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Solar energy curriculum study in Industrial Education

David Alonzo Cain
Iowa State University

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Solar energy curriculum study in
Industrial Education

by

David Alonzo Cain

A Thesis Submitted to the
Graduate Faculty in Partial Fulfillment of the
Requirements for the Degree of
MASTER OF SCIENCE

Department: Industrial Education
Major: Industrial Education (Industrial Vocation-Technical Education)

Iowa State University
Ames, Iowa
1980

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CHAPTER I. INTRODUCTION

Solar Energy. More and more these words are becoming a part of America's vocabulary. The continuing energy and environmental problems confronting the United States have been the primary catalyst to an increasing interest in energy from the sun. Its use for residential heating, cooling and domestic hot water heating has the potential for immediate benefits in energy savings and environmental improvements. With solar technology, it is feasible to make widespread use of solar energy for space and water heating right now. Financially, it's a matter of trade-offs again, first cost versus long-term operating cost over the life of the building. The sun is free, but until the necessary equipment for tapping and utilizing its energy can be mass-produced, its cost may increase the price of the average house by several thousand dollars. On the other hand, savings on heating and cooling bills could offset the initial cost in a few years.

For solar and other renewable sources systems to be economically feasible, a whole range of conservation measures must be taken in the design of buildings. Technically, solar technology and solar systems will become more reliable and cost effective. Increased public and private support for solar research and development will lead to breakthroughs in materials, designs, systems and instructional media for society. A better scientific and technical understanding of
the phenomenon of solar radiation conversion to thermal energy will improve man, society and its efforts.

Solar technology will be expanding rapidly in the next decade and will require knowledge and skilled employees to design, manufacture, install and maintain solar systems. Educational institutions must introduce solar technology and curriculum programs to take the lead and responsibility in providing adequate instruction within this area of need. Current data show that three types of students tend to be interested in solar skills: (1) those wanting to become entry-level solar workers, (2) those wanting some solar skills to complement their major technology, and (3) current employees in the community wanting practical solar skills for present or anticipated professional needs. A number of national and state studies assess the demand for solar personnel and identify the essential skills required for technicians and craftsmen. The educational system should identify and respond to the growth potential regarding energy education and solar curriculum instruction. Difference in opinion and philosophy exists regarding the level at which solar energy education should be introduced at this point in time. There are two schools of thought on this: (1) introducing solar education at the highest level of the educational system (university and colleges) and having it filter itself down, and (2) introducing energy education at the lowest possible grade level (k-12) and letting its interest filter upward. Little effort
both nationally and statewide has been expended to develop uniform curricular materials specifically adapted to various grade levels.

It is the author's opinion in this research that:
(1) solar energy education (solar curriculum) should be developed under the departments of industrial education at universities and colleges nationwide, and (2) that these solar energy curriculums and inservice activities be integrated into teacher preparation/teacher certification programs. The author further hopes that this research and information will prove helpful to curriculum planners at other educational institutions wanting to enrich their technology program with a solar curriculum.

Problem Statement

There is a need to investigate the informational needs and interest in solar energy concepts and knowledge of industrial education teachers within the state of Iowa.

Purpose of the Study

The purposes of the study are to provide those who plan and develop industrial education curriculum and inservice activities with the following:

1. Rationale behind the investigation and development of solar energy curriculum and inservice activities.
2. A proposed curriculum model for solar energy.
3. A comprehensive solar energy inservice education course outline.

Need for the Study

In President Carter's recent visit to Des Moines, Iowa, in May 1979, he noted Iowa State University solar energy research programs. Carter acknowledged Iowa State as one of the leaders in the field of solar energy research for grain drying, and encouraged increased research into alternate energy sources to make the United States less reliant on foreign oil.

Solar energy, in all of its essential forms, is now technically possible and economically sound. The only thing that stands in the way of its use is a stroke of a pen.... It's not a technical problem.... It's not an economic problem.... It is a political problem (Commoner, cited by Wicker, 1979).

Dr. Barry Commoner (Wicker, 1979) of Washington University recently argued his case for solar support in a speech in Los Angeles. To oversimplify Commoner's detailed case, which also appears in two issues of The New Yorker, he argues first that steady depletion of world oil supplies will soon make fuel and oil products too expensive for ordinary use and, second, that the declining supplies of uranium as well as additional reactor safety requirements will price conventional nuclear energy out of the electricity market. That leaves
solar energy, and Commoner outlines in great detail several proposals for its quick, relatively inexpensive development.

In a new area such as solar it is required that a local advisory board be used as well as existing regional experts to assist in preparing instructors and preparing courses (Irwin, in Doggett, 1976).

Donald Irwin (Doggett, 1976), Dean of Instruction, Southwestern Technical Institute, Sylva, North Carolina, discusses the necessity for colleges to explore all opportunities to identify and prepare solar energy instructors within teacher education programs.

The identification of the instructor should be approached cautiously. Being qualified to teach in an allied field is not enough. Potential instructors need initially to be interested in solar energy and motivated sufficiently to pursue self-study and self-generating activities to become proficient in a bootstrap educational effort (Dugger, in Doggett, 1976).

Navarro Community College, Corsicana, Texas, as explained by consultant Roy Dugger (Doggett, 1976), has held planning discussions with a regional advisory committee over the past a year to focus on the question, "Is there a need for a vocational training program in solar energy?" The advisory committee was composed of colleges from four states' building trades associations and local solar industries which determined and published a report affirming the need. (Note: Navarro has recently been funded by ERDA to develop curriculum materials for solar programs.)

William Aldridge (Doggett, 1976), on appointment to the National Science Foundation from Florissant Valley Community College
in Missouri, expressed the concern as a college faculty member that "lead time" is necessary to develop new curricula and programs to be implemented.

The issue of solar energy technicians frequently is answered with "we already prepare people with those competencies." There are no new laws, theories or principles involved. The same thing was said in the 1920's about electronic technicians, but they are readily accepted today.

A new curriculum will have to be developed to prepare people to install, service and diagnose difficulties in complete home and industry energy systems. The curriculum may be 80 percent similar to existing curriculum, but with enough significant differences to be called a solar energy technical curriculum (Aldridge, in Doggett, 1976).

James Schoenfelder (Doggett, 1976), an Iowa State University master's graduate in architecture who designed a solar curriculum for Scott Community College, Bettendorf, Iowa, to train solar technicians, states:

The focus of the program is to provide the solar technician with as broad a solar background as possible while emphasizing the heating and cooling area. It is a program which teaches both the fundamental theories of solar conversion and the practical construction and maintenance of these systems. The program is specific in that it identifies marketable operational systems. Yet, it is technical enough to allow for the inevitable progress and innovation in the fledging solar industry (Schoenfelder, in Doggett, 1976).

Assumptions of the Study

The following assumptions were made in the pursuit of the study:

1. That a solar energy curriculum and inservice activities should be developed and implemented in the
Industrial Education Department at Iowa State University.

2. That the proposed solar energy inservice education outline adequately provides data base knowledge for potential students and teachers enrolling.

3. That solar energy curriculum materials and information reflect current up-to-date knowledge.

4. That the utility, interest and need for solar energy concepts and knowledge will increase in demand in the general public.

5. That the survey and instrument employed and administered in the study, to assess the need, interest and knowledge for a solar energy curriculum and inservice activities, were valid as used.

Limitations of the Study

Generalizations of the results of this research study are limited by the following factors:

1. The study and survey only represent current Industrial Education teachers within the state of Iowa.

2. The solar energy survey/questionnaire items were developed for this study; consequently, the validity and reliability of the instrument has not been extensively tested.

3. Gathering data for this study was accomplished by the questionnaire method. Furthermore, it is limited
to the extent that the respondents provided honest answers and adequate information requested.

4. Response to the questionnaire is limited to one institution of higher education, therefore, cannot be generalized to other educational institutions.

5. The current state of knowledge in solar energy limits the content knowledge and the breadth of the information use throughout this study.

Hypotheses of the Study

Research Hypothesis I

It was hypothesized that the proportion of industrial education teachers within the state of Iowa indicating a need for inservice in solar energy education at Iowa State University does not exceed 20% of the population sampled. It was decided that the 20% proportion would represent the critical mass necessary to bring about substantial change in the energy cluster curriculum.

Statistical Hypothesis I

\[ H_0 : P = .20, \text{ i.e., the population proportion is equal to } .20 \ (20\%). \]

\[ H_a : P > .20, \text{ i.e., the population proportion exceeds } .20 \ (20\%). \]
Research Hypothesis II

It was hypothesized that the mean score for the total group of industrial education teachers sampled does not differ significantly from 14 or 70% on the solar energy measurement survey. It was felt that 70% of the items should be correctly answered by the industrial education teachers to meet minimum competency. The items used reflect current solar energy information available to the public. The items also represent a sample of possible items from a large population of information in regard to solar energy. The test items range from relatively simple to moderately difficult.

Statistical Hypothesis

\[ H_0 : U_1 - U_0 = 0 \], where \( U_0 = 14 \) or 70%

\[ H_a : U_1 - U_0 < 0 \]

Research Hypothesis III

It was hypothesized that the correlation between the level of education of the teachers and their scores on the solar energy measurement survey does not differ significantly from 0 beyond that expected by chance alone.

Statistical Hypothesis III

\[ H_0 : \rho = 0 \]

\[ H_a : \rho \neq 0 \]
Research Hypothesis IV

It was hypothesized that the correlation between the total number of years of teaching experience of the teachers and their scores on the solar energy measurement survey does not differ significantly from 0 beyond that expected by chance alone.

Statistical Hypothesis IV

$H_0 : \rho = 0$

$H_a : \rho \neq 0$

Research Hypothesis V

It was hypothesized that mean solar energy measurement survey scores of teachers classified into one of three teaching clusters would not differ significantly beyond that expected by chance alone.

Statistical Hypotheses V

$H_0 : U_1 = U_2 = U_3$

$H_a : U_1 \neq U_2 \neq U_3$

Procedure of the Study

The procedures pursued to complete the objectives of this study are illustrated in the Program Evaluation and Review Technique (PERT), Figure 1. Major activity blocks included are completion of:

A. ERIC search for review of literature.
Figure 1. PERT chart of major activities: Critical path of major nodes (network diagram)
B. Ascertaining books, magazines and articles for research study and review of literature.

C. Development of research parameters, purposes and hypotheses (committee approval).

D. Preparation of thesis Chapter I (Introduction).

E. Review and development of a solar energy curriculum model.

F. Development of solar energy inservice education course objectives and outline.

G. Preparation of thesis Chapter II (Review of Literature).

H. Solar energy education survey/instrument development, approval and duplication.

I. Preparation of thesis Chapter III (Methodology).

J. Random selection of population sample, and administration of instrument.

K. Response coding of data, development of computer program to analyze data.

L. Data analysis of results of instrument.

M. Preparation of thesis Chapter IV (Results and Findings) and Chapter V (Summary and Conclusions).

N. Defending thesis research and oral examination.

O. Preparation of research publication for submission to a refereed journal or magazine for publication.

Definition of Terms

The following terms of the study were defined:

**Curriculum:** Is considered to encompass the instructional activities planned and provided for students by the school or educational system. The curriculum, therefore, is a planned interaction of students with instructional content, instruc-
tional resources, and instructional processes for the attainment of educational objectives.

**Curriculum of solar study:** A program in which the student receives solar education while working on a related degree or diploma--doctorate, master's, bachelor's, associate; e.g., "Doctorate in Physics" with solar emphasis; "Bachelor's in Architecture" with solar design experience.

**Industrial arts:** Also known as industrial education; industrial arts as a curriculum area is defined as those phases of general education which deals with technology--its evolution, utilization, and significance, and with industry--its organization, materials, occupations, processes, and products, and with the problems and benefits resulting from the technological and industrial nature of society (Maley, 1973).

**Industrial education:** A generic term used to designate various types of education of an industrial nature--vocational industrial education, industrial areas, and technical education (Good, 1973).

**Industrial education teacher:** A teacher certified to teach industrial education courses, generally in the junior and senior high school. They are not normally required to have had industrial experience.

**Industrial technology:** A program of instruction designed to develop knowledge and understanding of scientific principles, mathematical concepts, and communicative and technical
skills, combined with appropriate laboratory experiences which will prepare the student to be supportive to the industrial engineer in production and planning. The subject matter emphasizes the design and installation of integrated systems of materials, machinery, equipment, and personnel.

**Innovative curriculum:** The manner in which school administrators and instructional supervisors encourage curricular innovation from individual teachers and groups of teachers by stimulating carefully planned experimentation in the use of new or unusual content, media, and methods of instruction.

**Inservice education:** Inservice education for the instructional staff includes systematized activities promoted, directed, or approved by a school system or school that contribute to the professional or occupational growth and competence of members of the instructional staff during the time of their service to the school system or school. Among these activities are workshops, demonstrations, school visits, courses for college credit, sabbatical leaves, and travel leaves.

