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An investigation of the energy and transportation component for junior high school technology education programs in Taiwan

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AN INVESTIGATION OF THE ENERGY AND TRANSPORTATION COMPONENT FOR JUNIOR HIGH SCHOOL TECHNOLOGY EDUCATION PROGRAMS IN TAIWAN

A Dissertation

Submitted

in Partial Fulfillment

of the Requirements for the Degree

Doctor of Industrial Technology

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ABSTRACT

The purpose of this study was to identify the appropriate content of the Energy and Transportation (E&T) unit for use in instruction in the junior high school Technology Education (TE) programs in Taiwan. Another purpose was to provide the Taiwanese higher education program administrators and educational planners with practical information for use in effectively designing and implementing preservice and in-service teacher preparation programs.

Survey instruments were developed through a literature review and validated by nine experts in E&T. The samples included 400 stratified and randomly selected TE teachers from four geographic parts of Taiwan, 200 stratified and randomly selected industrial managers from four industries, and all 43 industrial technology education faculty in the teacher preparation universities of Taiwan. A 61.43% usable return rate was reached after two follow-up mailings.

Based on the data analysis, 42 E&T content items were identified as being important in 9 categories including sources of energy, energy converters, costs of energy, energy conservation practices, transmission of energy, land transportation, marine transportation, air & space transportation, and careers. A five-point Likert Scale was used to rate perceived importance and perceived knowledge

level of each item by the respondents. One-way ANOVAs were used to detect perceptual differences among the three groups. Furthermore, Fisher's Least Significant Difference Procedure at the .05 and .01 level was used to identify the significant differences between any two groups on the items that had been detected by the ANOVAs below the .05 level.

The major conclusions drawn from the study were: (a) The grand mean of 39 out of 42 items were rated as being important or very important. (b) The most important category identified by the respondents was energy conservation practices, followed by careers and sources of energy. (c) Nine significant differences of knowledge level were found between the teacher and manager group, as well as between the faculty and teacher group. However, only three significant differences were found between managers and faculty members. (d) Of the total 42 content items that were rated by the teachers, the average importance level was 3.51 (high) and knowledge level 2.37 (low). This shows a large discrepancy between ratings by the teachers of importance level and knowledge level. The transportation area showed the greatest discrepancy between importance level and knowledge level. The necessity for in-service training of E&T content, based on rated importance and knowledge level, appears to be high.

CHAPTER I

INTRODUCTION

In the fall of 1997, the Industrial Arts courses for junior high school students in Taiwan will be changed to "Technology Education" courses (Lee, 1995). Like similar changes from Industrial Arts to Technology Education in the United States, which started to take place in the 1980s, the shift in Taiwan will not only involve a new name, but will involve a combining of old elements from Industrial Arts courses together with new concepts, knowledge, and teaching and learning methods. As a result, whereas currently Industrial Arts emphasizes skills and the finished product, the new Technology Education will emphasize the process of how various items are produced and how these processes effect society and the environment (Savage & Sterry, 1990).

To implement such a big change, a willingness to support and encourage Technology Education (TE) will be required of the current Industrial Arts/Technology Education (IA/TE) teachers (to be called TE teachers in this dissertation). To do this, these teachers also need to be capable of teaching the new content (Yu, 1993). The Energy and Power unit is an important component in Industrial Arts and Technology Education courses. However, because transportation technology is also becoming a critical part of technology literacy (Savage & Sterry, 1990), the Energy and Transportation (E&T) unit has been designated as one of the four major components of junior high Technology Education in Taiwan (Ministry of Education, 1994). The TE teachers should have enough ability and knowledge of technology education teaching to ensure that the new program will be successfully implemented. Of all essential elements to consider when making the transition to Technology Education, teacher retraining is one of the most important. Technology Education classes typically will be staffed with former industrial arts teachers. These teachers will need to broaden their knowledge base by in-service training or self-study. The result of this research intends to offer needed information for TE teachers and for the government to use in planning in-service training programs, as well as for universities to use to improve their teacher preparation programs.

Statement of the Problem

The major problem of this study was to investigate and identify the appropriate content of the Energy and Transportation unit for junior high school Technology Education programs in Taiwan as determined by a review of the literature and a panel of experts. The secondary problem was to compare the perceptions of TE teachers, teacher educators, and industrial managers regarding the importance of this content. In addition, the current perceived knowledge level of E&T of TE teachers was measured and compared with the perceived importance.

