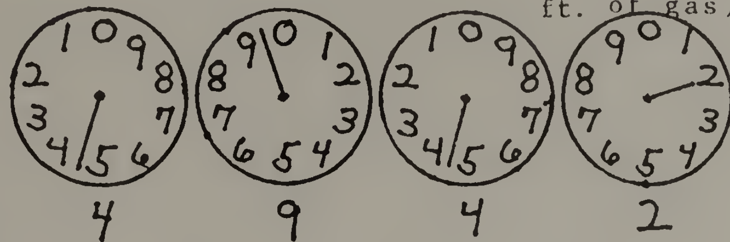
Electric meters

If second reading	13597	
First reading	13487	
Amount used	110	



Gas meters

If second reading	4942	
First reading	4842	
Amount used	100	(cubic ft. of gas)



Water Meters

If second reading	112800	
First reading	107700	
Amount used	5100	(cubic ft. of water)

First Reading	Second Reading
107700	112800

Energy Conservation Tips

Let us begin with the fact that hot air rises. Therefore, through the use of more insulation in the ceiling areas, insulated curtains, thermal shutters and plastic coverings around doors and windows, heat will be kept from escaping. As a result of these efforts, a large drop in energy consumption and expenses will be noticed. In the following pages, these will be discussed in further detail along with other energy conservation efforts that can be done now!

In an effort to live better on less, let us look at a few energy conservation tips that could be used in our daily lives. (Compiled from brochures published by: The Connecticut Light and Power Company, Western Massachusetts Electric Company, Holyoke Water Power Compnay, Northeast Nuclear Energy Company and the Northeast Utilities Service Company.)

Cooking uses a great deal of energy, and, with some thought, one could save both energy and money. Some efforts to help the air flow in an oven are:

1. Cookie pans should be staggered.
2. The racks should not be lined with foil.
3. The oven should be preheated not more than eight or ten minutes.
4. Use glass or ceramic pans--as a result the oven temperature can be turned down twenty-five percent or more.
5. Meat thermometers and timers can be used to avoid overcooking; double portions should be cooked, half of which can be frozen.

Here is an energy comparison for meatloaf preparation. Note the appliances, the temperature, the time, the energy used and the cost for various appliances:

APPLIANCE	TEMPERATURE	TIME	ENERGY	COST
Electric oven	350	1 hr.	1.5KWh	.12
Gas oven	350	1 hr.	.112 Ccf	.078
Toaster oven	450	50 min.	.4KWh	.032
Frypan	420	1 hr.	.44KWh	.035
Microwave	---	12 min.	.31 KWh	.025
Crockpot	200	7 hrs.	.52KWh	.042
Pressure Cooker	Low	10 min.	.23KWh	.019
	High	3 min.	.005KWh	.019

Assumes .08 per/KWh (kilowat hour)
Assumes .70 per Ccf (100 cubic feet of gas)

When using a self-cleaning oven, use the cleaning feature after cooking while the oven is already hot. Burner reflector surfaces should be kept clean and shiny so as to reflect more heat into the food being cooked instead of absorbing it into the appliance. This will make cooking more efficient--the smaller the area heated the better. The smaller of the two ovens should be used when possible. Toaster ovens are quite efficient as noted in the previous chart. Pressure cookers and flat bottom cookware that fit the burner are also more efficient. Turning the burner or the oven off a little before the end of cooking time will take advantage of the heat radiating from the burner and its surroundings. When using gas appliances, the flame should burn blue, if not they should be cleaned and adjusted. Also, turn the pilots off, matches are far less expensive than gas. Regarding the refrigerator: Defrosting food in the refrigerator before cooking will help keep the refrigerator cold and save cooking time. If a freezer had two pieces of plastic taped inside the door with staggered slits to reach through, it would help to keep the cool air in when the door is open. The location of the refrigerator should be away from any heat source, sunlight included. The door should be opened as seldom as possible. For example, after shopping, separate all your perishables and put them away at one time. After-school snacks should be prepared before the children get home. A list of the foods in the freezer and refrigerator could be taped to the outside door. Also, try to plan ahead for meals, removing them all at one time. All of these efforts will help keep the refrigerator from running. Keep the freezer full and defrost it whenever there is one-fourth inch of frost, and when doing this the frozen foods should be taken from the freezer and put into the refrigerator. This will help keep the refrigerator cold. Vacuum the condensor coils of the refrigerator every three months. If the refrigerator has a butter softener, set it on hard--many have a heater. The gasket around the refrigerator and freezer doors should be checked by closing them on a piece of paper. The paper should be set in several positions around the doors. If the paper can be pulled out easily, the door catch should be adjusted or the gasket replaced. Washing the gasket occasionally will help keep it soft and it will form a better seal. When storing liquids in the refrigerator, always keep them covered, otherwise the vapors given off will cause the compressor to work harder. Lastly, for refrigerators and all appliances that one may be purchasing, look for the latest energy saving devices such as power saving switches. As of May 18, 1980, the Federal Law required that all major appliances display a black and yellow energy guide tag. The advantages of one unit should be compared to another. The size that best services your needs should be purchased, too large or too small will only waste energy.