**Instruction:** The activities dealing directly with the teaching of students and with improving the quality of teaching. Teaching is the major aspect of instruction, and may provided for students in a classroom or in another location. It may be provided by direct pupil-teacher interaction or through some other approved medium such as television, radio,
telephone, and correspondence.

**Solar course or solar-related course:** A lecture workshop, seminar, research project, laboratory, on-the-job training experience, or other educational experience where the solar content is equal to one-third or more of the total course contact hours.

**Solar curriculum:** A program in which the student receives a degree or diploma in a solar field—doctorate, master's, bachelor's, associate; e.g., "Master's in Solar Engineering", "Associate Degree in Solar Installation".

**Solar energy:** Solar energy, also known as solar radiation, reaches the earth in two ways: (1) by direct (parallel) rays, (2) and by diffuse (nonparallel) sky radiation, reflected from clouds and atmospheric dust. Solar radiation is measured in langley, a unit named after Samuel Langley who invented instruments for measuring solar radiation. One langley is radiation energy equivalent to one calorie falling on an area of one square centimeter. Solar radiation is electromagnetic radiation transmitted in wave lengths which vary from .29 microns to 3 microns in length (one micron equals one-thousandth of a millimeter).

**Solar technologies:** Regionized applications of solar heating, cooling and electrification, also wind biomass conversion, and ocean thermal energy conversion.

**Solar technical training** (nonacademic degree): A program in which the student receives a certificate for study in
solar energy or a solar-related field; e.g., solar technician.

**Teacher-educator:** A person in the field of education responsible for the preparation and inservice training of teachers and one who assists teachers or prospective teachers in securing the professional knowledge, ability, understanding, and appreciation which will enable them to meet certification requirements or to advance in teaching positions.

**Workshop:** An inservice education activity, with or without a set program, providing opportunity for teachers, supervisors, administrators and sometimes consultants to explore together various problems in curriculum and instruction. Frequently workshops include sessions for planning, working, summarizing and evaluating.
CHAPTER II. REVIEW OF LITERATURE

Curriculum Defined

The concept of curriculum is implicit even in the earliest educational prescriptions and programs of civilized societies. Aristotle (Jowett, 1921) was concerned with curriculum when he wrote, "As things are...mankind are by no means agreed about the things to be taught.... Again about the means there is no agreement..." (p. 641). Yet the actual term curriculum is a relatively modern term, dating from the nineteenth century, according to the Oxford English Dictionary, whereas the term pedagogy dates back to the early seventeenth century. Therefore, this may imply that curriculum has had a long past but a rather short history.

The United States Office of Education (1970), in Standard Terminology for Curriculum and Instruction in Local and State School System, defines curriculum as:

To encompass the instructional activities planned and provided for students by the school or educational system. The curriculum, therefore, is the planned interaction of students with instructional content, instructional resources, and instructional processes for the attainment of educational objectives.

Figure 2 illustrates these relationships. It shows the way in which:

- Educational objectives are derived from identified needs;
- An organizational arrangement is developed or utilized for achieving these objectives; and
Figure 2. Aspects of curriculum and instruction and their relationships
- Students are brought into the environment of this organizational arrangement (usually a school) where they interact with content, resources, and the processes of instruction.

Instruction (U.S. Office of Education, 1970) is defined as:

The activities dealing directly with the teaching of students and improving the quality of teaching. Teaching, the major aspect of instruction, may be provided for students in a classroom of a school or in another location; it may be provided by direct student-teacher interaction or through some other approved medium.

They summarized the meaning of the two terms curriculum and instruction by simply stating, "Curriculum is what is taught, and Instruction is how it is taught" (p. 3).

Tanner and Tanner (1980) regard curriculum as that reconstruction of knowledge and experience, systematically developed under the auspices of the school or university, to enable the learner to increase his or her control of knowledge and experience.

Wolansky (1978) reports that curriculum has been defined by many. Some educators prefer the content-centered curriculum, others the process-centered, still others the core-curriculum and most recently the student-centered curriculum.

Curriculum Development

Curriculum development is referred to by Wolansky (1978) as a functional organization which grows up from local problems and is fashioned to meet the needs. It may be that curriculum development occurs in response to fiscal support
(federal funding), shifting state or national priorities (career education), or occasionally theoretical proposals (Technology). Curriculum development may be defined as "those endeavors directed toward the development of new designs for guiding instructional practices."

Wolansky (1978) elaborated that curriculum development may involve a series of tasks areas which the supervisor undertakes to see that the programs of instruction meet the needs of the individual students in their localities.

Ralph W. Tyler (1949) published a syllabus entitled, Basic Principles of Curriculum and Instruction, for a course he was teaching at the University of Chicago. The syllabus was intended to represent "the rationale for viewing, analyzing and interpreting the curriculum and instructional program of an educational institution" (p. 1).

The rationale proposed by Tyler (1949) for analyzing and developing the curriculum beings with a mandate for seeking answers to the following four fundamental questions:

1. What educational purposes should the school seek to attain?
2. What educational experiences can be provided that are likely to attain these purposes?
3. How can these educational experiences be effectively organized?
4. How can we determine whether these purposes are being attained? (p. 1).

Tanner (1980) elaborates more precisely that, in essence, the Tyler questions represent the four-step sequence of (1) identifying objectives, (2) selecting the means for the
attainment of these objectives, (3) organizing these means, and (4) evaluating the outcomes.

Taba (1962) stressed the educators must approach curriculum design and improvement as a systematic process and she identified the following sequence of steps in the process: (1) diagnosis of needs, (2) formulation of objectives, (3) selection of content, (4) organization of content, (5) selection of learning experiences, (6) organization of learning experiences, and (7) determination of what to evaluate and of the ways and means of doing it.

As reported by Tanner and Tanner (1980), teachers are expected to be architects of core curricula although administrators fail to provide them with the needed materials, and teachers' education programs neglect to prepare them with the necessary skills, and inservice education does not make up the deficit. Although interest in curriculum reform has continued to rise, a number of teacher preparation programs that once required that prospective teachers study curriculum development no longer do so. The decline of curriculum development may also be attributed to the free-school movement of the late 60's and early 70's.

Foshay (1967) suggests that certainly an adequate education of teachers must include curriculum development (both theory and the work of curriculum development) if teaching is to be a profession and if educational opportunities for learners are really to be improved.
The importance of continuing integration and articulation of educational theory with practice following induction into teaching is recognized throughout the literature. Professional growth may be encouraged through follow-up, in-service and graduate study experiences (Ebel, 1969).

Parker (1971) notes a shift in locus and responsibility to the public school while increasing the linkage with other related programs is seen as two of the current major needs in teacher training. Emphasis on the career ladder under carefully coordinated administration, instruction and supervision in the field setting with maximal performance-based individualization of training and optimal use of group resources to integrate curriculum and research in interdisciplinary seminars briefly summarize this proposal.

Harris, Bessent, and McIntyre (1969) regard the laboratory approach as another possible pattern for inservice education. This strategy provides for involvement in stimulating realistic experiences with which individuals with diverse needs and interests can identify.

Borgealt's (1970) research indicates that teachers prefer inservice experiences in the following descending order: interclassroom visitation, individual inservice conferences with specialists, directed professional reading, county and state workshops, local workshops, and faculty meetings.
O'Hanlon (1967) reports that teachers consider higher education classes on a par with interclassroom visitation as to effectiveness of inservice experiences. Inservice, ideally, ought to be a collaborative sharing of ideas, separate from salary or tenure, and/or professional advancement, and offered by a third party separate from teachers or administrators. Teachers are most receptive to innovations and inservice experience which: (1) provide for variability in group size and time allotments, (2) are related to their immediate day-to-day instructional concerns, (3) involve teachers in leadership activities, (4) are evaluated in terms of their effectiveness, and (5) include teachers in the activity planning. He states that:

Inservice demonstrations do change teacher behavior. Teachers must be granted the "right to creative failure," however, as a means of insuring imaginative professional behavior (p. 45).

Howey and Joyce (1978) report that the inservice phase of teacher education has been diagnosed as "not in the best health."

Tanner and Tanner (1980) elaborate more by reporting that inservice education declined in the late 1970s along with the teacher's curriculum development role and is suffering from neglect. They further cite that from the standpoint of theory, inservice education is in surprisingly good condition; its unifying elements are the improvements of instruction and the teacher's growing professional
capability. However, they suggest that there is a wide gap between theory and practice.

In reference to industrial education teacher preparation, Betts (1974) studied teacher programs in 32 schools and found that 28 reorganized their curriculum into three cluster groups: (1) materials and processes, (2) graphic communications, and (3) energy and power.

Several other industrial education educators felt that the organization of technological knowledge should be organized into groups or clusters.

Wolansky and Duvall (1975) stated:

Exponential growth of technological knowledge suggests grouping (clustering) of common concepts or content elements, a defensible route to effective management of greater quantities of knowledge. Clustering also allows for better organization of information into coherent units (p. 60).

Solar Energy Curriculum

One major review of related literature to this study centers around the proceedings of the Energy Technology Training Conference (Doggett, 1976) held in Atlanta, Georgia, October 27-29, 1976. The conference was sponsored by such agencies as the American Association of Community and Junior Colleges, Energy Research and Development Administration (ERDA) in Washington, D.C., and the Oak Ridge Associated Universities, Tennessee. An exciting highlight of the conference was that Scott Community College, Bettendorf, Iowa,
and the Lennox Corporation of Marshalltown, Iowa, were the primary contributors to the solar technology workshop presented at this conference. Conference goals included: identifying projected technical manpower needs and skill mix requirements; identifying potential obstacles to developing an adequate technical education base; and stimulating education, industry and labor cooperation in technical program development and federal interagency coordination and cooperation. Findings of the conference indicated: national data rarely reflected local employment demands; proprietary concerns of employers restricted access to employment trend data; limited exchange of energy-related skill supply data was evident between colleges and universities; uniform energy occupational categories were lacking; high technology programs require equipment and facilities that were too costly for most colleges and universities; and industrial employers did not universally accept that colleges and universities produced quality employees. This conference document has helped the investigator to develop thoughts and research questions into a working model to pursue and investigate the demand, interest and need of a solar energy curriculum and inservice activities at the teacher education level.

Another related and significant study was done at Houston University, Texas, Clear Lake City Branch, entitled A Survey of Precollege Energy Education Curricula at the State Level by Robert M. Jones and John E. Steinbrink (1977).
Their study reported a high need level for developing national and statewide energy programs. This publication includes a survey and descriptions of selected state energy education curriculum materials. The survey represents one attempt at identifying baseline data which can be employed in the development of an energy education policy. Such data contain the potential to contribute to more effective teacher training programs and instructional materials. The basic tasks of the survey were to determine (1) if states had a systematic energy education program for their elementary and secondary schools and (2) if existing curriculum materials met national needs. Results from the study reveal that although only one-third of the states already have energy education programs, as of 1977, many states are developing programs. An instrument to evaluate energy education curriculum was developed and used by Jones and Steinbrink. A telephone survey was made of state science curriculum coordinators who did not reply to the mailed survey. The major recommendations made from the survey data included: (1) energy education materials tend to stress technical topics; (2) they often lack consistent core themes and an adequate conceptual framework; and (3) they provide little that is useful in developing an alternative energy ethic. The study cites the energy education curriculum programs of 20 selected states; however, the author chose to summarize only the results for the state of Iowa.
Iowa is one of the leaders in recognizing the threat of the energy crisis to the nation's schools. It is also one of the first states to develop a comprehensive energy-environment resource materials guide. This guide, entitled Energy Materials, was published during the 1973-74 school year by the Department of Public Instruction, Des Moines, Iowa. It contains detailed bibliographies, including audio-visual materials, a list of classroom activities for elementary, intermediate, and secondary levels, and a brief glossary of energy terms and definitions. Many states are currently developing similar guides after recognizing the seriousness of our energy problems.

In a recent journal article entitled, "Solar Energy Curriculum Project," Savarin (1979) presented a solar energy model. With the aid of a selected team of technical and curriculum experts, the three-week instructional unit entitled, "Solar Energy Application in Construction Industry," was developed and evaluated. Two instructors and four classes of eighth grade students in a World of Construction (WOC) course field-tested and evaluated the unit. The solar energy instructional unit was effective in transmitting information. Statistical analysis of the pre- and post-test scores showed significant improvement. The unit was also well-accepted by the instructors and students. Evaluations from all participants aided the researcher in making necessary revisions and recommendations.
In a dissertation research project entitled, "Solar Energy: A Source for Science," Emira (1964) states that solar radiation is the most important source of energy on the earth. The direct harnessing of solar radiation is of special importance to nations that do not have adequate supplies of conventional energy sources. To make use of solar energy it is necessary to understand the scientific principles upon which its utilization is based (p. 23).