Statement of Purpose

The two purposes of this study were:

1. To identify and determine, as perceived by a panel of experts, the appropriate content of the Energy and Transportation unit to be used in instruction at the junior high school level in Taiwan so that TE teachers will know what knowledge they should possess, as well as, what content should be included in their teaching.

2. To provide the Taiwanese higher education program administrators and educational planners with practical information which can be used to design and implement preservice and in-service teacher preparation programs effectively.

Statement of Needs

Energy use plays an important role in human civilization. After the industrial revolution, especially during the 1950s and 1960s, because of cheap and plentiful petroleum supplies, most countries enjoyed high economic development. Very few people thought about the energy issue, but the energy crisis which occurred in 1973 and 1978 forced most people to face the importance of the use of energy, energy sources and generation, and energy conservation.

Taiwan is a small island with very high population density and poor energy resources. In 1973, Taiwan imported 72% of its energy and the import ratio has increased every year. In 1992, the import ratio reached 95%, this is higher than most other countries (Tien, 1993). During the period of the energy crisis, as with other industrialized countries, Taiwan experienced economic depression, increased unemployment, and rising commodity prices. Also during this time, Taiwan had the lowest economic rate of growth in the past 50 years (Kang, 1993).

The importance of transportation becomes more apparent when one considers that the growth of civilization is directly associated with the development of transportation systems. Transportation systems are capable of moving people and product from one location to another. Throughout history, people have devoted some of their best efforts to moving people and product over the earth, across waters, through the air and into space. The technology of transportation seeks to accomplish this movement in the most efficient way. However, the financial resources that must be invested in transportation are significant. For example, each year, the United States spends over 20 percent of the gross national product on moving people and products (Coyle, Bardi, & Cavinato, 1986). To be a technologically literate citizen, everyone needs to understand transportation technology, and examine its application to the environments of land, sea, air and space, as well as how it relates to other industries in our economy.

Industrial Arts has been replaced by Technology Education according to the standards for Taiwanese junior high school curriculum, however, this new curriculum will not be implemented until 1997 (Ministry of Education, Taiwan, 1994). In order to foster the development of technologically literate citizens, both boys and girls should study technology education as required courses--this will be a change from the current situation where industrial arts courses are offered only to boys. The new curriculum standards contain four major parts: (a) technology and life, (b) communication and information, (c) construction and manufacturing, and (d) energy and transportation (Ministry of Education, Taiwan, 1994). Most of the content of the major parts of the new curriculum has been taught in Industrial Arts, however, in the new curriculum the content has been expanded and transportation has been added as a new area of content for the curriculum standards in order to reflect social needs.

The need for this study was based on: (a) fulfillment of the E&T component as a major part of technological literacy, (b) the need for data that can be used to develop appropriate in-service teacher training, and (c) the need to offer teachers appropriate content guidelines so that they can plan their study activities using self-study, attending workshops, or selecting courses.

Fulfillment of the E&T Component as a Major Part of Technological Literacy

The creation of technology is a unique human endeavor and a distinguished characteristic of a developed civilization. A technological society requires new forms of literacy and the people must understand the relations among technological systems and human affairs (Savage & Sterry, 1990). Today, educators from all areas are addressing the study of technology as a part of basic education and the new liberal arts. This new form of literacy is called technological literacy (DeVore, 1986).

Technological literacy can be developed with technology education by hands-on oriented activities which allow students to practice the process they are learning (Hansen, 1995). Technology education focuses on a systematic approach for developing technological understanding. The systems of manufacturing, construction, communication, energy, and transportation constitute broad content areas for study. Technology education is designed to help students understand, live, and work in an advanced technological and information based society. When technology education is included in the basic education curriculum, students will have the opportunity to understand the impact of technology on the society in which they live. Part of this understanding involves the ability to evaluate change resulting from technology (Cuetara, 1988).

The Need for Data that Can Be Used to Develop Appropriate In-Service Teacher Training

According to Lee (1994), in the past 10 years Industrial Arts programs were unsuccessfully implemented in Taiwan. One of the major causes was that most teachers did not have enough knowledge of the content of the program and also lacked the appropriate ability for teaching (Lee, 1988, 1994). In order to ensure that technology education will be implemented successfully, the main focus of the government should be preservice and in-service teacher preparation. In-service teacher training is especially urgent because of the obvious difference in content, as well as teaching methods between industrial arts and technology education. In Taiwan, the government has the major role in planning and conducting in-service teacher training. However, the appropriate content of each part of the technology education programs and the knowledge level that teachers possess should be understood before the planning work is started. The researcher found that there was no research concerned with investigating E&T content in Taiwan. This study intends to offer needed information for use by the government to plan in-service teacher training.