Hot water is another high energy waste area. Although solar alternatives will be discussed later, there are several things that can be done to make many present systems, as well as a solar system, more efficient. An insulation jacket installed around your hot water heater hard--many have a heater. The gasket around the refrigerator and freezer doors should be checked by closing them on a piece of paper. The paper should be set in several positions around the doors. If the paper can be pulled out easily, the door catch should be adjusted or the gasket replaced. Washing the gasket occasionally will help keep it soft and it will form a better seal. When storing liquids in the refrigerator, always keep them covered, otherwise the vapors given off will cause the compressor to work harder. Lastly, for refrigerators and all appliances that one may be purchasing, look for the latest energy saving devices such as power saving switches. As of May 18, 1980, the Federal Law required that all major appliances display a black and yellow energy guide tag. The advantages of one unit should be compared to another. The size that best services your needs should be purchased, too large or too small will only waste energy.

Hot water is another high energy waste area. Although solar alternatives will be discussed later, there are several things that can be done to make many present systems, as well as a solar system, more efficient. An insulation jacket installed around your hot water heater is a must. Some electric and gas companies will install this free of charge on their rental heaters. Usually the hot water heater is in the basement or other cool area which draws heat out of the unit. If possible, the heater should be installed in a well insulated hot spot--near your furnace, wood stove, sauna, etc. The pipes coming off the hot water tank should also be wrapped with insulation; otherwise the area around them is heated each time you draw hot water--this is a very difficult way to heat a basement. There are usually two thermostats on a hot water heater. Both thermostats should not be set any higher than one-hundred and twenty degrees fahrenheit. Also, low-flow shower heads and water restricting sink devices should be used.

Glossary of Terms

Barrel - A liquid measure of oil, usually crude oil, equal to 42 gallons or about 306 pounds.

Barrel of oil equivalent - Energy equal to a barrel of crude oil - 5.8 million Btu's.

Biomass - Living matter, plant and animal, in any form.

Btu - British thermal unit, the amount of heat necessary to raise the temperature of one pound of water one degree fahrenheit or about a quarter of a calorie.

Carcenogen - A substance or agent producing or inciting cancerous growth.

Cogeneration - The production of two useful forms of energy from the same process. In a factory, for instance, steam needed for industrial processes.

EER - Energy efficiency ratio, A common measurement of the energy efficiency of home appliances.

Efficiency - The ratio of useful work or energy output to the total work or energy input.

Fossil Fuels - Fuels such as coal, crude oil or natural gas formed from remains of animals.

Gasahol - In the U.S., this is a mixture of ninety percent unleaded gasoline and ten percent ethyl alcohol.

Geopressured Gas - Natural gas that is dissolved in hot brine and trapped under great pressure deep within the earth.

Glazed Windows - Windows which have more than one pane of glass between inside and outside. A double-glazed window has two panes, a triple glazed window has three panes. The dead air spaces between the panes act as insulation.

Greenhouse Effect - The warming effect of carbon dioxide and water vapor in the atmosphere. These molecules are transparent to incoming sunlight (long waves) but hold in infared (short waves - heat) radiation escaping from the earth.

Megawatt - A unit of power equal to 1000 kilowatts, or one million watts. A gigawatt is a billion watts.

OPEC - The Organization of Petroleum Exporting Countries, thirteen nations that aim at developing common oil-marketing policies.

Operable Sash - The moveable part of a window in which the panes of glass are set.

Photovaltaics - The process by which radiant (solar) energy is converted directly into electrical energy through the use of a solar cell.

Quad - A quadrillion Btu's. The energy contained in eight billion gallons of gasoline, a year's supply ten million automobiles.

Renewable Energy Source - One that is constantly or cyclically replenished, including direct solar energy and indriect sources such as biomass and wind power.