The purpose of the study was to provide the science teacher with a source of basic information related to energy sources in general, and solar energy and its utilization in particular, and to suggest demonstrations, projects, and instructional materials that might be useful in the teaching in this area of science and technology. Emira constructed a sourcebook as part of the research project. The sourcebook consisted of five parts, as follows:

1. Energy sources on earth
2. Origin and nature of solar energy
3. Solar radiation as a man-controlled source of energy
4. The teaching of solar energy
5. Bibliography and appendixes

In a special report published by National Advisory Council on Vocational Education, in December 1977, entitled, "The Response of Vocational Education to the National Energy Crisis," the Council presented a rationale and recommendations for vocational education's response to the national energy crisis in light of the present involvement and future needs. The problem is stated in terms of the need
for training programs in the newer energy technologies, including those related to conservation. Federal policies are outlined, specifically the national energy goals for 1985. These are followed by a review of the status of energy technology development in four areas: solar energy, coal mining technology, nuclear energy, and other energy sources. For each area, implications for vocational education are noted.

In reference to implication for industrial education, Phipps (1977) states:

Some of the present industries will become nonexistent or will employ fewer workers. This will change the demand for certain types of vocational industrial courses. New industries will be started, or certain old industries will become more important and vocational industrial education will have to gear up to prepare workers for these industries.

For example, it appears that the recycling industries will become more important and will employ more workers. Vocational workers and technicians will need to be prepared for the recycling industries. It appears that vocational workers and technicians will need to be prepared in large numbers for the solar energy industry.

Industrial educators will need to make many decisions and changes in the years ahead as a result of the energy problem (p. 49).

A discussion of present energy-related vocational/technical curriculum development activity at both postsecondary and secondary levels includes results of a national survey of postsecondary institutions, programs and enrollment in eight energy-related technology fields. It is concluded that there is some awareness of the problem and general methods necessary to reduce it, but that the response of the vocational educa-
tion sector must be one of strong leadership in the total educational community. Six specific recommendations in this regard are addressed to the new Department of Energy, to state and local advisory committees in vocational education, and to the National Institute of Education. Focus in the recommendations is on inservice training in new energy and energy conservation technologies for vocational educational personnel and on curriculum development in these areas.

The Solar Energy Applications Laboratory, at Colorado State University, Ft. Collins, designed, developed and published a document report entitled, "Solar Heating and Cooling of Residential Buildings: Design of Systems" in October 1977. The effort was sponsored by the Department of Commerce, Washington, D.C. The document concerns itself with the development of a training course developed by the staff of the Solar Energy Applications Laboratory and vocational educational specialists at Colorado State University in cooperation with the NAHB Research Foundation, Inc., Rockville, Maryland. This is the second of two training courses designed to develop the capability of practitioners in the home building industry to design solar heating and cooling systems. The course is organized in 23 modules to separate selected topics and to facilitate learning. Although a compact schedule of one week, a variety of formats can be arranged. In general, the course progresses from simple sizing procedures for making preliminary estimates of
collector area requirements, to computer-aided methods, and finally to automated design techniques. Such details as systems economics, energy conservation trade-offs, and component selections are also presented.

Curriculum Guidelines for Energy and Power

Basmajian (1977), a curriculum member of the National Educational Council on Energy and Power whose members have developed a national curriculum model, explains that:

The energy-related social, economic and political upheavals in the U.S. and worldwide have added a new dimension and new responsibilities for educators. Certainly, the most important concern is preparing the students of today for the energy conditions that will exist tomorrow.

The Nation's energy demand for the future and the declining supply of fossil fuels indicate clearly a need for a new emphasis on alternate energy systems. Federal, Industrial or Research Agencies conducting an energy analysis all agree on one matter...the ultimate solution of U.S. energy shortages depends on the development of alternate energy sources. For this reason, education has to play an important role in the transition from traditional "power technology" programs that are essentially small engine programs into those inclusive of alternate energy sources.

The student needs to be able to relate new energy sources to devices that can produce power. Additionally, he must develop an awareness of the emerging occupations in this field. A well planned curriculum with the proper hardware and software will be the beginning of a transitional period of growth as the student develops new career awareness. It is imperative that a curriculum be structured modularly and with continuity. He must be able to follow the program through various levels and achieve the prescribed competency levels. No doubt an Energy and Power Curriculum model must offer the student an awareness, orientation, exploration and preparation sequence (p. 3).
Basmajiam (1977) states:

It is hoped that the following model can serve as a basis for the above objectives and assist educators and administrators in making their decisions as how best to serve the needs of the students and the nation (p. 3).

The energy flow chart (Figure 3) indicates:

The interrelationships which exist between energy sources, conversion devices, transmission, storage and controls. In order for the student to develop total energy awareness for energy and power, in a given area of a laboratory, he must be able to explore the various sources of energy and the corresponding conversion systems. Upon producing power, the student certainly must be aware of the various methods by which power is transmitted and stored.

Basmajiam (1977, p. 10) developed the following curriculum outline and guidelines for the solar energy area:

**SOLAR ENERGY SOURCES**

I. Solar Energy  
   A. Introduction to solar radiation as a direct source of energy  
      1. Geographic distribution of solar energy input  
      2. Solar flux at various parts of the day and night cycle  
   B. Safety in the laboratory  
   C. Solar-electric generator  
      1. Fundamental principles of operation and silicon solar cells  
      2. Components and subsystems of a solar-electric generator  
         a. Sources of energy  
            1. Natural - sun  
            2. Artificial - high density lamp  
         b. Energy conversion systems  
            1. Silicon solar cell array  
            2. Other crystals  
         c. System loads  
            1. Resistors  
            2. Batteries  
            3. Electro-mechanical  
      3. Power output, solar electric generators  
         a. How to measure the output power  
         b. How to vary the output power
Figure 3. Energy flow chart and their relationships
c. Relationship of output power and load
d. Relationship of output power and light density
e. Relationship of output power and distance from light source

4. Applications
5. Environmental aspects
6. Career Opportunities

D. Solar thermal system
1. Fundamental principles of operation of solar thermal systems
2. Components and subsystems of a solar-thermal system
   a. Energy conversion
      1. Solar collector
         (a) Types of collectors
         (b) Insulation
         (c) Paint selection
         (d) Glass covering
      2. Plumbing system
         (a) Pumps
         (b) Tubing-fittings
   3. Operation and controls
   4. Applications
   5. Environmental aspects
   6. Career opportunities

Future Curriculum: Solar Energy Education

President Carter has stated that with the exception of preventing war, energy is the greatest challenge that our country will face during our lifetime.

According to Gierke (1978), the major challenge to education for the future involves energy attitude modification and values direction: (1) Americans must adhere to the conservation ethic, which demands reduced consumption, preserved natural resources and greater efficiencies for our machines; (2) education must prepare students to intelligently select career choices within the spectrum of energy-related fields;
and (3) schools must confront the realities of the 21st Century and focus on the perspectives and attitudes crucial in ensuring our global survival.

Gierke (1978) states:

We must begin preparing students now for the energy world of tomorrow directing them through an interdisciplinary approach toward careers which will help the massive problem solving task ahead (p. 9).

Najarian (1978) strongly emphasized that it is essential that industrial educators at both secondary and postsecondary levels begin to prepare for an emerging solar energy technology and supporting industries and jobs. New curricula are needed at both levels of education. Incorporation of alternate energy concepts, techniques, and skills into existing programs and sources must be considered. Inservice training programs for administrators and instructors must be developed in cooperation with local representatives of solar energy systems designers, manufacturers, and installers.

Public Law 94-482 under Title II, Vocational Education, provides funding for energy education programs. It specifically mentions solar energy:

Funds available under section 120 may also be used to make grants to postsecondary institutions to carry out programs for the training of individuals needed for the installation of solar energy equipment, including training necessary for the installation of glass-paneled solar collectors and of wind generators, and for the installation of other related applications of solar energy.

Gierke (1978) suggests that industrial arts is rich with tradition and the realization that it is indeed an
intellectual discipline. As such, industrial arts has the responsibility for reorganizing the need for change. He further stresses that industrial arts is best prepared to institute the energy education of America's youth. Our laboratories already have the necessary space, equipment and tools to initiate meaningful activities, tests and experimentation.

Similarly, Berger (1977), from Florida State University, Tallahassee, on discussing solar energy technology for the classroom, states:

Solar energy technology is just beginning to emerge as the most practical alternative to our present energy and one that should be fully explored in every industrial arts lab (p. 32).

He further emphasizes that one such way might be by incorporating solar energy concepts into our regular shop activities, culminating in a useful "solar energy" project of some sort.

Berger (1977) concluded that by using the technical skills most industrial arts teachers possess and understanding a few solar energy concepts, it is a simple matter to design and build solar energy collectors as a part of your school shop activities. When finished, the panels could be mounted on the roof and connected into the hot water system of the school, or used for heating water in the industrial arts shop itself. Another classroom/laboratory application might be the production of detailed architectural drawings and the building of models of solar energy homes.
CHAPTER III. METHODS AND PROCEDURES

This chapter includes the discussions of the methods and procedures that were used to obtain and analyze the data for this study. This study was conducted at Iowa State University in the Department of Industrial Education and with the participation of industrial education teachers within the state of Iowa. The purpose of this study was designed to investigate the informational needs and interest in solar energy concepts and knowledge.

This chapter describes the following activities:

1. Questions of the study
2. Variables to be examined
3. Instrument development
4. Pilot testing
5. Population sampled
6. Administration procedures
7. Data analysis procedures
8. Statistical procedures

Questions of the Study

1. Is there a need to investigate the informational needs and interest in solar energy concepts of industrial education teachers within Iowa?
2. What is the current level of solar energy knowledge among current industrial education teachers in Iowa?
3. Is there a need to provide solar energy instruction in the energy and power cluster area to industrial education teachers at Iowa State University?

4. Does solar energy education seem to be a primary technology area for providing inservice instruction for industrial education teachers in Iowa?

Variables to be Examined

The following variables were examined in this study:

1. The examination of the need, interest and demand for the development of solar energy instruction offering from the Industrial Education Department at Iowa State University, specifically the examination of need for the inservice activities to benefit industrial education in Iowa.

2. The examination for the development of a solar energy curriculum including inservice activities for the infusion of solar energy instruction into existing industrial education power and energy cluster.

3. The examination of a comprehensive solar energy inservice education course outline.

4. The examination of curriculum guidelines for the potential development of solar energy.

5. The examination of available curriculum models, specifically those models related to solar energy which are available to the development of curriculum.

6. The examination and identification of solar energy
concepts and knowledge.

7. The examination of solar energy content: textbooks, films, tapes, slides, laboratory experiments, published research and other sources of solar information. Note: Content covers a large variety of media resources; therefore, the list is not inclusive.

8. The examination of existing energy and solar energy education offerings at Iowa State University.

Instrument Development

The instrument used for this study (see Appendix E), titled, Solar Energy Education Survey, was developed to obtain desired information concerning solar energy concepts and knowledge. The basic format and ideas of the instrument were developed from a national solar energy curriculum survey which was developed at the Solar Energy Research Institute, Golden, Colorado, under contract with the United States Department of Energy. The preliminary instrument underwent many changes. The final draft was reviewed and approved by the members of the graduate study committee. The instrument and description of the study also met the approval of the Human Subjects in Research Committee at Iowa State University.

This solar energy instrument consists of three major headings: (1) biographic information, (2) solar energy curriculum information, and (3) the solar energy measurement survey. There are a total of 40 items. The biographic data
consist of 10 general information questions, the solar energy curriculum information data consist of 10 specific questions related to curriculum, and the solar energy measurement survey consists of 20 test questions. The test questions are designed to measure current solar energy knowledge. Test questions were constructed utilizing 10 important current solar energy concept areas. Two questions were then derived from each of the concept areas.

The developed solar energy instrument was designed for ease in response, coding of the data, and quick reply. Utilization of the attached "left and right" answer column, which can be readily detached and returned to the researcher, enhanced the participation and resulted in high response.

The instrument format utilized the following three major headings and revealed the following information:

**Biographic information**

1. Current level of education
2. Total years of teaching experience
3. Teaching certification level
4. Population of community
5. Teacher preparation classification(s)
6. Learning experiences beyond formal education of credit and noncredit courses.
Solar energy curriculum information

1. Energy and power and solar energy classroom instruction credit hours
2. Solar energy resource materials
3. Method of instruction for gaining additional knowledge in solar energy education
4. Textbook development and subject classification for solar energy
5. Agencies responsible for development of solar energy curriculum materials
6. Individual use of solar energy curriculum materials
7. Solar energy inservice need (represented by a 9-point scale).

Solar energy measurement survey

Twenty test questions were developed from the following 10 current solar energy concept areas:

1. Solar energy history
2. Solar energy components
3. Solar hot air and water systems
4. Passive solar heating
5. Active solar heating
6. Solar cooling
7. Solar design concepts
8. Solar electric
9. Solar legislation (Iowa)
10. Hybrid and advanced solar energy systems.