The Need to Offer Teachers Appropriate Content Guidelines so that They Can Plan Their Study Activities Using Self-Study, Attending Workshops, or Selecting Courses

This is a world filled with various accumulated knowledge, especially in the field of technology. In order to acquire new information, people have to continue to learn. Technology Education programs should reflect the content of contemporary technology. Thus IA/TE curriculum standards have been revised by the Taiwanese government every ten years since 1960. There was an obvious change in each revised edition. However, compared with several previous revisions, the newest curriculum standards promulgated in 1994 have been changed significantly. Although the government is going to plan in-service teacher training, it is impossible to include every IA/TE teacher in the training program in the near future in that there is a limitation in training capacity. The teachers are expected and encouraged to educate themselves, to attend workshops, or to select courses from colleges to make up for their lack of sufficient relevant knowledge. Thus, a content guideline of E&T is greatly needed by teachers to plan their study activities.

Research Questions

This study was designed to provide responses to the following questions:

1. What should be the scope and elements of the content of the E&T unit within junior high level TE in Taiwan as determined by a review of the literature and a panel of experts?

2. How do TE teachers, teacher educators, and industrial managers rate the level of importance of specific content areas for the E&T unit?

3. What differences in perception exist among TE teachers, teacher educators, and industrial managers concerning the importance of the content of E&T?

4. What is the current perceived level of knowledge of the content of the E&T unit possessed by TE teachers?

5. What discrepancies exist between how teachers rate their knowledge of a topic and how they rate the importance of that topic?

Assumptions

This study was conducted with the following assumptions:

1. The experienced faculty and experts on the panel in Taiwan were qualified to comment on and modify the objectives and content of the E&T component of TE.

2. The respondents to the questionnaire would respond in a responsible and honest manner.

3. The language translation of the questionnaire would not affect validity and reliability.

Delimitations

The following delimitations were made with respect to this study:

1. This study investigated only junior high TE teachers, teacher educators, and industrial managers in Taiwan.

2. This study investigated full-time junior high school teachers who teach IA/TE for at least half of their teaching hours.

3. This study investigated full-time industrial technology education faculty from the Normal Universities in Taiwan.

4. This study investigated industrial managers of energy and power, manufacturing, construction, and transportation firms who are members of the Chinese Engineer Association in Taiwan.

Limitations

1. The questionnaire depended upon self-reported and subjectively perceived information, therefore, the investigator could not control for the integrity of the responses of the respondents.

2. There may have been some misunderstanding of survey items because the implications of the questions may not have been completely explained in the written form. This could have been improved by an interview, but this was not possible.

Statement of Methodology

The methodology used for this study was divided into these segments: (a) population, (b) sample, (c) expert panel, (d) instrument, (e) pilot test, (f) data collection, and (g) data analysis.

Population

The population examined in this study consisted of (a) approximately 2,000 junior high school TE teachers in Taiwan (Luo, 1995), (b) approximately 550 industrial managers who work in energy and power, manufacturing, construction, and transportation firms (Chinese Engineer Association, 1995), and (c) approximately 40 industrial technology education faculty members in the teacher preparation universities of Taiwan (Dennis, 1995).

Sample

The sample for this study consisted of (a) 400 stratified and randomly selected TE teachers from the north, south, east, and central parts of Taiwan with 100 teachers from each geographic part, (b) 200 stratified and randomly selected industrial managers from the energy and power, manufacturing, construction, and transportation firms with 50 managers from each industry, and (c) 43 industrial technology education faculty members in the teacher preparation universities of Taiwan (Dennis, 1995).

Expert Panel

A list was developed covering the important content areas of E&T. To develop this list a first draft of important content of E&T was compiled from appropriate and related literature and interviews with nine experts selected from teachers, university faculty, and industrial managers. In selecting expert panelists, the main concern was that they have published books or journal articles related to energy and transportation in approximately the last three years. A second draft of the list of content was sent to these experts for a final review.

Instrument

After the final list was validated by experts, the questionnaire was developed, incorporating this list. There were two parts in the questionnaire. The first part was designed to gather information on specific content areas for the E&T unit, as well as, the perceived importance of each item. The second part included demographic information.

The developed instrument was translated into English and submitted to the faculty advisory committee at the University of Northern Iowa for criticism and advice. Then the instrument was revised according to the opinions of the committee and the revised questionnaire was translated back into Chinese.