Reserve - That portion of a resource that has been discovered but not yet exploited and which at present is technically and economically extractable.

R-Value - The measurement of an insulation material's ability to resist heat loss. The higher the R-value, the more heat you save. R-Values are usually printed on the insulation covering.

Seasonal Performance Factor - This is a measurement of a heat pump's efficiency over a heating season compared to electric heat.

Shower Head Flow - This is measured by Gallons Per Minute (GPM). Collect water for 15 seconds, measure the amount and multiply by 4 to get the GPM.

Synfuels - Fuels synthesized from sources other than crude oil or natural gas and used in place of them or their derivations, primarily for transportation and the heating of boilers.

Slab Insulation - This should be found on homes built on concrete slabs. It prevents heat from leaking through the slab.

Vapor Barriers - These are thin coverings of paper foil or plastic film that protect insulation and wood from moisture damage. They face the area to be heated.

Easy Do-it-Yourself Projects and Conservation Efforts

IN THE HOME:

1. Insulating, weather stripping, plastic covering and caulking.
2. Installing low flow water restrictors.
3. Add attic insulation.
4. Insulate hot water pipes, heating ducts, and cooling ducts.
5. Install a hot water tank insulation blanket.
6. Turn the hot water temperature down. If electric, inquire about off-peak heating at a lower rate.
7. Installing electric outlet seals.

IF YOU HAVE A POOL:

1. Cover it at night.
2. Put a timer on the filter.
3. Install a thermal syphoning solar hot water heater.

TRANSPORTATION CONSERVATION:

1. Use car pools.
2. Use public transportation.
3. Keep your car running efficiently.
4. Shop close to home whenever possible.
5. Plan automobile usage to accomplish several errands in one trip.

PEDDLE POWER:

1. Use a bicycle to save money, energy and improve your health.

Appendix E

Consent Form--Program Abstract

For Seminar Participants

I am a doctoral student at the University of Massachusetts in the School of Education. I am conducting an alternative energy program and research of current knowledge and attitudes about energy. My proposed research will involve two groups of about thirty human subjects. One group, the control group, will have the project explained to them and they will complete a twenty-four item questionnaire. This questionnaire will be filled out on two separate occasions (total time commitment about two hours). The questionnaire is designed to measure attitudes and knowledge of energy.

The second group, the experimental group, will complete the same questionnaire, participate in a two day seminar, and a follow-up telephone interview. The seminar, an experiential curriculum intervention strategy, will include discussion sessions, demonstrations, hands-on activities, and a review of the enclosed energy packet. Each participant will be given the energy education packet, lodging, free instruction, and a free home energy audit consultation upon request.

My research will involve the above described program, and requires the following responsibilities (with approximate time commitments) of the participants:

1. Questionnaire completions (1 hour each)
2. Attendance at a 2 day seminar (in Rhode Island)
3. Telephone interview (45 minutes)
4. Provision of own transportation to and from the seminar site
5. Home energy audit consultation (2 hours) (If requested by the participant)

Additional energy related information will be available through:

W.J. Landry, Jr.
University of Massachusetts
School of Education
Future Studies Program
Instructional Leadership Division
Amherst, MA 01003

The participants' anonymity will be assured by the assignment of a letter code to each participant upon the completion of the initial questionnaire. Subsequent questionnaires, interviews, data recording and reporting will use the participants' codes rather than names. The results of my research will be used in my dissertation, shared with colleagues and published. However, the names of the participants will not be used.

It is my intent that through involvement with the program you will:

1. Gain a better understanding of the energy options and conservation practices available to you today;
2. Develop and/or reinforce a positive attitude toward the use of alternative energy devices and conservation practices;
3. Experience various hands-on construction techniques;

4. Not only use the knowledge within your living situation, but share it with friends and neighbors so that many people can benefit from your experiences in the program.

If at any time, there are questions or concerns about the program, my research or any other requests, please feel free to ask. In addition, if you wish to discontinue participation in the program at any time, you are free to do so without prejudice toward you.

In the unlikely event of injury occurring to and from the seminar site, or during participation in the program, the U.S. Department of Health and Welfare requires that I inform you that the University of Massachusetts will not be held responsible for any medical treatment and/or compensation in any form should injury occur.

Thank you for your assistance in this program.

Program Director________________________
W. J. Landry, Jr.

I/we agree to participation as stated in the above program:

Date________________ Participant______________

Date________________ Guardian_________________

NOTE: Things to bring along; Money for food, sleeping bag, pillow, pencils, two towels, bathing suit, tooth brush, and other personal items as needed.