Pilot Testing

To determine whether the instrument was appropriate for administering and data collection, a pilot test was conducted. The pilot sample consisted of two groups: (1) 31 industrial education (IEd 110) undergraduates of Iowa State University and (2) 25 randomly selected industrial education teachers within the state of Iowa.

The industrial education undergraduate pilot test information was used for questionnaire item revision consideration and trial-run data for the statistical package program and to construct a reliability coefficient. The industrial education teacher information was also used for questionnaire item revision consideration and for reporting the solar energy measurement test item analysis statistics. As reported:

Number taking test = 25
Group mean = 9.87
Variance = 8.70
Standard deviation = 2.94
Average test score = 49%
Standard error of measurement = 3.01
Kuder-Richardson reliability estimate = .675
Population Sampled

The population of this study consisted of industrial education teachers in both junior and senior high school. The population was limited to the state of Iowa.

The sample size consisted of 150 teachers. The sample was randomly selected by the Department of Public Instruction (DPI), Des Moines, Iowa, using a computer random table generator. With the total population of industrial education teachers in Iowa being approximately 1,130 (1979-80), it was determined to select every 9th school district. School districts were listed alphabetically.

Administration Procedures

The solar energy education survey was administered by mail. Each randomly selected respondent was sent (1) a cover letter, (2) the 40-item solar energy education instrument, including answer column, and (3) a self-addressed envelope. The 150 instruments mailed were coded by number. Those individuals who did not respond at the end of two weeks were sent a 3 x 5 card reminding them to respond. It was decided to use only those instruments which were fully completed, and to eliminate those which were partially completed. Participants and their responses to the mailed instrument were held confidential.
Data Analysis Procedure

Several meetings were conducted with Dr. Rex Thomas of the Iowa State University Computer Science Department to discuss and develop the data analysis procedures. The data collected by the survey instrument were coded and punched on IBM cards. That information was then machine-read and transferred to a magnetic tape. The data were than analyzed by computer utilizing the Statistical Package for the Social Sciences program (SPSS) (Nie, Hull, Jenkins, Steinbrenner, and Bent, 1978). The IBM-Itel facilities of the computing service located at Iowa State University were utilized in this research. The following computations were made by the computer for analysis of each question and hypothesis of the study:

1. The "student" $t$-test was utilized to test the hypothesis that the population proportion of industrial education teachers marking a 1 or higher indicating a need for inservice solar energy education does not exceed 20% of the population sampled. The formula for the $t$-test (McNemar, 1969) used in the analysis of this data is as follows:

$$t = \frac{P_{obs} - .20}{\sqrt{\frac{P_{obs} (1-P_{obs})}{N - 1}}}$$
where:

\[ t = \text{the value by which the statistical significance of the mean difference will be judged} \]

\[ P_{\text{obs}} = \text{observed sample proportion of subjects selecting a value of 1 or higher} \]

\[ .20 = \text{hypothesized proportion} \]

\[ N - 1 = \text{degrees of freedom for the } t\text{-test.} \]

2. The "student" \( t \)-test was again used to test the hypothesis that the mean score on the solar energy measurement survey of the total group of industrial education teachers sampled does not differ significantly from 14 or 70%. The formula for the \( t \)-test used in this analysis of data is as follows:

\[ t = \frac{\bar{X} - 14}{\sqrt{\frac{S_{X}^2}{N - 1}}} \]

where:

\[ t = \text{the value by which the statistical significance of the mean difference will be judged} \]

\[ S_{X}^2 = \text{variance} \]

\[ \bar{X} = \text{mean} \]

\[ N - 1 = \text{degrees of freedom for } t\text{-test.} \]

3. The Pearson product-moment correlation coefficient was utilized to assess the degree of relationship among continuous variables. The variables included
were the level of education and test score on the solar energy measurement survey. The departure of the correlation obtained from 0 was tested by means of the "student" \( t \)-test:

\[
\begin{align*}
t &= \frac{r}{\sqrt{\frac{1 - r^2}{N - 2}}} \\
\end{align*}
\]

where:

- \( r \) = the Pearson product-moment correlation
correlation
- \( t \) = sample test statistics
- \( N - 2 \) = degrees of freedom for the \( t \)-test.

4. The Pearson product-moment correlation coefficient was utilized to assess the degree of relationship between the number of years of teaching experience and the test score on the solar energy measurement survey. The departure of the obtained correlation from 0 was tested by means of the "student" \( t \)-test used above.

5. The analysis of variance (single-classification) was utilized to test the significance of differences among the mean test scores obtained by teachers classified in each of the three teaching clusters in industrial education. The F statistic with 2 and 99 degrees of freedom was used at the .05 confidence level of significance. The F statistic was obtained
by the standard formula shown in Figure 4 (Popham and Sirotnik, 1973, p. 168-170).

6. Additional descriptive statistics were obtained from the instrument; these include (a) frequency of responses to categories of each item, and (b) means and standard deviations of continuous items.

Statistical Procedures

Since the hypotheses have already been stated in Chapter I, this section will begin with the manner in which the statistical tests were determined. The following statistical procedures were followed and utilized to answer the research questions in this study:

1. The research hypotheses were determined and written.
2. The statistical research and null hypotheses were written from the research hypotheses statement.
3. The significance levels for rejecting the null hypotheses were determined.
4. The statistical tests were computed for each hypothesis.
5. The hypotheses were either rejected or failed to be rejected on the basis of the probability level supported by each statistical test.

Note: The convention of using the .05 and .01 levels of
<table>
<thead>
<tr>
<th>Source of variation</th>
<th>Degrees of freedom</th>
<th>Sum of squares</th>
<th>Mean square</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between treatments</td>
<td>G-1</td>
<td>[SS_G = \sum_{j=1}^{G} \left( \frac{n_j}{G} \right) \left( \sum_{i=1}^{n_j} X_{ij} \right)^2 - \frac{1}{N} \sum_{j=1}^{G} \sum_{i=1}^{n_j} X_{ij} \right)^2 ]</td>
<td>[MS_G = \frac{SS_G}{G-1} ]</td>
</tr>
<tr>
<td>Within treatments</td>
<td>[G \sum_{j=1}^{N} (n_j-1) ]</td>
<td>[SS_w = SS_{total} - SS_G ]</td>
<td>[MS_w = \frac{SS_w}{G \sum_{j=1}^{N} (n_j-1)} ]</td>
</tr>
<tr>
<td>Total treatments</td>
<td>[SS_{total} = \sum_{j=1}^{G} \sum_{i=1}^{n_j} X_{ij}^2 - \frac{1}{N} \sum_{j=1}^{G} \sum_{i=1}^{n_j} X_{ij} \right)^2 ]</td>
<td>[ ]</td>
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Where:  
- \(G\) = no. of groups  
- \(n_j\) = no. of observations within group  
- \(N\) = total no. of observations  
- \(X_{ij}\) = the \(i\)th observed score in the \(j\)th group

Figure 4. Computational procedures for the one-way analysis of variance
significance was utilized in determining the significance of all statistical results obtained by computer calculations. The symbol (*) was used in the tables provided in the following chapter to designate statistical findings that were significant at the .05 level, while the symbol (**) was used for higher significant statistical findings at the .01 level.
CHAPTER IV. FINDINGS

The results of the analysis of the data collected for this investigation are presented in this chapter. The primary purpose of this study, as stated in Chapter I, was to determine the informational needs and interest in solar energy concepts and knowledge expressed by industrial education teachers within the state of Iowa. The questionnaire was completed by 135 individuals; however, 100 of the most complete surveys were used. Table 1 illustrates the number of completed questionnaires received from the industrial education teachers and included in this study.

Table 1. Number of questionnaires returned by the industrial education teachers and used for the study

<table>
<thead>
<tr>
<th>Item</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Returned questionnaires</td>
<td>135</td>
</tr>
<tr>
<td>Completed questionnaires used in the study</td>
<td>100</td>
</tr>
</tbody>
</table>

This chapter utilized the following procedures and describes the following activities:

1. Responses and findings of industrial education teachers to Part I, the biographic information, of the survey instrument.

2. Responses and findings of industrial education
teachers to Part II, the solar energy curriculum information, of the survey instrument.

3. Findings of the group on the solar energy measurement survey.

4. Hypotheses and findings of the study.

Responses and Findings of Industrial Education Teachers to Part I

On Part I of the questionnaire the industrial education teachers were asked to respond to general questions dealing with biographic and educational background information. The teachers were asked to indicate their current highest level of education, total number of years of teaching experience, and their teaching certification level. Table 2 depicts the responses of the industrial education teachers to the categories of highest level of formal education. Table 3 expresses the responses of the industrial education teacher to the categories of total number of years of teaching experience including the present year. Likewise, Table 4 represents the responses of the teachers to the categories of teaching certification the industrial education teachers have achieved.

The industrial education teachers were asked to rank order the top three grade levels and number of students enrolled in the class they taught. This information is contained in Table 5.

Table 6 illustrates the calculated group mean of the
Table 2. Current highest level of education of industrial education teachers within Iowa

<table>
<thead>
<tr>
<th>Level of education</th>
<th>Number (N=100)</th>
<th>Relative frequency (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than Bachelor's</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Bachelor's, Art/Science</td>
<td>65</td>
<td>65</td>
</tr>
<tr>
<td>Master's, Art/Science</td>
<td>32</td>
<td>32</td>
</tr>
<tr>
<td>Doctorate</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Certificate</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Other (specify)</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 3. Total number of years of teaching experience including the present year for industrial education teachers within Iowa

<table>
<thead>
<tr>
<th>Total years of teaching experience</th>
<th>Number (N=100)</th>
<th>Relative frequency (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No response</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>0 - 2 years</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>3 - 7 years</td>
<td>22</td>
<td>22</td>
</tr>
<tr>
<td>8 - 12 years</td>
<td>26</td>
<td>26</td>
</tr>
<tr>
<td>12 years and over</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>
Table 4. Certification level of teaching

<table>
<thead>
<tr>
<th>Certification grade level(s)</th>
<th>Number (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>K - 6</td>
<td>0</td>
</tr>
<tr>
<td>K - 12</td>
<td>38</td>
</tr>
<tr>
<td>6 - 8</td>
<td>15</td>
</tr>
<tr>
<td>9 - 12</td>
<td>58</td>
</tr>
<tr>
<td>Other (specify)</td>
<td>2</td>
</tr>
</tbody>
</table>

Table 5. Rank order of top three grade levels and number of students enrolled

<table>
<thead>
<tr>
<th>Grade levels</th>
<th>1st ranking</th>
<th>2nd ranking</th>
<th>3rd ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>Number</td>
<td>Number</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>6</td>
<td>1</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td>15</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>8</td>
<td>7</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>9</td>
<td>20</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>10</td>
<td>28</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>11</td>
<td>6</td>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td>12</td>
<td>23</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>Totals</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>
Table 6. Estimated population size of teaching community data

<table>
<thead>
<tr>
<th>Statistics</th>
<th>Results (N=100)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group mean ($\bar{X}$)</td>
<td>24,820</td>
</tr>
<tr>
<td>Standard deviation (S.D.)</td>
<td>45,972.18</td>
</tr>
<tr>
<td>Median</td>
<td>5,480</td>
</tr>
<tr>
<td>Skewness</td>
<td>3.400</td>
</tr>
<tr>
<td>Range</td>
<td>150 - 250,000</td>
</tr>
</tbody>
</table>

estimated population size of the community/town in which the industrial education teachers taught.

Table 7 expresses the industrial education subject classification that teachers have been prepared to teach as compared to Table 8 which expresses the industrial education subject classification that industrial education teachers were predominantly teaching. The subject classifications were categorized into three major industrial education teaching clusters:

1. Graphic communication
2. Energy and power

Additionally, the industrial education teachers were asked to indicate their responses to questions dealing with credit hours of formal education beyond the bachelor's degree in the following areas:
Table 7. Subject classification of teaching preparation area

<table>
<thead>
<tr>
<th>Preparation area</th>
<th>Number and percent&lt;sup&gt;a&lt;/sup&gt; (N=100)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Graphic communication/arts</td>
<td>35</td>
</tr>
<tr>
<td>2. Energy and power</td>
<td>47</td>
</tr>
<tr>
<td>3. Material and processes</td>
<td>75</td>
</tr>
<tr>
<td>a. Manufacturing and production</td>
<td>39</td>
</tr>
<tr>
<td>b. Construction</td>
<td>26</td>
</tr>
</tbody>
</table>

<sup>a</sup>Totals are greater than 100. Respondents had the opportunity to check more than one choice; therefore, 100% cannot be expected.