Pilot Test

A pilot test group was chosen from the three different population groups selected to complete the questionnaire and assess the instrument in order to avoid ambiguity or some format problem. Fifteen people were selected with each group composed of five people. According to the suggestions of the pilot test group, the researcher analyzed the results in the pilot test and made necessary corrections from the comments gathered from the assessments.

Data Collection

The first step in data collection was accomplished by identifying a list of important E&T content in the literature review and validating the list through interviews with experts. The revised list of important E&T content was sent to the same experts for validation. Then it was revised and sent to them again for a final validation.

After the pilot test, the next and most important step in the data collection process was to send the questionnaire to randomly selected samples in Taiwan. A cover letter and a self-addressed, stamped envelop were enclosed with the questionnaire. A follow-up letter was sent if a response had not been received in order to ensure a 50% expected total response rate.

Data Analysis

The process of data analysis was as follows. The researcher:

1. Conducted a frequency distribution to analyze the demographic data and opinion items from the questionnaire.

2. Calculated a mean score using a scale composed of a numerical code with options assigned to each item.

3. Conducted an ANOVA on the scores concerning the importance of E&T content as perceived by the three groups.

4. Conducted a *t* test to identify any significant differences between teachers perceived knowledge level and its perceived importance.

Definition of Terms

The following terms were defined to clarify their use in the context of this study:

1. Technology Education: "A comprehensive, action-based educational program concerned with technical means, their evolution, utilization, and significance; with industry, its organization, personnel, systems, techniques, resources, and products; and with the sociocultural impact of both" (International Technology Education Association, 1985, p. 25).

2. Technology: "Technology is a body of knowledge and the systematic application of resources to produce outcomes in response to human needs and wants" (Savage & Sterry, 1990, p. 7).

3. Technological Literacy: "The ability to locate, sort, analyze, and synthesize information related to achieving practical purposes through efficient action" (Loepp, 1986, p. 37).

4. Industrial Arts: Those phases of general education which deal with technology--its evolution, utilization, and significance to industry--its organization, materials, occupations, processes and products, and with the problems and benefits resulting from the technological and industrial nature of society (Maley, 1975).

5. Energy: Potential sources or radiant waves which have the capacity to perform work. Examples of potential energy sources are oil, coal, and biomass. Examples of

radiant energy sources include heat, light, and X-radiation (Hunter, 1979).

6. Transportation: Efficient utilization of resources to obtain time and place utility and to attain and maintain direct physical contact and exchange among individuals and societal units through the movement of materials/goods and people (Snyder & Hales, 1981).

7. Manufacturing: Efficient utilization of resources to extract and convert raw/recycled materials into industrial and consumer goods (Snyder & Hales, 1981).

8. Construction: Efficient utilization of resources to build structures or constructed works on a site (Snyder & Hales, 1981).

9. Junior High School: Referred to grade levels seven, eight, and nine in the education system of Taiwan.

10. Industrial Managers: In this study this group was defined as the people who work in industrial firms concerned with energy and power, manufacturing, construction, and transportation. They serve as general managers or division managers and are members of the Chinese Engineer Association.

Summary and Description of Subsequent Chapters

This study was designed to provide the Taiwanese higher education program administrators and educational planners with practical information regarding appropriate content of the Energy and Transportation unit to be used in instruction at the junior high school level. The differences in the perceptions of teachers, managers, and faculty have also been compared and the discrepancies that exist between teachers' perceived level of knowledge and the importance of the content have been discussed.

Chapter two is comprised of a review of relevant literature. It provides a background on research in the identification of technology education, technological literacy, and energy and transportation education.

Chapter three includes a detailed description of the methodology used for the research in the study. There is a discussion of expert validation, survey process, and statistical methods in this chapter.

Chapter four provides an analysis of the data and reports the findings. The description of the findings of this study and an interpretation of the statistical analysis of the results are also contained in this chapter.

The summary, conclusions, and recommendations are included in chapter five. The conclusions and recommendations of the researcher are based on the literature and the results of this study.

CHAPTER II

LITERATURE REVIEW

This review of the literature is concentrated in seven major areas: (a) historical perspective, (b) technological literacy, (c) technology education curriculum development, (d) transitional characteristics of the curriculum, (e) rationale for energy education, (f) rationale for transportation education, and (g) technology education in Taiwan.

Historical Perspective

Throughout history the development of technology has stimulated a belief that progress is a natural part of human life. Men and women have always lived in a technological age because their lives and cultures have always been surrounded by technology. The relationship between technology and humankind is in a constant state of transition as humans and product remain static for various periods of time, then the new replaces the old and modifies civilization.