Appendix F

Questionnaire

Target Population

Overall Group	Sub Group
I. Teenagers - 75%	People who have had the project explained to them
II. Adults over age 20 - 25%	People who have participated in the experiential education intervention sessions

A computer analysis will be made of the energy inventory questions to conclude the mean differences in attitudes and knowledge between the control and experimental groups. The analysis will compare the pre-intervention questionnaire answers of the two groups, and the post-intervention questionnaire answers of the two groups. In addition, there will be a demographic breakdown of the groups according to age, sex and education. The telephone interview of the program participants will be used as additional data for my qualitative conclusions.

The questions and above analysis method have been reviewed and approved by Jane Rogers of the Research Consulting Services (Room 149A, Hills South).

DEMOGRAPHIC DATA

NAME:
AGE:
SEX:
OCCUPATION:
EDUCATION (years completed):
ADDRESS:
TELEPHONE:

ENERGY INVENTORY QUESTIONNAIRE

The following questions are designed to inventory your attitudes and knowledge of energy.

For the attitude questions, circle A if you agree or D if you disagree. For the knowledge questions, circle Y if you agree and N if you disagree.

A D 1. People need to become more aware of available alternative energy devices/practices in order to conserve energy and save money.

Y N 2. Do you know how a solar collector works?

Y N 3. There are few, if any, alternative energy devices that I could construct and/or install.

Y N 4. There are many inexpensive alternative energy conservation practices that I could adopt which would save money as well as energy.

Y N 5. There are some inexpensive alternative energy devices that I could construct and use to save money.

Y N 6. Alternative energy installations would not be cost effective for me.

A D 7. Solar, wind and water power are viable alternatives for the production of energy in today's world.

A D 8. The world's present nuclear fission programs should be expanded.

A D 9. The use of alternative energy devices and practices could be financially beneficial to me.

A D 10. It is everyone's responsibility to conserve energy.

Y N 11. Without oil we could not produce any plastics or synthetic fibers.

A D 12. Science will find an answer before the energy problem gets too bad.

A D 13. We should relax our environmental standards in order to increase our energy production.

A D 14. People who can afford it should buy and use as much energy as they want.

Y N 15. It is worth the extra expense to me to keep the thermostat above sixty-five degrees in cold weather.

Y N 16. Have you read anything about alternative energy in the last six months?

Y N 17. Have you ever done an energy audit where you live?

Y N 18. Have you ever monitored your utility usage?

Y N 19. Have you been exposed to any alternative energy programs?

PLEASE CIRCLE ALL CHOICES THAT YOU AGREE WITH IN EACH QUESTION:

20. Alternative energy is:
a. Nuclear b. Solar c. Coal d. Renewable e. Oil
f. Wind

21. Renewable energy is power from:
a. Nuclear fission b. Solar c. Nuclear fusion
d. Fossil fuels e. Hydroelectric facilities f. Wind

22. Fossil fuels are:
a. Gas b. Oil c. Coal d. Wood e. Geothermal
f. Nuclear

23. The country that produces the most oil annually is:
a. U.S.A. b. Saudi Arabia c. Mexico d. U.S.S.R.
e. Iran f. Libya

Would you be interested in receiving any additional energy information?

Appendix G

TELEPHONE INTERVIEW

QUESTIONS

NAME:

1. What are some renewable energy sources that you can think of.

2. Have you noticed any alternative energy devices/installations in your area? If so, how many different ones?

3. Do you feel that you have a better understanding of how to use alternative energy devices and practices after having been exposed to the project?

4. In what ways have your thoughts changed in regard to the use of alternative energy devices and practices?

5. What alternative energy <u>devices</u> could you use in your living situation?

6. What are some of the alternative energy <u>practices</u> that you could use in your living situation.

7. At what temperature do you usually keep your thermostat in the winter:

Day when away -
Evening when at home -
Night while sleeping -

8. What, if anything, have you done to conserve energy and save money?

Since being exposed to the project

During 1984

During 1983

Earlier

9. Do you know how a solar collector works?

10. Have you read anything about alternative energy since the program?

11. Have you done an energy audit of your home since the program?

12. Have you monitored your utility usage since the program?

13. How has the program has been helpful to you?

14. Would you be interested in any additonal alternative energy information? If so, what kinds of information would you be most interested in?