Table 8. Subject classification area predominantly teaching

<table>
<thead>
<tr>
<th>Predominantly teaching area</th>
<th>Number and percent&lt;sup&gt;a&lt;/sup&gt; (N=100)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Graphic communication/arts</td>
<td>18</td>
</tr>
<tr>
<td>2. Energy and power</td>
<td>40</td>
</tr>
<tr>
<td>3. Material and processes</td>
<td>58</td>
</tr>
<tr>
<td>a. Manufacturing and production</td>
<td>28</td>
</tr>
<tr>
<td>b. Construction</td>
<td>16</td>
</tr>
</tbody>
</table>

<sup>a</sup>See footnote for Table 7.
1. Energy and power
2. Energy conservation
3. Solar energy

All credit hours were converted to semester hours. Table 9 shows the responses of the industrial education teachers to these questions.

Responses and Findings of Industrial Education Teachers to Part II, Solar Energy Curriculum Information

Part 2 of the survey instrument gathered information concerning specific solar energy curriculum information. The industrial education teachers were asked to respond to ten questions dealing with the affective domain of solar energy curriculum construction. For the most part, the results are interesting and positive.

The industrial education teachers were asked to respond to two very similar questions: (1) the estimated number of total classroom hours devoted (per year) to teaching energy and power and solar energy concepts and (2) how many hours should be devoted (per year) to teaching energy and power and solar energy concepts. Tables 10 and 11 present the responses for the two questions. Included are the means, standard deviations, variances, range and sums. A mean of 51.9 hours of classroom instruction was currently devoted to energy and power concepts per year compared to a slight increase in the mean of 55.8 hours of classroom instruction that should be
Table 9. Credit hours (semester) beyond bachelor's degree

<table>
<thead>
<tr>
<th>Energy and power (semester hours)</th>
<th>Number</th>
<th>Energy conservation (semester hours)</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>25</td>
<td>0</td>
<td>99</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>10</td>
<td>Mean ((\bar{X})) 0.030</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>9</td>
<td>Standard deviation 0.30</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>2</td>
<td>0</td>
<td>98</td>
</tr>
<tr>
<td>14</td>
<td>2</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>15</td>
<td>2</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>18</td>
<td>3</td>
<td>Mean ((\bar{X})) 0.050</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>2</td>
<td>Standard deviation 0.359</td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean ((\bar{X}))   7.130</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standard deviation 7.874</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

devoted to teaching energy and power concept hours per year. A mean of 3.24 hours of classroom instruction was being devoted for solar energy concept per year compared to a significant increase in the mean of 22.59 hours of classroom instruction that should be devoted to the teaching of solar energy concepts per year.
Table 10. Actual and estimated number of classroom instruction hours devoted to teaching energy and power concepts

<table>
<thead>
<tr>
<th>Energy and power (hours per year)</th>
<th>Mean</th>
<th>Standard deviation</th>
<th>Variance</th>
<th>Range</th>
<th>Sum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actual (what is taught)</td>
<td>51.93</td>
<td>83.053</td>
<td>6897.743</td>
<td>400</td>
<td>5193</td>
</tr>
<tr>
<td>Estimated (what should be taught)</td>
<td>55.84</td>
<td>96.110</td>
<td>9237.045</td>
<td>700</td>
<td>5584</td>
</tr>
</tbody>
</table>

Table 11. Actual and estimated number of classroom instruction hours devoted to teaching solar energy concepts

<table>
<thead>
<tr>
<th>Solar energy (hours per year)</th>
<th>Mean</th>
<th>Standard deviation</th>
<th>Variance</th>
<th>Range</th>
<th>Sum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actual (what is taught)</td>
<td>3.24</td>
<td>6.138</td>
<td>37.68</td>
<td>40</td>
<td>324</td>
</tr>
<tr>
<td>Estimated (what should be taught)</td>
<td>22.59</td>
<td>27.652</td>
<td>764.65</td>
<td>180</td>
<td>2259</td>
</tr>
</tbody>
</table>
Table 12 indicates the responses of the industrial education teachers to the question of the resources which they have used to obtain information concerning solar energy concepts. The question further asked teachers to rank order the resource found to be most helpful; teachers could have checked all or none of the six categories. A total of 39% of the teachers ranked popular magazines as the number one resource used to obtain solar energy information and a total of 28% of the teachers ranked higher education institutions as their second choice of resource used to obtain solar energy information. The table further illustrates the other percentages.

The industrial education teachers were asked to indicate, of the four categories listed, which was their preferred method for increasing knowledge about solar energy. Table 13 pictures the responses to this question. The response of inservice workshops was chosen by 70% of the industrial education teachers, while the next highest response was extension courses for college credit with 49%.

Table 14 includes the responses of industrial education teachers to the question asking which method of instruction would be preferred if the teachers were to gain additional solar energy instruction. A total of 54% of the industrial education teachers preferred the workshop/extension courses, while 48% preferred the lecture/laboratory method and only 13% indicated the lecture/discussion method.

The responses of the industrial education teachers to the
<table>
<thead>
<tr>
<th>Ranking in order of choice</th>
<th>Textbooks</th>
<th>Popular magazines</th>
<th>Department of energy</th>
<th>Higher education institutions (colleges &amp; universities)</th>
<th>Commercial manufacturers and advertisements</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 (no response)</td>
<td>25</td>
<td>14</td>
<td>37</td>
<td>20</td>
<td>35</td>
<td>95</td>
</tr>
<tr>
<td>1st</td>
<td>19</td>
<td>39</td>
<td>5</td>
<td>28</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>2nd</td>
<td>22</td>
<td>25</td>
<td>18</td>
<td>14</td>
<td>11</td>
<td>1</td>
</tr>
<tr>
<td>3rd</td>
<td>15</td>
<td>11</td>
<td>18</td>
<td>17</td>
<td>21</td>
<td>1</td>
</tr>
<tr>
<td>4th</td>
<td>13</td>
<td>8</td>
<td>15</td>
<td>14</td>
<td>17</td>
<td>1</td>
</tr>
<tr>
<td>5th</td>
<td>6</td>
<td>3</td>
<td>7</td>
<td>7</td>
<td>17</td>
<td>1</td>
</tr>
<tr>
<td>Total responding</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>
Table 13. Preferred method for increasing knowledge about solar energy

<table>
<thead>
<tr>
<th>Preferred method for increasing knowledge</th>
<th>Number and percent responding</th>
<th>No response</th>
<th>Total (N=100)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extension courses for college credit</td>
<td>49</td>
<td>51</td>
<td>100</td>
</tr>
<tr>
<td>Inservice workshops</td>
<td>70</td>
<td>30</td>
<td>100</td>
</tr>
<tr>
<td>Media materials (books, films, pamphlets etc.)</td>
<td>47</td>
<td>53</td>
<td>100</td>
</tr>
<tr>
<td>Advertising materials and other media materials</td>
<td>24</td>
<td>76</td>
<td>100</td>
</tr>
<tr>
<td>Other</td>
<td>5</td>
<td>95</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 14. Preferred method of instruction to gain additional instruction in solar energy education

<table>
<thead>
<tr>
<th>Method of instruction</th>
<th>Number and percent responding</th>
<th>No response</th>
<th>Total (N=100)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lecture/discussion</td>
<td>13</td>
<td>87</td>
<td>100</td>
</tr>
<tr>
<td>Lecture/laboratory</td>
<td>40</td>
<td>52</td>
<td>100</td>
</tr>
<tr>
<td>Workshops/extension</td>
<td>54</td>
<td>46</td>
<td>100</td>
</tr>
<tr>
<td>Research/independent study</td>
<td>23</td>
<td>77</td>
<td>100</td>
</tr>
<tr>
<td>Other</td>
<td>2</td>
<td>98</td>
<td>100</td>
</tr>
</tbody>
</table>
question relating to which of the seven subject areas would they prefer that solar energy concepts units be developed in textbooks are depicted in Table 15. A total of 90% of the industrial education teachers selected the industrial education area, while 72% responded in the science area. The agriculture area was next with 43%, followed by 26% in the home economics area. Math and social studies were respectively 12% and 8%.

Table 15. Preferred subject areas of solar energy concepts units developed in textbooks

<table>
<thead>
<tr>
<th>Subject area</th>
<th>Number and percent responding</th>
<th>No response</th>
<th>Total (N=100)</th>
</tr>
</thead>
<tbody>
<tr>
<td>English</td>
<td>2</td>
<td>98</td>
<td>100</td>
</tr>
<tr>
<td>Math</td>
<td>12</td>
<td>88</td>
<td>100</td>
</tr>
<tr>
<td>Sciences</td>
<td>72</td>
<td>28</td>
<td>100</td>
</tr>
<tr>
<td>Social studies</td>
<td>8</td>
<td>92</td>
<td>100</td>
</tr>
<tr>
<td>Industrial education</td>
<td>90</td>
<td>10</td>
<td>100</td>
</tr>
<tr>
<td>Agriculture</td>
<td>43</td>
<td>57</td>
<td>100</td>
</tr>
<tr>
<td>Home economics</td>
<td>26</td>
<td>74</td>
<td>100</td>
</tr>
<tr>
<td>Other</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>
Table 16 reveals the responses of the industrial education teachers to the question about the level(s) at which solar energy education should be taught. The high school level received a response of 99%, followed by the college undergraduate category with 93%. Other responses included 83% selecting the junior high school level, followed by the college graduate level with 74%, and 53% responding that solar energy should be taught at the elementary level.

Table 16. Level(s) of education at which solar energy should be introduced and taught

<table>
<thead>
<tr>
<th>Level of education for solar energy education</th>
<th>Number and percent responding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elementary</td>
<td>53</td>
</tr>
<tr>
<td>Junior high school (6-8)</td>
<td>83</td>
</tr>
<tr>
<td>High school (9-12)</td>
<td>99</td>
</tr>
<tr>
<td>College undergraduate</td>
<td>93</td>
</tr>
<tr>
<td>College graduate</td>
<td>74</td>
</tr>
<tr>
<td>Other (specify)</td>
<td>9</td>
</tr>
<tr>
<td>Total</td>
<td></td>
</tr>
</tbody>
</table>

The industrial education teachers were asked the question of which of the following six agencies should be most responsible for developing solar energy curriculum materials
for instruction. Table 17 illustrates the responses and results. A total of 47% responded to colleges and universities/faculty while industry received 42% followed by state department curriculum specialists and public schools/teacher receiving 35% and 34% of the responses, respectively.

Table 17. Agencies that should be responsible for developing solar energy curriculum materials for instruction

<table>
<thead>
<tr>
<th>Agency</th>
<th>Number</th>
<th>Relative frequency (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public school and teachers</td>
<td>34</td>
<td>34</td>
</tr>
<tr>
<td>Private enterprises</td>
<td>29</td>
<td>29</td>
</tr>
<tr>
<td>Industry</td>
<td>42</td>
<td>42</td>
</tr>
<tr>
<td>State department curriculum specialists</td>
<td>35</td>
<td>35</td>
</tr>
<tr>
<td>Colleges and universities/faculty</td>
<td>47</td>
<td>47</td>
</tr>
<tr>
<td>Federal/state energy agencies</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>Other</td>
<td>3</td>
<td>30</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>230</td>
<td></td>
</tr>
</tbody>
</table>

*Totals are greater than 100. Respondents had the opportunity to check more than one choice; therefore, 100% cannot be expected.*
Table 18 indicates the responses of the industrial education teachers to the question asking if they have adopted curriculum materials from the sources listed above. Ninety-three percent indicated that they had not adopted curriculum materials, while only 7% stated that they had adopted curriculum materials.

Table 18. Have you adopted curriculum materials from sources other than those listed above?

<table>
<thead>
<tr>
<th>Adopted curriculum materials</th>
<th>Number</th>
<th>Relative frequency (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>93</td>
<td>93</td>
</tr>
<tr>
<td>Yes</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 19 reveals the responses of the industrial education teachers to the last question of whether the teachers considered solar energy to be a primary technology area for inservice needs for industrial education teachers. The nine point scale (-4 - +4) was utilized for representing their responses. All selected responses ranged from 0 to +4. The zero response received 2%, while the +1 received 7%, the +2 and +3 both received 27%, and 37% were included in the +4 category. The calculated mean was 2.9, the median was 3.019
Table 19. The responses of the industrial education teachers to whether they considered solar energy to be a primary technology area for inservice needs

<table>
<thead>
<tr>
<th>Inservice value number</th>
<th>Number</th>
<th>Relative frequency (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not needed</td>
<td>-4</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>-3</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>-2</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>-1</td>
<td>0</td>
</tr>
<tr>
<td>Neutral</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>+1</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>+2</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td>+3</td>
<td>27</td>
</tr>
<tr>
<td>Highly needed</td>
<td>+4</td>
<td>37</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>100</td>
</tr>
</tbody>
</table>

Mean = 2.90  
Mode = 4.0  
Median = 3.019  
Standard deviation = 1.049  
Standard error of measurement = 0.105

and mode was 4.0. The calculated standard deviation was 1.049.
Hypotheses and Findings of the Study

The format to report the findings of this section of the study includes a restatement of each hypothesis, followed by displaying the tables for the statistical test for each hypothesis containing significant differences, and to discuss and explain the findings.