Many models have been utilized to teach technology throughout history. During this century, several educational programs have emerged to teach technology in the United States. These stratified and interrelated programs have been categorized into a variety of educational fields and make a huge contribution to American industry. Silvius and Curry (1956) defined these programs as follows:

> Industrial Education is a generic term used in referring to vocational-industrial education, industrial training, the offerings of private schools, apprenticeship, industrial arts, trades and industry, and technical education. It is concerned with all education which has been adapted to meet the needs of industrial technology.
>
> Practical Arts is concerned with areas of study which emphasize practical activities and understanding typified by industrial arts, basic business, home living and general agriculture. The major objective was to enable individuals to prepare for personal living needs through practical activities. The major aims were non-vocational, consumer education and exploratory experiences, as contrasted with vocational preparation for producer proficiency.
>
> Vocational Education is an educational program organized to prepare the learner for entrance into a chosen vocation, or to upgrade employed workers. It included such major divisions as trade and industrial education, agricultural education, business education, and home economics education. (pp. 9-10)

These educational programs are of relatively recent origin, however, the idea on which they are based is as old as civilization itself. Humans have learned that they can improve their living standards by developing new technology. Technologies are developed and applied so that we can do things not otherwise possible, or so that we can do them cheaper, faster, and easier (Volti, 1992).

The beginnings of Technology Education can be traced back several thousands years through the history of civilization. Cochran (1970) noted that:

> One can only guess as to when such efforts began to take place on a formal basis, for they developed slowly from generation to generation. The educational effort grew from conscious imitation on a father-to-son relationship, to the apprenticeship system in Egypt, through the Golden Age of Greece, by way of the Romans, and was nurtured by the guilds until it was ready for inclusion as part of educational programs in the Renaissance. (p. 1)

The educational system of the guilds in Europe were composed of two categories. One category included education for the young children of guild members. Children were taught reading, writing, arithmetic, and religion by clergymen. The other category was the apprenticeship indenture system. Sons of journeymen were indentured to a master who agreed to train the apprentice in the skills of the craft. In addition, the indenture obligated the master to provide education, clothing, and shelter (Barlow, 1967).

A number of scholars during and after the Reformation period contributed ideas that influenced the development of the educational theory and practice of early Technology Education. Comenius (1592-1670) was one of the founders of modern education. The work of Comenius in educational theory, curriculum, and method was typified by his efforts to proceed from the simple to the complex. Also, his approach to education was through sense experiences and his interest in teaching students to learn by acquaintance with actual objects (Cochran, 1970). Pestalozzi (1746-1827), a Swiss educator, believed that children in school should learn to work, not only because of the economic value of skill and the habit of labor, but because this experience gave sense-impressions which, like the study of objects, became the basis of knowledge. He recognized the fact and advocated that doing leads to knowing (Barlow, 1967). Froebel (1782-1852), who studied with Pestalozzi, was impressed by his ideas of education and introduced the first co-operative program where he advocated education for work through work as well as the use of drawing and practical work in school (Barlow, 1967).

A Swedish scholar, Otto Salomon (1849-1907), developed the Sloyd educational system in Scandinavian countries during the 1870s. The Sloyd system emphasized handcraft skills to develop useful articles. Skills such as carpentry, carving, turning, smith's work, basket making, saddlery, stone cutting, fretwork, and painting were taught (Barlow, 1967). In contrast, the Russian Manual Training System developed by Victor Della Vos (1829-1890) was based strictly on an analysis of processes, operations and handtool work.

The Russian system is an example of the beginnings of early Technology Education which satisfied the needs of the time. It pointed the way to an organized method of teaching hand skills as part of the educational system. Because this method of skills learning was highly efficient, other countries in the world soon imitated and developed programs which focused on know-how to extend human potential by emphasizing hand skills in the educational system.

Manual Training first appeared in American schools in the 1880s. It was modeled in part on English craft guilds, Swedish Sloyd, and the Russian system of handwork. The goal was to send the whole boy to school as expressed by Calvin M. Woodward (1837-1914), one of the founders of Manual Training. Woodward advanced the idea that all of the manual arts, mechanical processes, and the tools used in common with the trades and occupations should be arranged in a systematic course of instruction and incorporated into the general system of education.

In 1880, the St. Louis Manual Training School of Washington University enrolled its first class for boys of intermediate grades, starting at the age of fourteen. The program of study was comprised of two hours of woodworking and one hour each of mathematics, science, Latin or English, and drawing (Barlow, 1967).