Appendix H

The Commonwealth of Massachusetts
University of Massachusetts
Amherst 01003

SCHOOL OF EDUCATION

July 19, 1984

To whom it may concern:

I am a graduate student currently enrolled in a program of doctoral studies at the University of Massachusetts. My field of study is alternative energy practices and development, and my research includes the compilation of data regarding perspectives on current and forecasted energy alternatives in nations throughout the world.

An interview with a national energy advisor in your country and portfolio of your energy needs and uses, present and forecasted, would be greatly appreciated, and would aid in my research toward the development of safe viable energy for home and industry.

I plan to be in Europe from August 13-17, and hope that an interview would be possible at this time. My schedule will take me through six countries during this limited period.

In addition, if there are specific agencies which may be contacted for material and information, their names and addresses would be greatly appreciated.

I thank you in advance for for your cooperation and assistance, and look forward to meeting with you on the critical issues of energy that face us.

Sincerely,

W.J. Landry, Jr.

W.J. Landry, Jr.

Future Studies Program
Furcolo Hall
Amherst, MA 01003
U.S.A.

Appendix I

Pre/Post Questionnaire Answers

The following compilation of the groups' pre/post questionnaire responses are included in this document for your review.

KEY FOR READING

QUESTION RESPONSES

Questions 1-23

Code number for each Participant

2. = post-test answers (Only answer changes noted)

1. = pre-test answers

#1 Sex:F Age:38 Education:18

Q-1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1.A	N	Y	Y	N	N	A	D	A	A	Y	D	D	D	Y	N	N	Y	N	BF	BDF	BC	B
2.	Y	N		Y						Y				N	Y			Y	BDF	BEF	ABC	D

Pre/Post Questionnaire Answers--1-23
Experimental Group

#:1 Sex:F Age:38 Education:18

Q-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1.	A	N	Y	Y	N	N	A	D	A	A	Y	D	D	D	Y	N	N	Y	N	BF	BDF	BC	B
2.		Y	N		Y						N				N	Y			Y	BDF	BEF	ABC	D

#:2 Sex:F Age:24 Education:16

Q-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1.	A	N	N	Y	Y	N	A	D	A	A	N	D	D	D	N	N	N	N	N	BDF	BEF	ABC	B
2.		Y														Y			Y				D

#:3 Sex:F Age:32 Education:15

Q-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1.	A	N	Y	N	N	Y	A	A	D	A	Y	D	D	D	N	N	N	N	N	BCDF	BDF	BCD	B
2.		Y	N	Y	Y	N		D	A		N					Y			Y	BDF	BEF	ABC	D

#:4 Sex:M Age:26 Education:13

Q-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1.	A	N	Y	Y	N	N	A	D	A	A	N	A	D	D	N	N	N	N	N	BF	BF	BCD	B
2.		Y	N		Y											Y			Y	BDF	BEF	ABC	D

#:5 Sex:M Age:24 Education:12

Q-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1.	A	N	Y	Y	Y	N	A	A	A	A	N	D	A	D	N	N	N	N	N	ABCF	BD	CD	E
2.		Y	N										D			Y			Y	ABCDF	BEF	ABC	B

#.6 Sex:F Age:58 Education:12

Q-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1.	A	N	Y	Y	N	Y	A	A	A	A	Y	A	D	D	Y	N	N	Y	N	DF	BEF	ABCD	A
2.		Y	N			N					N					Y			Y	BDF		ABC	D

Pre/Post Questionnaire Answers--1-23
Experimental Group

#:7 Sex:M Age:29 Education:18

Q-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1.	A	Y	N	Y	Y	N	A	D	A	A	N	A	D	D	N	Y	N	Y	Y	BDF	BEF	ABC	B
2.																							D

#:8 Sex:M Age:54 Education:12

Q-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1.	A	N	Y	Y	N	Y	A	A	A	A	N	A	A	D	N	N	N	Y	N	AB	ABC	ABC	B
2.		Y			Y	N										Y			Y	ABCDF	BEF		D

#:17 Sex:F Age:14 Education:8

Q-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1.	A	Y	Y	Y	N	Y	A	D	A	A	Y	D	D	A	Y	N	N	N	N	A	BF	ABC	C
2.			N		Y	N					N					Y				AB	BEF		D

#:18 Sex:F Age:16 Education:11

Q-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1.	A	Y	Y	Y	N	N	A	A	A	A	Y	D	D	D	Y	N	N	N	N	AB	BEF	ABC	B
2.			N		Y						N					Y			Y	ABDF	BF		D