Findings of the Group on the Solar Energy Survey

Table 20 illustrates item analysis for each test question on the solar energy measurement survey. A total of 100 industrial education teachers made up the number of observed cases. Table 21 presents additional descriptive statistics. The total group mean ($\bar{X}$) was 9.610, with a standard deviation (S.D.) of 1.906, and a variance ($S_{X}^2$) of 3.634. The Kuder-Richardson (20) coefficient estimate was .779 for the 100 industrial education teachers on the solar energy measurement survey. The intercorrelation between test items was .735.

Research Hypothesis I

It was hypothesized that the proportion of industrial education teachers within the state of Iowa indicating a need for inservice in solar energy education at Iowa State University does not exceed 20% of the population sampled.

The analysis of data for the proportion of industrial education teachers indicating a need for inservice in solar energy education is presented in Table 22. The calculated
Table 20. Solar energy measurement data\textsuperscript{a} (N=100)

<table>
<thead>
<tr>
<th>Test item number</th>
<th>Correct response (letter)</th>
<th>Number and percent correct</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A</td>
<td>21</td>
</tr>
<tr>
<td>2</td>
<td>A</td>
<td>73</td>
</tr>
<tr>
<td>3</td>
<td>D</td>
<td>20</td>
</tr>
<tr>
<td>4</td>
<td>B</td>
<td>23</td>
</tr>
<tr>
<td>5</td>
<td>B</td>
<td>17</td>
</tr>
<tr>
<td>6</td>
<td>D</td>
<td>92</td>
</tr>
<tr>
<td>7</td>
<td>B</td>
<td>44</td>
</tr>
<tr>
<td>8</td>
<td>C</td>
<td>18</td>
</tr>
<tr>
<td>9</td>
<td>C</td>
<td>79</td>
</tr>
<tr>
<td>10</td>
<td>C</td>
<td>91</td>
</tr>
<tr>
<td>11</td>
<td>B</td>
<td>21</td>
</tr>
<tr>
<td>12</td>
<td>C</td>
<td>81</td>
</tr>
<tr>
<td>13</td>
<td>D</td>
<td>64</td>
</tr>
<tr>
<td>15</td>
<td>A</td>
<td>58</td>
</tr>
<tr>
<td>16</td>
<td>D</td>
<td>77</td>
</tr>
<tr>
<td>17</td>
<td>B</td>
<td>92</td>
</tr>
<tr>
<td>18</td>
<td>B</td>
<td>14</td>
</tr>
<tr>
<td>19</td>
<td>D</td>
<td>69</td>
</tr>
<tr>
<td>20</td>
<td>D</td>
<td>27</td>
</tr>
</tbody>
</table>

\textsuperscript{a}Cronbach alpha (equal to Kuder-Richardson 20 formula) = .779.
Table 21. Additional descriptive statistics for the solar energy measurement survey (N=100)

<table>
<thead>
<tr>
<th>Statistic</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean ($\bar{X}$)</td>
<td>9.610</td>
</tr>
<tr>
<td>Variance ($S_X^2$)</td>
<td>3.634</td>
</tr>
<tr>
<td>Standard deviation (S.D.)</td>
<td>1.906</td>
</tr>
<tr>
<td>Kuder-Richardson (20) coefficient estimate</td>
<td>.779</td>
</tr>
<tr>
<td>Intercorrelation between test items</td>
<td>.735</td>
</tr>
</tbody>
</table>

Table 22. Proportion of industrial education teachers indicating a need for inservice in solar energy education

<table>
<thead>
<tr>
<th>Statistic</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean ($\bar{X}$)</td>
<td>2.900</td>
</tr>
<tr>
<td>Mode</td>
<td>4.000</td>
</tr>
<tr>
<td>Median</td>
<td>3.019</td>
</tr>
<tr>
<td>Standard error</td>
<td>.105</td>
</tr>
<tr>
<td>Skewness</td>
<td>0.289</td>
</tr>
<tr>
<td>Standard deviation t-test formula:</td>
<td>1.049</td>
</tr>
<tr>
<td>[ t = \frac{P_{obs} - .20}{\sqrt{\frac{P_{obs}(1-P_{obs})}{N-1}}} ]</td>
<td>[ t = \frac{.78}{\sqrt{.98(.02)}} ]</td>
</tr>
</tbody>
</table>

* $p < .001$. 
t-value was 55.44. Therefore the t-value was significant at the .05 level and the null hypothesis was rejected.

**Research Hypothesis II**

It was hypothesized that the mean score for the total group of industrial education teachers sampled does not differ significantly from 14 (possible score of 20) or 70% on the solar energy measurement survey.

The analysis of data for the mean score for the total group of industrial education teachers on the solar energy survey is presented in Table 23. The calculated t-value from Table 23 is 22.913. The estimated population mean does differ from 14 (70%) in the direction expected (i.e., the mean obtained by the industrial education teachers was significantly lower than the minimum criteria level (14) chosen by the investigator). Therefore, the t-value was significant at the .05 level. The null hypothesis was therefore rejected.

**Research Hypothesis III**

It was hypothesized that the correlation between the level of education and the teacher's score on the solar energy measurement survey does not differ significantly from zero beyond that expected by chance alone.

To perform this analysis, the Pearson product-moment correlation coefficient was computed between the two variables, level of education and the test score. Table 24 presents the correlation coefficient value and the calculated t-value. The
Table 23. Analysis of data for the mean score for the total group of industrial education teachers on the solar energy survey

<table>
<thead>
<tr>
<th>Statistic</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean ($\bar{X}$)</td>
<td>9.610</td>
</tr>
<tr>
<td>Variance ($S_X^2$)</td>
<td>3.634</td>
</tr>
<tr>
<td>Standard deviation (S.D.)</td>
<td>1.906</td>
</tr>
<tr>
<td>Range</td>
<td>12.0</td>
</tr>
<tr>
<td>Skewness</td>
<td>-0.289</td>
</tr>
<tr>
<td>Observations (number taking test)</td>
<td>100</td>
</tr>
</tbody>
</table>

\[ t = \frac{\bar{X} - 14}{\sqrt{\frac{S_X^2}{N - 1}}} \]
\[ t = \frac{9.610 - 14}{\sqrt{\frac{3.634}{99}}} \]
\[ t = -22.913^* \]

*\( p < .001 \).

correlation coefficient of .0120 and t-value of .1188 were not significant at the .05 level. Therefore, there was no relationship between the level of education and test scores. There was insufficient evidence to reject the null hypothesis.

Research Hypothesis IV

It was hypothesized that the correlation between the total number of years of teaching experience of the teachers and their scores on the solar energy measurement survey does
Table 24. A comparison of the level of education and the test scores on the solar energy measurement survey

<table>
<thead>
<tr>
<th>Variables</th>
<th>Number of cases</th>
<th>Correlation coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level of education</td>
<td>100</td>
<td>r = 0.120, p = 0.453</td>
</tr>
<tr>
<td>Test score</td>
<td>100</td>
<td>.05 level = .195, .01 level = .254</td>
</tr>
</tbody>
</table>

\[
t = \frac{r}{\sqrt{1 - r^2}}
\]

\[
p(t \geq .1188) = .453
\]

not differ significantly from the value of zero beyond that expected by chance alone.

To perform this analysis, the Pearson product-moment correlation coefficient was computed between the total number of years of teaching experience and the teacher's score on the solar energy measurement survey. Table 25 presents the correlation coefficient and the calculated t-value. The correlation coefficient of .0970 and a t-value of .9648 show that no relationship was identified between the two variables. Therefore there was insufficient evidence to reject the null hypothesis at the .05 level.
Table 25. A comparison of the total number of years of teaching experience and the test scores on the solar energy measurement survey

<table>
<thead>
<tr>
<th>Variables</th>
<th>Number of cases</th>
<th>Correlation coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teaching experience</td>
<td>100</td>
<td>r = 0.0970</td>
</tr>
<tr>
<td>(total years)</td>
<td></td>
<td>p = 0.168</td>
</tr>
<tr>
<td>Test scores</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td></td>
<td>.05 level = .195</td>
<td>.01 level = .254</td>
</tr>
</tbody>
</table>

t-test formula:

\[
t = \frac{r}{\sqrt{1 - r^2}}
\]

\[
t = \frac{0.0970}{\sqrt{1 - 0.009409}} = 0.9648
\]

p(t ≥ 0.9648) = .168

Research Hypothesis V

It was hypothesized that the mean (\(\bar{X}\)) solar energy measurement survey scores of teachers classified into one of the three teaching clusters would not differ significantly beyond that expected by chance alone.

The analysis of variance (single-classification) among the mean test scores obtained by the industrial education teachers classified in each of the three teaching clusters are presented in Tables 26-28. Because the individuals could have been prepared in more than one teaching cluster, it was necessary to perform a sequence of three single one-way
Table 26. Analysis of variance (single-classification) of the graphic communication teaching cluster

<table>
<thead>
<tr>
<th>Source</th>
<th>Degrees of freedom</th>
<th>Sum of squares</th>
<th>Mean squares</th>
<th>F ratio</th>
<th>F probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between groups</td>
<td>1</td>
<td>4.9858</td>
<td>4.98</td>
<td>1.377</td>
<td>0.2434</td>
</tr>
<tr>
<td>Within groups</td>
<td>98</td>
<td>354.8037</td>
<td>3.6204</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>99</td>
<td>359.7893</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

α = 0.05

Table 27. Analysis of variance (single-classification) of the energy and power teaching cluster

<table>
<thead>
<tr>
<th>Source</th>
<th>Degrees of freedom</th>
<th>Sum of squares</th>
<th>Mean squares</th>
<th>F ratio</th>
<th>F probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between groups</td>
<td>1</td>
<td>4.2832</td>
<td>4.2832</td>
<td>1.181</td>
<td>0.2799</td>
</tr>
<tr>
<td>Within groups</td>
<td>98</td>
<td>355.5056</td>
<td>3.6276</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>99</td>
<td>359.7888</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

α = 0.05
Table 28. Analysis of variance (single-classification) of the material and processes teaching cluster

<table>
<thead>
<tr>
<th>Source</th>
<th>Degrees of freedom</th>
<th>Sum of squares</th>
<th>Mean squares</th>
<th>F ratio</th>
<th>F probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between groups</td>
<td>1</td>
<td>6.7498</td>
<td>6.7498</td>
<td>1.874</td>
<td>0.1742</td>
</tr>
<tr>
<td>Within groups</td>
<td>98</td>
<td>353.039</td>
<td>3.6024</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>99</td>
<td>359.7891</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

α = 0.05

Analysis of variance to test the hypothesis that those who prepared in a given cluster do not differ from those who did not prepare in that cluster. Therefore, the classifications are not mutually exclusive.

The calculated F value of 1.377 was obtained for the graphic communication teaching cluster as presented in Table 26. Therefore, there was insufficient evidence to reject the null hypothesis at the .05 level.

Table 27 displays the calculated F-value of 1.181 for the energy and power teaching cluster. Here again, there was insufficient evidence to reject the null hypothesis at the .05 level. The research hypothesis was not significant.
The calculated F-value of 1.874 was obtained for the materials and processes teaching cluster, as presented in Table 28. There was insufficient evidence to reject the null hypothesis. Therefore, the research hypothesis was not significant at the .05 level.
CHAPTER V. SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

The first four chapters of this research study dealt with the introduction and background, methodology, analysis and findings of this research. The function and purpose of this chapter is to summarize the preceding chapters, draw conclusions based on the findings, and present some primary and secondary recommendations.

Summary and Conclusions

This section provides a summary and the conclusions of the study which are presented in relation to each research hypothesis. The five research hypotheses are restated followed by a brief discussion of the findings.

Restatement of the problem

The problem of this study was to investigate the informational needs and interest in solar energy concepts and knowledge of industrial education teachers within the state of Iowa.

Restatement of the purpose

The purpose of the study was to provide those who plan and develop industrial education curriculum and inservice activities with the following:

1. Rationale behind the investigation and development of a solar energy curriculum and inservice activities.
2. A proposed curriculum model for solar energy.
3. A comprehensive solar energy inservice education course outline.
4. Guidelines and a description of the solar energy curriculum intergradation into existing industrial education energy core.

**Research Hypothesis I**

It was hypothesized that the proportion of industrial education teachers within the state of Iowa indicating a need for inservice in solar energy education at Iowa State University does not exceed 20% of the population sampled. It was decided that the 20% proportion would represent the critical mass necessary to bring about substantial change in the energy cluster curriculum.

**Discussion**

It is concluded that, based on the findings in the previous chapter and Table 22, there is a need in Iowa for inservice education in the technology area of solar energy for industrial education teachers.

**Research Hypothesis II**

It was hypothesized that the mean score for the total group of industrial education teachers sampled does not differ significantly from 14 or 70% on the solar energy measurement survey. It was felt that 70% of the items should be correctly answered by the industrial education teachers to meet
minimum competency. The items used reflect current solar energy information available to the public. The items also represent a sample of possible items from a large population of information in regard to solar energy. The test items range from relatively simple to moderately difficult.