Manual Arts was a new term used by Charles A. Bennett and others during the beginning of the 20th century. It emphasized technical skills and sensitivity to form and function. The major point of divergence between Manual Training and Manual Arts was the amount of concern for creative design as a conspicuous feature of the Manual Arts program. The Manual Arts program was composed of five major areas: blacksmithing, machining, wood turning, carpentry, and drawing. Manual Arts remained a part of education well into the 1930s (Cochran,1970).

During the early 1900s, because of the increasing demands of manufacturers, labor leaders and the public for more functional instruction in public schools, motivated educators began to investigate and develop other teaching methods. John Dewey, a famous educator, encouraged the use of industrial materials, tools, and activities in all of education beginning at the elementary school level. During the same period of time, professor Charles R. Richards of Columbia University suggested that the term "Industrial Arts" better expressed the purposes and responsibilities of this field (Cochran, 1970).

Vocational education was encouraged by various states at the same time. The pursuit of federal aid for vocational education started in 1907 in an attempt to provide additional funds for industrial education courses in rural and urban high schools. The need for industrial education was so huge that the Commission of National Aid to Vocational Education was formed in 1914 to acquire federal aid for vocational education. In 1917, the Smith-Hughes Act was passed because of the Commission's efforts. This act helped to transfer responsibility for vocational classes to separate facilities which were established to serve a particular purpose and to direct Industrial Arts toward the goal of general education. Consequently, Industrial Arts shops became more like laboratories where students could obtain skills and knowledge through the hands-on exploration of many materials, tools, and processes (Cochran, 1970).

During the two decades following the passage of the Smith-Hughes Act, Industrial Arts and vocational education were developed within the guidelines which had been formulated. Industrial Arts and vocational education were generally accepted in educational programs. The American Industrial Arts Association was organized in 1939. In 1942, it became a department of the National Education Association (NEA). The decision to join the NEA was prompted by the need for closer connection with leadership in the general field of education (Barlow, 1967).

After World War II, extensive curriculum development occurred. William Warner of Ohio State University, along with several graduate students, presented, "A Curriculum to Reflect Technology" in 1947 (Lux, 1983, p. 8). The proposed curriculum was comprised of the areas of communication, construction, manufacture, power, transportation, and management.

The field of Industrial Arts was moving toward technology rather than industry even though progress seemed slow. During the 1950s, other curriculum developments were also taking place. The Industrial Arts profession was working on a broad range of program ideas. The development of a company to design and produce a product, mass production as a unit of instruction, and the development of a business structure were all used as program concepts.

Don Maley was a leader in developing "The Maryland Plan" at the University of Maryland (Maley, 1973). The Maryland Plan emphasized the development of the abilities, interests, and motivations of students of all ability levels in grades seven, eight, and nine. Students were given freedom to select activities of interest to them, had opportunities to pursue a variety of approaches in their study, and encouraged to become independent learners (Maley, 1973). Many features of the Maryland Plan are widely used in contemporary technology education programs. Maley proposed that students' activities should be arranged around investigation, exploration, analysis, testing, and the use of tools and materials in order to solve problems (Lux, 1983).

Additional curriculum studies occurred in the 1960s. Paul W. DeVore conducted research using technology as a discipline, first at Oswego, New York and then at West Virginia University. Delmar Olson at Kent State University wrote Industrial Arts and Technology to publicize the concept of technology education (Miller, 1991).

During the late 1960s and early 1970s, some innovative programs were developed. One example was the Industrial Arts Curriculum Project centered at Ohio State University under the direction of Donald G. Lux and Willis Ray. Two areas were focused on in the project, the World of Manufacturing and the World of Construction (ITEA, 1985). Another example of innovative curriculum development was the American Industry Project at the University of Wisconsin-Stout, conducted by Robert S. Swanson, Wesley Face and Eugene Flug. The project analyzed a broad spectrum of American industry to establish a conceptual framework for program activities.

During the late 1970s, with the publication of the task force report called "Jackson's Mill Industrial Arts Curriculum Theory," the stage was set for the field's evolution to Technology Education. The Jackson's Mill task force was comprised of 21 Industrial Arts educators who tried to translate into action the discussion about the direction and future of Industrial Arts. The debate focused on the relationship of Industrial Arts to comprehensive education and the rededication of Industrial Arts educators to a common professional cause. As a result, in many states and institutions, Technology Education is now acknowledged as the most dynamic subject in both middle and secondary schools (Snyder & Hales, 1981).