#:19 Sex:F Age:16 Education:16

Q-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1.	A	N	Y	Y	N	N	A	A	A	A	N	A	D	D	N	N	N	N	N	BCF	E	BCD	B
2.		Y	N		Y							D				Y			Y		BEF	ABC	D

#:20 Sex:F Age:16 Education:11

Q-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1.	A	Y	Y	Y	N	N	A	D	A	A	Y	A	D	D	Y	N	N	Y	Y	BDF	BEF	ABC	B
2.			N		Y											Y							

Pre/Post Questionnaire Answers
Experimental Group

#:21 Sex:F Age:17 Education:11

Q-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1.	A	N	N	Y	Y	Y	A	A	A	A	N	D	A	D	N	N	Y	N	Y	BF	BF	ABCD	B
2.		Y				N																ABC	B

#:22 Sex:F Age:17 Education:12

Q-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1.	A	N	N	Y	N	N	A	D	D	A	N	A	A	D	Y	N	N	N	Y	E	D	C	D
2.		Y			Y				A			D	D			Y				EB	BEF	ABC	

#:23 Sex:F Age:18 Education:12

Q-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1.	A	N	N	Y	N	N	A	A	A	A	Y	A	A	D	N	N	Y	Y	Y	ABDF	ABCEF	B	A
2.		Y			Y						N					Y					BCEF	ABC	D

#:24 Sex:F Age:17 Education:12

Q-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1.	A	Y	Y	Y	N	N	A	A	A	A	N	A	D	D	N	N	N	Y	Y	DF	EF	ABC	B
2.												D				Y				BDF	BCEF		

#:25 Sex:F Age:18 Education:12

Q-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1.	A	N	N	Y	Y	N	A	A	A	A	N	D	A	D	N	N	N	N	N	BCF	B	AC	D
2.		Y																			BEF	ABC	

#.26 Sex:F Age:17 Education:11

Q-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1.	A	Y	N	Y	Y	N	A	A	A	A	Y	A	D	D	N	N	N	N	N	BC	D	ABCD	B
2.																Y			Y		BEF	ABC	D

Pre/Post Questionnaire Answers
Experimental Group

#:27 Sex:F Age:18 Education:12

Q-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1.	A	N	Y	Y	Y	Y	A	A	A	A	Y	D	A	D	N	N	N	N	N	ACDF	CD	CD	A
2.	Y			N					N		D									ABCDF	BCEF	BCD	B

#:28 Sex:F Age:18 Education:12

Q-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1.	A	N	N	Y	Y	N	A	D	A	A	Y	D	D	D	Y	N	N	N	N	BF	D	D	B
2.		Y																			BEF	BCD	

#:41 Sex:M Age:15 Education:10

Q-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1.	A	Y	Y	Y	N	N	A	A	A	A	Y	D	D	D	N	N	Y	Y	Y	BDF	BEF	ABC	A
2.			N		Y																		D

#:42 Sex:M Age:16 Education:11

Q-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1.	A	N	Y	Y	N	Y	A	D	A	A	Y	A	D	D	N	Y	N	N	N	ABF	D	ABC	D
2.		Y	N		Y	N					N								Y		BCEF		

#:43 Sex:M Age:16 Education:10

Q-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1.	A	Y	Y	Y	N	Y	A	D	A	A	Y	A	D	D	N	Y	Y	N	Y	ABDF	BEF	ABC	A
2.			N		Y	N					N									BDF	BCEF		D

#.44 Sex:M Age:16 Education:11

Q-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1.	A	Y	N	Y	Y	N	A	D	A	A	N	A	D	D	N	Y	N	Y	Y	BDF	BEF	ABC	A
2.																							D

Pre/Post Questionnaire Answers
Experimental Group

#:45 Sex:M Age:17 Education:11

Q-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1.	A	Y	N	Y	N	N	A	D	A	A	Y	A	D	D	Y	Y	N	N	Y	ABCDF	BEF	ABC	B
2.					Y															BCDF			D

#:46 Sex:M Age:17 Education:11

Q-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1.	A	N	Y	Y	N	Y	A	D	A	D	N	A	D	D	N	N	Y	N	N	BF	E	ABC	A
2.		Y	N		Y											Y			Y	BDF	BEF		D

#:47 Sex:M Age:16 Education:11

Q-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1.	A	Y	N	Y	Y	N	A	D	A	A	N	D	A	D	N	N	N	N	N	BCF	B	ABCE	B
2.													D			Y			Y	BCDF	BEF	ABC	D