Discussion

It is concluded that based on the findings reported in Table 23 that the industrial education teachers in Iowa do not possess the minimum competency level as established for this study (70%) on the solar energy measurement survey.

Research Hypothesis III

It was hypothesized that the correlation between the level of education of the teachers and their scores on the solar energy measurement survey does not differ significantly from 0 beyond that expected by chance alone.

Discussion

It is concluded that based on the findings reported in Table 24 that the correlation between the level of education and scores on the solar energy measurement survey was extremely low. There was no relationship between the variables; therefore, one might suspect that the knowledge base of solar energy is low at this point in time, and unrelated to one's level of education.
Research Hypothesis IV

It was hypothesized that the correlation between the total number of years of teaching experience of the teachers and their scores on the solar energy measurement survey does not differ significantly from 0 beyond that expected by chance alone.

Discussion

It is also concluded that based on the findings reported in Table 25 that there is no correlation between the total number of years of teaching experience and scores on the solar energy survey. In fact, there was a slight negative value but it did not differ significantly from zero and therefore no conclusion can be drawn regarding the relationship. No relationship exists between the variables. Therefore, one might suspect that the knowledge base of solar energy is very low at this point in time and unrelated to one's years of teaching experience.

Research Hypothesis V

It was hypothesized that mean solar energy measurement survey scores of teachers classified into one of three teaching clusters would not differ significantly beyond that expected by chance alone.
Discussion

It is concluded that based on the findings reported in Tables 26-28 that classification in the three teaching clusters had no relationship to the solar energy test scores. One might deduce that none of the three subject classification areas possessed, at the time of the study, a high relationship of solar energy knowledge.

Recommendations

The final section of the study is devoted to the recommendations. The recommendations are presented in two parts. The first part contains primary recommendations based upon the findings and conclusions; the second part contains the secondary recommendations for additional and future research related to this study.

Primary recommendations

1. It is recommended that an instrument be developed to assess the need for inservice education in solar energy and be administered to the total population of industrial education teachers in Iowa. It could further be extended to the United States as a national assessment.

2. It is recommended that a solar energy test be constructed with 100 or more items, having a reliability coefficient value between .7 and .9 and having good
test validity, to measure minimum competency.

3. It is recommended that further study be undertaken to determine the correlation between an industrial education teacher's biographic information and their knowledge of solar energy.

4. It is recommended that further study be conducted to determine one's relationship between the teacher preparation cluster and general solar energy knowledge to see if any one area complements its content to solar energy content.

**Secondary recommendations**

1. It is recommended that a similar study be undertaken using the total population of industrial education teachers in the state of Iowa.

2. It is recommended that an experimental solar energy course be taught for a quarter/semester in the industrial education department at Iowa State University to determine the impact that such a course could have in providing industrial education teachers with adequate solar energy principles, concepts, and knowledge.

3. It is recommended that other instructional formats, such as institutes, workshops, technical update sessions, etc., be provided and evaluated as to their effectiveness in providing a knowledge base for industrial education teachers.
4. It is recommended that a recognized state consortium explore a standardized solar energy curriculum for industrial education teachers in Iowa.

It is the author's opinion in this research that:

(1) solar energy education (solar curriculum) should be developed under the departments of industrial education at universities and colleges nationwide, and (2) that these solar energy curriculums and inservice activities be integrated into teacher preparation/teacher certification programs. The author further hopes that this research and information will prove helpful to curriculum planners at other educational institutions wanting to enrich their technology program with a solar curriculum.
LITERATURE CITED


Foshay, Arthur W. Professional education: The discipline of the act. Theory into Practice, 1967, 6, 244.


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To my master's committee: Dr. William G. Miller, Graduate Student Coordinator, for setting a high standard of professionalism and devoting innumerable hours assisting with statistical expertise; Dr. Trevor Howe, thank you for your backing and support to undertake a solar energy study.

This solar energy thesis is dedicated to my lovely fiancee Pamela Jean Cook. Thank you for all the love, patience, and dedicated support which has helped me to get where I am.
APPENDIX A. SOLAR ENERGY CURRICULUM MODEL
Model of Procedures

Need for solar energy education

Selection of solar energy content

Interface solar energy content with energy curriculum

Development of prototype instructional unit

Feedback from technical content experts

Feedback from curriculum experts

Pilot test
Instructor and student evaluation; and revision

Field test (1)
Instructor and student evaluation; and revision

Evaluation by selected team of technical content and curriculum experts

Field test (2)
Instructor and student evaluation

Analysis of all evaluations for final revisions
APPENDIX B. SOLAR ENERGY INSERVICE OUTLINE
SOLAR ENERGY

Course Outline

Provide basic consumer information on solar energy

I. Energy situations
II. Potential contributions of solar heating
III. Solar systems
IV. Architectural and environmental concerns
V. Economic considerations
VI. Other solar information sources

Course Objectives

To provide basic consumer information on solar energy
To present the present energy problem
To illustrate basic types of solar systems
To identify the potential contribution of solar to the total energy problem
To provide sources of solar information
To provide architectural information as it relates to solar information
SOLAR ENERGY

Course Outline

I. Energy situations
A. Energy situation use
   1. U.S. vs. world
   2. Exponential growth
      a. World population
      b. Energy demand
      c. % coal removed from mine
      d. % air pollutants removed
      e. % heating supplied by solar
   3. Total energy production (past, present and future)
      a. Natural gas
      b. Oil
      c. Coal
      d. Nuclear fission
      e. Hydroelectric
      f. Nuclear fusion
      g. Geothermal
      h. Wind
      i. Methane generation
      j. Solar
   4. The value of energy per unit (e.g., per therm 100,000 BTU)
      a. Electricity
b. Natural gas
c. Gasoline
d. LP gas
e. Wood
f. Coal
g. Oil

B. Division of energy use
1. Industrial--commercial
2. Transportation
3. Residential
   a. Heat
   b. Cool
   c. Other

C. Social conditions contributing to energy use
1. Total comfort
2. Convenience
3. Appearance
4. Legislation
5. Lowest initial cost of buildings, goods vs. energy consumption
6. Apathy
7. Public education

II. Potential contributions of solar heating
A. To total energy situation 1%
B. To residential heat

Sample numbers
1. 60%* of total heat
2. 25%* of January heat
3. 100%* of spring and fall
4. 100%* of DHW spring, summer and fall

III. Solar systems

A. Basic systems

1. Active systems
   a. Hydronic
   b. Air
   c. Domestic hot water
   d. Cooling

2. Passive systems

3. Combination systems

B. System components

1. Collectors
   a. Flat plate
      (1) Liquid
         (a) Closed systems
         (b) Drain down systems
         (c) Trickle systems
      (2) Air
   b. Evacuated tube
      (1) Liquid
      (2) Air
   c. Concentrating
(1) Liquid
(2)

2. Heat storage
   a. Water
   b. Air
   c. Latent
3. Heat exchanger
4. Auxiliary Heat
5. Pumps and fans, ductwork, pipework
6. Controls and control systems

IV. Architectural and environmental concerns
   A. Geographic
      1. Relationship to weather data
         a. Insulation (amount available, etc.)
         b. Tilt, latitude, azimuth angle
            (1) Space heating
            (2) Water heating (domestic)
      2. Degree days
   B. Orientation of house
   C. Aesthetics
   D. Types of structures (including additions)
      1. Roof slopes
   E. Collector location
      1. Integral with house
         a. Roof
         b. Wall
2. Remote installation

F. Space allowance for equipment

G. Structural considerations
   1. Storage
   2. Collectors
   3. Transfer equipment (ducts, pipes)
   4. Installation quality

H. Passive
   1. Windows and thermal shutters
   2. Overhangs
   3. Ventilation
   4. Storage methods & types

V. Economic considerations

A. Legislative incentives
   1. Low cost loans
   2. Income tax rebate
   3. Property tax
   4. Legal access to sun
   5. Depreciation

B. Fuel cost per unit (e.g., therm 100,000 BTU) to make solar competitive
   1. Unit costs and inflation rates
      a. Electric
      b. Natural gas
      c. Fuel oil
      d. Propane
e. Wood
f. Coal

C. Cost of conventional systems
   1. First cost and operating cost
      a. All types of fuels
      b. Forced air
      c. Hydronic

D. Cost of solar systems
   1. First cost
      a. New building
      b. Retrofit
   2. Operating cost

E. Life-cycle cost
   1. Computer assisted
      a. "F" chart
      b. Sol-cost
   2. Hand calculated
      a. Relative areas

F. Financing - mortgage
   1. Loan agency attitudes toward solar
   2. Mortgage rates
   3. 30-year mortgage payments
      a. Housepayment plus utility payment
         (1) Without solar system
         (2) With solar system

VI. Other sources of information
A. Written information
1. Book bibliography
2. Magazine bibliography
3. Pamphlets bibliography
4. Manufacturers bibliography
5. Contractors list for local area
6. Research institutions
7. Solar information centers
8. Meeting minutes dealing with solar topics
   a. Local
   b. State
   c. Federal
9. Departments of energy
   a. Federal agencies
   b. State agencies

B. Location of local solar construction
APPENDIX C. INSTRUMENT VALIDATION EXPERTS

1. George Corcolcotes
   Academic Coordinator
   Solar Energy Research Institute (SERI)
   Golden, Colorado

2. Don Witt
   Educational Coordinator
   Mid-America Solar Energy Complex (MASEC)
   Bloomington, Minnesota

3. Dr. William G. Miller
   Professor of Industrial Education
   Iowa State University
   Coordinator of Graduate Studies

4. Dr. William Wolansky
   Professor and Head
   Department of Industrial Education
   Iowa State University
APPENDIX D. COVER LETTER
January 30, 1980

Dear

Solar Energy. More and more these words are becoming a part of America's vocabulary. The continuing energy and environmental problems confronting the United States have been the primary catalyst to an increasing interest in energy from the sun.

Iowa, in its tradition, strives to stay current with emerging technology. Research points out that practicing teachers generally are more up to date with emerging technology than are teacher preparation programs (Kendell Starkweather, 1976).

You have been selected to participate in this research study of informational needs and interest in solar energy concepts and knowledge. Approximately 100 Industrial Education teachers within Iowa are being asked to participate. Your responses to the attached questionnaire will help provide a basis for establishing recommendations for curriculum materials and teacher preparation in the area of energy education. Responses of participants will, of course, be held confidential.

Please reply, and return your response in the self-addressed envelope, within two (2) weeks or less. If I do not receive your response within two (2) weeks I will send you a reminder on a 3 x 5 card.

Thank you for your participation. Your help in this project will support Industrial Education and the improvement of instruction in this important emerging area of need.

Sincerely,

David A. Cain
Graduate Student
Industrial Education

Sincerely,

Dr. William Wolansky
Department Chairman
Industrial Education
APPENDIX E. INSTRUMENT: SOLAR ENERGY MEASUREMENT SURVEY
SOLAR ENERGY EDUCATION SURVEY

PART I - BIOGRAPHIC INFORMATION

1. What is your current highest level of education?
   - less than bachelor's
   - bachelor's art/science
   - master's art/science
   - doctorate
   - certificate
   - other (specify)

2. What is your total number of years of teaching experience including the present year?
   - 0 - 2 years
   - 3 - 7 years
   - 8 - 12 years
   - 12 and up

3. What grade level(s) have you received certification to teach?
   - k - 6
   - k - 12
   - 6 - 8
   - 9 - 12
   - other (specify)

4. What are the grade levels and number of students enrolled in which you teach?
   Rank order the top three.

<table>
<thead>
<tr>
<th>Grade</th>
<th>No.</th>
<th># of Students</th>
</tr>
</thead>
</table>

5. What is the estimated population size of the community/town in which you teach?

6. What Industrial Arts/Education subject classification have you received your teacher preparation in?
   - graphic communication/arts
   - energy and power
   - materials and processes
   - manufacturing and production
   - construction
   - other (specify)

7. In what subject classification area, using those stated above, are you predominantly teaching?
   - graphic communication/arts
   - energy and power
   - materials and processes
   - manufacturing and production
   - construction
   - other (specify)

8. How many credit hours, if any, of formal education have you received in the following areas? Please circle qtr. or sem.
   - energy and power quarter/semester hours
   - energy conservation quarter/semester hours
   - solar energy quarter/semester hours

9. Have you participated in any credit courses, beyond the bachelor's degree, in the area(s)? Please circle qtr. or sem.
   - energy and power quarter/semester
   - energy conservation quarter/semester
   - solar energy quarter/semester

10. Have you participated in any non-credit workshops, beyond the bachelor degree in energy related area? If yes, please indicate.
    - no
    - yes
    - topic
    - clock hours
## Part II - Solar Energy Curriculum Information