Ten years after the Jackson's Mill symposium, another group of 25 technology educators from across the country met for a series of three weekend workshops. The report of their deliberations integrated much of the best of current thinking concerning the role of technology education in contemporary culture. This report, A Conceptual Framework for Technology Education (1990) presented quite a different approach to designing the curriculum for technology education from the Jackson's Mill project. The group and its work are often called "Jackson's Mill II" because it built upon the framework established by the Jackson's Mill group (Savage & Sterry, 1990), but modified that framework and brought it up-to-date.

The national professional orgnization, the American Industrial Arts Association (AIAA), which began in 1939, officially changed its name to the International Technology Education Association (ITEA) in 1985, because of the growing interest of educators in Technology Education. The long-range plan of the ITEA (1986-1990) called attention to the need for technological literacy and identified Technology Education as the discipline to provide such education (Jones & Wright, 1986).

Technological Literacy

The topic of technological literacy was brought to the public's attention by scientists, social scientists, and technologists during the late 1960s (Miller, 1987). The term "technological literacy" has become something of a buzzword in the last 10 years. Recently, a number of studies have focused on what technological literacy is and how it influences technology education and human life.

The concept of technological literacy is becoming more and more important today. Both experts and professionals in the technology education field and elsewhere have made ongoing commitments to investigate this concept. DeVore (1987) claimed that the need for technological literacy is an essentially democratic need and one of the essential elements of our society.

> A technological society is based upon knowledge and know-how. As our society has progressed technologically we have become aware that a new form of literacy is required if all citizens are to function effectively as free and reasonable members of the society. (p. 9)

Scientific and technological understanding is key to living and participating in a world that continues to change very rapidly. Technological literacy allows people to learn about technology so that they can accommodate it should the need arise. The goal of technological literacy for all is reasonable, given the nature of life in modern society (New Jersey Bell, 1988).

Dyrenfurth et al. (1991) defined technological literacy as a multidimensional term that necessarily includes the ability to understand the issues raised by or use of technology, and an appreciation for the significance of technology. Wright (1985) elucidated technological literacy by means of two concepts:

> One simple way to look at technological literacy is to break it down into technical and technological concepts. Technical concepts are easily identified by analyzing the tools and processes used in each system. We essentially have been doing that for many years. But being technically literate does not necessarily lead to being technologically literate. The second type of literacy deals with understanding the impact on technology of people and society. We have not done much in that area but should if the program is to truly represent a technology education approach. (p. 103)

Lauda (1988) noted that technological literacy required a new weltanschauung, "that is, understanding that modern technology is itself a new organization of meanings, and assumptions about the world and human life. It involves technical skills as well as knowledge of socio-technical systems, the sort of things that alter culture, force a new way of life, a new morality and a new purpose for human beings" (p. 6).

In a study conducted by Dyrenfurth and Lemons (1982), they defined technological literacy as knowledge of consumer products, how they are made and how to use them. Another definition was made by Hatch (1985) who defined technological literacy as a three-dimensional construct including: (a) the functional ability to use tools, (b) an understanding of the issues raised by technology, and (c) an appreciation of the significance of technology.

A number of studies defining the meaning of technological or scientific literacy concluded that the definition depends vastly upon one's definition of science and technology. For instance, it has been stated that science observes nature to derive principles, laws, and generalizations; however technology practices tend either to test or to refine theories of efficient action (Lux, 1983).

Also from the science and technology viewpoint, DeVore (1985) stated as follows:

> Although there is much disagreement about the meaning of the terms "science" and "technology" practitioners who are designing technological literacy programs should avoid the seemingly unresolvable controversy and instead determine what constitutes the science of technology. (p. 7)

Gilberti (1989), in making recommendations in reference to the curricular area of technology education, states that technology educators can contribute to technological literacy. Technology teachers should provide learning experiences allowing students to: (a) understand the conceptual framework of technology, (b) develop a knowledge of technological concepts and devices, (c) apply technology assessment to human problems, (d) develop a knowledge of statistics and modeling techniques, (e) learn and apply mathematics in the technology education classroom, (f) develop a knowledge of the relationship and role of technology on society and environment, (g) understand the limits and the possibilities of technology, (h) understand how technology has influenced personal values and social institutions, (i) gather, analyze, and value data, and (j) apply decision making and value clarification skills to selected problems.

Technology education focuses on a systematic approach and uses appropriate instructional methods to develop technological literacy. The systems of communication, production, and transportation provide students with broad content areas of study. Technology education also provides for the integration of natural sciences, social sciences, and humanities so that students can be helped to understand, live, and work well in an advanced technological and information based society.

An article on the nature of a technological society presented by the Technology Education Advisory Council (1988) noted that "technology affects society and society affects technology. The nature of a technological society is determined by the balance and control exercised for these links and the uses society chooses for its technology" (p. 4).