#:48 Sex:M Age:17 Education:12

Q-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1.	A	Y	Y	Y	Y	Y	A	A	D	A	Y	A	D	D	Y	N	N	N	N	ABDF	E	C	D
2.			N			N										Y					ABC		

#:49 Sex:M Age:18 Education:12

Q-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1.	A	N	Y	Y	Y	N	A	D	A	A	N	A	D	D	N	Y	N	Y	N	ABCDF	C	ABCD	D
2.		Y	N																Y	BCDF	BCEF	ABC	

#50. Sex:M Age:18 Education:12

Q-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1.	A	Y	Y	Y	N	N	A	D	A	A	N	D	A	D	N	Y	N	N	Y	D	D	E	B
2.			N		Y								D							BDF	BCEF	ABC	

Pre/Post Questionnaire Answers
Experimental Group

#:51 Sex:M Age:18 Education:12

Q-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1.	A	N	Y	Y	N	Y	A	A	D	A	N	A	A	D	Y	N	N	N	N	ABCDF	ABEF	ABCD	A
2.			N		Y	N										Y				BCDF	BCEF	ABC	D

#:52 Sex:M Age:18 Education:12

Q-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1.	A	Y	Y	Y	Y	Y	A	A	D	A	Y	A	A	D	Y	N	N	Y	N	ABCD	ACDE	BC	B
2.						N					N					Y			Y	ABCDF	BCEF	ABC	D

Pre/Post Questionnaire Answers
Control Group

#:9 Sex:F Age:34 Education:16

Q-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1.	A	N	Y	Y	N	Y	A	D	A	A	Y	A	A	D	N	N	N	N	N	ABC	AB	BCF	B
2.									D											ACF			

#:10 Sex:F Age:39 Education:18

Q-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1.	A	N	Y	Y	N	Y	A	D	A	A	Y	D	D	D	Y	N	N	N	N	BE	BDF	BC	C
2.									D											BF			B

#:11 Sex:F Age:22 Education:14

Q-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1.	A	N	Y	N	N	Y	A	A	A	A	Y	A	A	D	N	N	N	N	N	ABC	ABC	ABCF	B
2.																							

#:12 Sex:F Age:59 Education:12

Q-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1.	A	N	Y	Y	N	Y	A	D	D	A	Y	A	D	D	Y	N	N	Y	N	BF	BF	B	A
2.																							

#:13 Sex:M Age:22 Education:16

Q-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1.	A	Y	N	Y	Y	N	A	D	A	A	N	D	D	D	N	Y	N	N	Y	BDF	BEF	ABCD	B
2.																							

#:14 Sex:M Age:51 Education:8

Q-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1.	A	N	Y	Y	N	Y	A	A	D	A	N	D	A	D	Y	N	N	Y	N	BCF	ABE	BC	D
2.																							

Pre/Post Questionnaire Answers
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#:15 Sex:M Age:34 Education:18

Q-1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1.A	N	Y	N	N	N	A	D	A	A	Y	A	D	D	N	N	N	N	N	BCF	BF	BCD	B
2.																						

#:16 Sex:M Age:26 Education:14

Q-1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1.A	Y	N	Y	Y	N	A	A	A	D	N	D	D	D	N	Y	N	N	Y	BDF	ABF	ABC	B
2.																						

#:29 Sex:F Age:14 Education:9

Q-1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1.A	N	Y	Y	Y	N	A	A	A	A	N	D	D	D	N	N	N	Y	N	ABF	ABCF	BC	B
2.																						

#:30 Sex:F Age:15 Education:9

Q-1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1.A	Y	Y	N	Y	N	A	A	D	A	N	A	D	D	N	N	N	N	Y	ABF	D	BC	A
2.																						

#:31 Sex:F Age:16 Education:9

Q-1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1.A	N	N	Y	N	Y	A	D	A	A	N	A	A	D	Y	N	N	N	N	BE	B	D	E
2.				Y															B			

#:32 Sex:F Age:16 Education:11

Q-1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1.A	Y	Y	Y	N	Y	A	A	A	A	Y	A	D	D	N	N	N	Y	Y	BDF	BF	ABCD	B
2.				Y	N															DF	ABC	D

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#:33 Sex:F Age:17 Education:11

Q-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20		21	22	23
1.	A	Y	Y	Y	N	N	A	D	A	A	Y	A	A	D	N	D	N	N	N	N	BDF	BEF	BCD	B
2.						Y							D			Y							CD	