1. What is the typical number of hours of classroom instruction that you devote per year to teaching energy concepts to your students?
   - Energy and power concepts hours per year: ___________
   - Solar energy concepts hours per year: ___________

2. For the students you teach, how many hours per year should be devoted to energy education concepts?
   - Energy and power concepts hours per year: ___________
   - Solar energy concepts hours per year: ___________

3. Check the following resources which you have used to obtain information concerning solar energy concepts, if any? Now rank order the resource(s) you have checked and have found to be most helpful.
   - Textbooks
   - Popular magazines
   - Department of Energy
   - Higher Education institutions (colleges and universities)
   - Commercial manufacturers and advertisers
   - Other (specify)

4. Which of the following is your preferred method for increasing knowledge about solar energy?
   - Extension courses for college credit
   - In-service workshops
   - Books, films, pamphlets and other media materials
   - Advertising materials from solar manufacturers
   - Other (specify)

5. If you were to gain additional instruction for solar energy education which of the following is your preferred method?
   - Lecture/discussion
   - Lecture/laboratory
   - Workshops/extension courses
   - Research/independent study
   - Other (specify)

6. In which of the following subject areas would you prefer to see solar energy concepts units developed in textbooks?
   - English
   - Math
   - Sciences
   - Social studies
   - Industrial education
   - Agriculture
   - Home economics
   - Other (specify)

7. Check all the level(s) of education at which you think solar energy education should be taught at.
   - Elementary
   - Jr. High School
   - High School
   - College undergraduate
   - College graduate
   - Other (specify)

8. Which of the following agencies should bear the most responsibility for developing solar energy curriculum materials for instruction?
   - Public schools and teachers
   - Private enterprises
   - Industry
   - State department curriculum specialists
   - Colleges and universities/faculty
   - Federal/state energy agencies
   - Other (specify)

9. Have you adopted curriculum materials from sources other than those listed above? If yes, please list.
   - No
   - Yes

10. Do you consider solar energy to be a primary technology area for in-service needs to Industrial Arts/Education teachers? Represent your value using the nine point scale.
   - Not needed
   - Very highly needed

---

* Energy and power as defined by the "Iowa Guide for Curriculum Improvement in Industrial Arts, K-12"
**SOLAR ENERGY MEASUREMENT SURVEY**

**INSTRUCTIONS:** Select the correct response which best completes the statement by filling the letter in the appropriate blank provided in the answer column to the far right or left of each page.

| Answer Column | 1. The growing interest in the United States for solar energy began in the:  
|  | a) 1930's  
|  | b) 1940's  
|  | c) 1950's  
|  | d) 1960's & 70's |
| 2. Any solar system must consist of three generic components: collector, distribution and  
|  | a) storage  
|  | b) controls  
|  | c) auxiliary system  
|  | d) heat exchanger |
| 3. Solar radiation is most commonly measured in units of  
|  | a) fahrenheit  
|  | b) British thermal unit (BTU)  
|  | c) degree days  
|  | d) langleys |
| 4. Which phrase is not true for concentrating collectors:  
|  | a) possible to achieve very high temperatures  
|  | b) recommended for residential housing  
|  | c) best used absorption cooling  
|  | d) must track the sun |
| 5. Each year, % of our nation's energy is used for heating and cooling homes.  
|  | a) less than 5%  
|  | b) 10%  
|  | c) 20%  
|  | d) 30% |
| 6. Electricity can be generated by the sun and the use of:  
|  | a) batteries  
|  | b) heat pumps  
|  | c) flat plate collectors  
|  | d) photovoltaic solar cells |
| 7. Another term which best describes a liquid circulating system is:  
|  | a) active collector system  
|  | b) hydronic solar system  
|  | c) solar assisted heat pump  
|  | d) hydro powered system |
| 8. The two principal methods for solar cooling are evaporation and  
|  | a) humidification  
|  | b) absorption  
|  | c) refrigeration  
|  | d) dehumidication |
| 9. Solar energy systems are broken down into two major categories, passive and  
|  | a) integrated  
|  | b) hydronic  
|  | c) active  
|  | d) hybrid |
| 10. An R-factor is a number which represents the resistance to heat flow of any material, the higher the R-factor,  
|  | a) the greater the heat flow  
|  | b) the less the resistance to heat flow  
|  | c) the greater the resistance to heat flow  
|  | d) none of the above |
11 Which of the following items is not considered to be a passive solar collector:
   a) thermo pane window
   b) skylight
   c) sliding glass doors
   d) translucent fiberglass window

12 The best selective coating for solar collector panels is:
   a) green
   b) red
   c) black
   d) blue

13 With an air-type solar system which medium (material) is generally recommended for storage:
   a) barrels of water
   b) sand
   c) concrete thermal mass
   d) rocks

14 Solar energy can also be defined as:
   a) btu / ft. / hr.
   b) solar radiation
   c) calorie / cm / min.
   d) insolation

15 In a water circulating system using a heat exchanger it is generally recommended to use a mixture of water and:
   a) ethylene glycol
   b) eutectic salts
   c) alcohol
   d) none of the above

16 A typical passive solar heating system can be described by:
   a) large window areas
   b) no mechanical contrivances
   c) large thermal mass areas
   d) all of the above

17 For best results in optimizing the sun’s heat energy, the solar panels should face ___________________ at some design angle:
   a) North
   b) South
   c) East
   d) West

18 Iowa has passed which of the following solar legislation laws.
   (Note as of Jan. 79)
   a) Partial tax shelter up to $3,500 for a solar system.
   b) Exempts solar energy systems from property tax assessment.
   (Jan. 79-Dec. 85)
   c) Interest-free loan program ($2000 max. per dwelling) for installation of a system.
   d) no such legislation

19 A hybrid solar system refers to a system which uses:
   a) a highly modified hot air system
   b) a dual water circulating system
   c) a supplemental heat unit
   d) both active and passive methods to operate

20 In terms of cost for residential housing, what system would be the most expensive for consumer purchase:
   a) active system
   b) passive system
   c) hybrid system
   d) compound parabolic concentrator system
APPENDIX F. LETTER FROM SOLAR ENERGY RESEARCH INSTITUTE (SERI)
November 12, 1979

Mr. Dave Cain
Iowa State University
A153 Linden Hall
Ames, Iowa 50013

Dear Mr. Cain:

Sorry I took so long in responding. We had a mini-crisis with our data base which took a while to straighten out. Our first survey was mailed in August 1978 to about 3,173 schools. We requested they be returned by September 15th though we kept the data base open for entry until late November. The results of this survey are enclosed. We revised the survey during January-February and in cooperation with Congressman George E. Brown, sent out our survey the last week of April 1979. Surveys were sent to each department within a school which responded positively to the first survey, plus to school presidents at all other institutions. In addition, we surveyed another 1,200 vocational technical schools and other miscellaneous organizations which we discovered throughout the U. S. The results are not yet broken down, though I do know that we now have identified at least 800 organizations offering solar study in the U. S.

DOE is financing several curriculum development projects. USC and Jet Propulsion Labs are working on K-6: S. Lampert at USC-(213)741-2944, and Gil Yanow at JPL. The New York State Board of Education at Albany is working on 7-12: Tom Boehm-(518)474-7746. The League for Innovation in Los Angeles is working on a curriculum to teach teachers how to teach solar on the community college level: Bob Leo-(213) 479-3941.

I hope this information is of some help for you. If you have any further questions, please let me know.

Sincerely,

George Corcoleotes
Academic Programs

GC:jap
APPENDIX G. LETTER FROM MID-AMERICAN SOLAR ENERGY COMPLEX (MASEC)
March 12, 1979

Dr. David Cain
M. 317 Larch
Iowa State University
Ames, Iowa  50013

Re: Telephone Conversation 3/9/79

Dear Dr. Cain:

Enclosed are the copies of the solar curriculum which we discussed. Use them in any way you wish.

If I can be of further help, feel free to call on me.

Sincerely,

Don Witt
Education Coordinator

DW:ng

Enclosure
APPENDIX H. LETTER FROM THE STATE EDUCATION DEPARTMENT OF NEW YORK
April 1, 1980

Dr. Dave Cain
A 153 Linden Hall
Iowa State University
Ames, Iowa 50013

Dear Dr. Cain:

Your request for the Solar Energy Project curriculum was referred to this office by Thomas Boehm. I am sending you, under separate cover, a set of the solar curriculum.

Since the project is currently undergoing national pilot testing for eventual revision, we will provide a limited number of complimentary sets to teachers interested in providing the Project with feedback during the 1979-80 school year. Enclosed is a Project Overview and an application to pilot test which you, of course, may duplicate for local distribution.

Thank you for your interest in the project.

Sincerely,

Carolyn S. Graham
Field-Test Coordinator
Solar Energy Education Project

Enclosures
APPENDIX I. LETTER FROM THE UNIVERSITY OF SOUTHERN CALIFORNIA
March 28, 1980

Dr. Cain
A.153 Linden Hall
Iowa State University
Ames, Iowa 50013

Dr. Dr. Cain:

Enclosed you will find a copy of "Solar Energy Curriculum for Elementary Schools". Since this material has been made available to us by the Department of Energy, we are pleased to offer it to you at no charge.

If we can be of further assistance, please feel free to call or write us.

Sincerely,

[Signature]

Dr. S. Lampert
Principal Investigator

ds
Encl
APPENDIX J. LETTER FROM THE LEAGUE FOR INNOVATION IN THE COMMUNITY COLLEGE
March 25, 1980

Dave Cain
A-153 Lyndon Hall
Iowa State University
Ames, Iowa 50013

Dear Dave:

It was a pleasure chatting with you concerning solar energy. I would suggest that you contact the individuals listed on the attached sheet. In addition, you should get in touch with Bill Bolin, Air Conditioning and Refrigeration, North Lake College, 2000 Walnut Lane, Irving, Texas 75062; James A. Tressel, Solar Energy Technician program, Massasoit Community College, 290 Thatchor, Brockton, Massachusetts 02402; Robert Walker, director of the Energy Education Center, Lehigh County Community College, 2370 Main Street, Schnecksville, Pennsylvania 18078.

These individuals may be able to assist you. If I can be of further assistance, please contact me.

Sincerely yours,

/\ Robert J. Leo
Associate Executive Director

RJL:lm

enclosure
SECONDARY SCHOOL SOLAR ENERGY CURRICULUM

A cooperative effort of science educators and scientists has resulted in a comprehensive Solar Energy Curriculum for Grades 7-12. The curriculum was developed by the New York State Education Department and the Atmospheric Science Research Center at the State University of New York at Albany with support from the U.S. Department of Energy (DOE), and is now available for national distribution.

The secondary school Solar Energy Curriculum, designed to be integrated into existing science classes, was developed by 80 secondary school science teachers working with technical and education experts. Field tested nationally during the 1978-79 school year, the curriculum includes a Teacher's Guide, 43 Classroom Activities, a Text, and Reader.

"Solar Energy is a renewable energy resource that has long-term implications," said Dr. Lawnie Taylor of DOE's Office of Solar Applications, "and by teaching our young people of its potential, educators can be instrumental in shaping our nation's energy future." Dr. Taylor is encouraged by the fact that science teachers are already incorporating applied energy activities into existing courses and noted that "the Solar Energy Curriculum was designed to assist in that task."

"To provide school systems with a complete solar energy package, DOE has also sponsored the development of an elementary school curriculum for Grades K-6. Currently being field tested in Southern California, the elementary curriculum should be available during the 1979-80 school year."

The secondary school Solar Energy Curriculum is designed as an infusion model that incorporates 43 Solar Energy Activities into existing courses of study. The Activities are arranged in five packets according to subject area: Junior High Science, General Solar Topics, Earth Science, Chemistry and Physics, and Biology. Each activity includes directions to the student and explanatory information for the teacher.

- over -
Supportive materials include the Solar Energy Text, the Reader, and the Teacher's Guide which includes plans for integrating the activities, directions for constructing solar demonstration projects, a solar bibliography and solar activity ideas for the non-science teacher.

Although each activity contains a teacher-resource section, the Text, written for teachers, is available to those who wish more comprehensive information on the technical, social and economic aspects of solar technology. The Text also provides the framework for a short course in solar energy.

The Reader consists of 21 articles reprinted from magazines and journals. Each article deals with a specific topic related to the solar energy activities.


#061-000-00228-6 Activities: Junior High Science $2.75
#061-000-00229-4 Activities: Chemistry & Physics 2.20
#061-000-00230-8 Activities: Biology 1.70
#061-000-00231-6 Activities: General Solar Topics 2.50
#061-000-00232-4 Activities: Earth Science 2.75
#061-000-00233-2 Solar Energy Text 2.75
#061-000-00234-1 Solar Energy Teacher's Guide 2.20
#061-000-00235-9 Solar Energy Reader 2.75

###

(Note: Complimentary sets of the curriculum are available to those interested in participating in the pilot test. For further information, contact:
The Solar Energy Education Project
c/o Bureau of Science Education
The State Education Department
Albany, New York 12234)