#:34 Sex:F Age:17 Education:12

Q-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1.	A	Y	N	N	Y	N	A	D	D	A	N	D	D	D	Y	N	N	N	N	F	D	C	B
2.				Y	N				A		Y	A								BCD	CF	BCF	

#:35 Sex:F Age:17 Education:12

Q-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1.	A	N	N	Y	N	N	A	D	A	A	N	D	A	A	N	N	N	N	N	BE	AB	CD	B
2.		Y		N		Y		A	D	D		A		D			Y			B	C	C	B

#:36 Sex:F Age:18 Education:12

Q-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1.	A	N	Y	Y	Y	N	A	A	A	A	N	A	D	D	N	N	N	N	N	ABF	D	BCD	A
2.																						CD	

#:37 Sex:F Age:18 Education:12

Q-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1.	A	N	Y	Y	N	N	A	A	A	A	Y	D	D	D	N	N	N	N	Y	ABCEF	DE	ABCE	A
2.											N	A				Y				ABCF		ABC	B

#.38 Sex:F Age:16 Education:10

Q-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1.	A	N	Y	Y	Y	Y	A	D	A	A	Y	A	A	D	Y	Y	N	N	N	BDF	BDEF	ABCD	B
2.																							

Pre/Post Questionnaire Answers
Control Group

#:39 Sex:F Age:17 Education:11

Q-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1.	A	Y	N	Y	Y	Y	A	D	A	A	N	D	D	D	Y	Y	N	N	N	BCEF	AC	CE	B
2.																							

#:40 Sex:F Age:18 Education:12

Q-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1.	A	N	Y	Y	N	N	A	D	A	A	N	D	D	D	N	Y	N	N	N	BDF	D	BC	D
2.																							

#:53 Sex:M Age:15 Education:10

Q-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1.	A	N	Y	Y	Y	N	A	D	A	A	Y	A	D	D	N	N	N	N	N	ABCF	BEF	CDE	D
2.						Y															BDEF		

#:54 Sex:M Age:16 Education:11

Q-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1.	A	Y	N	Y	Y	Y	A	D	A	A	Y	D	A	D		Y	N	Y	N	BDF	BDF	BDF	B
2.						N														ABCDF			

#:55 Sex:M Age:16 Education:11

Q-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1.	A	N	N	Y	N	Y	A	A	A	A	Y	A	D	D	Y	N	N	N	N	BE	F	BCD	A
2.																							B

#.56 Sex:M Age:17 Education:11

Q-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1.	A	N	Y	Y	N	Y	A	D	D	A	N	A	D	D	Y	N	N	N	N	AE	ACE	ABC	B
2.				N																	ABCE	ABCE	

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#:57 Sex:M Age:17 Education:11

	Q-1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1.	A	Y	N	Y	Y	N	A	D	A	A	N	A	D	D	N	Y	Y	Y	Y	ABF	BE	ABC	B
2.																					BEF		

#:58 Sex:M Age:17 Education:11

	Q-1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1.	A	N	N	Y	Y	N	A	A	A	A	N	A	A	D	N	N	N	Y	N	ABDF	BDEF	BCD	B
2.																							

#:59 Sex:M Age:17 Education:11

	Q-1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1.	A	Y	N	Y	N	N	A	A	A	A	N	A	D	D	Y	N	N	Y	N	ABDF	B	ABC	B
2.																							

#:60 Sex:M Age:18 Education:12

	Q-1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1.	A	Y	Y	N	Y	N	A	A	A	A	Y	A	D	D	N	N	N	N	Y	BF	BEF	BC	B
2.			N	Y																		ABC	

#:61 Sex:M Age:18 Education:11

	Q-1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1.	A	Y	N	Y	Y	Y	A	D	A	A	N	D	D	D	N	Y	N	N	Y	BDF	BCEF	ABC	B
2.					N																		

#.62 Sex:M Age:16 Education:11

	Q-1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1.	A	N	Y	Y	N	N	A	D	A	A	Y	A	D	D	Y	N	N	N	N	BE	D	CDE	A
2.																	Y				BD	BCE	

Pre/Post Questionnaire Answers
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#:63 Sex:M Age:18 Education:12

Q-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1.	A	N	Y	Y	N	N	A	A	A	A	Y	D	A	D	N	N	N	N	N	ABF	ADF	CD	B
2.																				AF		BCD	

#:64 Sex:M Age:16 Education:11

Q-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1.	A	N	N	Y	N	N	A	A	A	A	N	D	D	D	N	N	N	N	Y	ABDF	BEF	ABCD	A
2.																							