Lauda (1988) defined technological literacy and also listed technological survival skills (see Figure 1). This

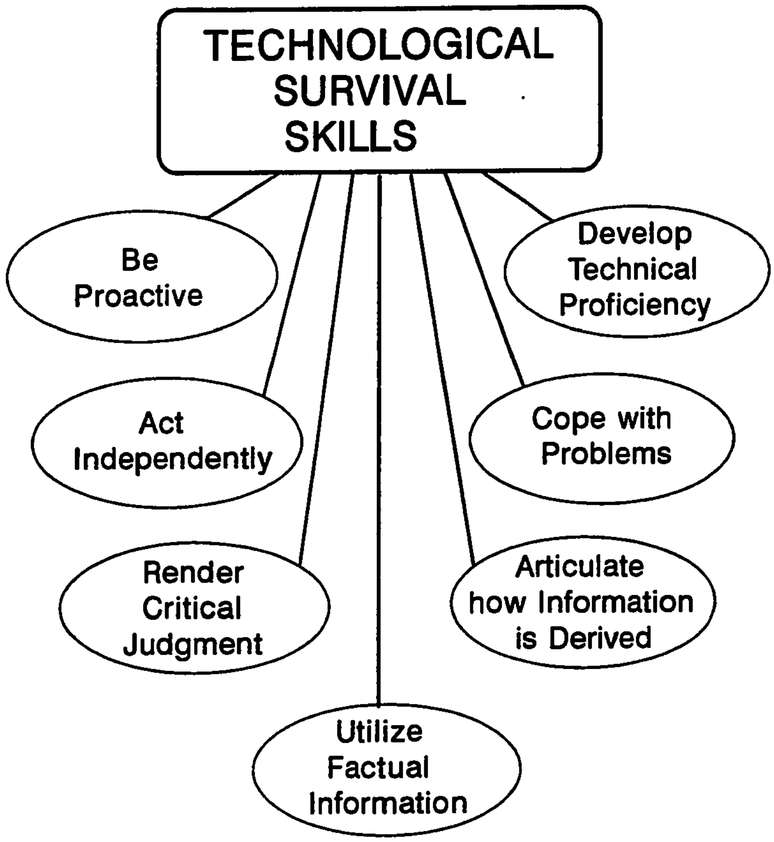


Figure 1. The technological survival skills needed in a technology curriculum (Lauda, 1988, p. 11).

list summarized the basis of technological literacy, which is considered the goal of technology education. According to Lauda, the list was "designed to help individuals entering the work force to figure out what they need to know, where to get it and how to use it in their productive activity" (p. 12).

Lauda is also an advocate of instilling the value of life-long learning in the minds of young students. He argues that technology requires responsibility and "it mandates that students entertain ideas involving outcomes caused by human decisions. Traditionally, this has been neglected in the discipline of industrial arts" (pp. 12-13). Educators need to improve instruction that leads to technological literacy so that students can become knowledgeable about technological development, technological change, technological assessment, technological forecasting, and technological decision making.

Implementation of technology education programs in schools can contribute significantly to student awareness of technology. The knowledge that students acquire through such programs will enhance their technological literacy, provide them with the abilities to manage technological change, increase their understanding of their own cultures, and thereby contribute to the progress of society (Daiber, 1980).

Technology Education Curriculum Development

The 1980s was a period for change in the technology education profession. When the American Industrial Arts

Association changed its name to the International Technology Education Association, the name change from Industrial Arts to Technology Education may have been somewhat premature, as many programs had changed in name only. However, there had been some curriculum development and revision activity in an effort to reflect the technology of the contemporary world. Some instructional content such as computer aided drafting design (CADD), computer aided manufacturing (CAM), and robotics had found its way into the new curriculum.

Of primary concern is the need to decide what logically should be selected as the content for such curricula when developing new curricula. Bensen (1988) noted that four methods used for structuring technology education curriculum include: the conceptual, behavior analysis, problem-solving, and systems approach. The conceptual approach uses taxonomies to structure content into conceptual categories and hierarchies. The taxonomy is used to show where a particular concept fits into the discipline. An advantage of the conceptual approach is that it "promotes inclusiveness and ensures a holistic study of technology. The goals of the program, rather than the concepts themselves, dictate the nature of the study" (Bensen, 1988, p. 173).

The behavior analysis method is an approach that selects content based on what a person needs to survive in a technological society. These life tasks are those skills which it takes to be a home owner, citizen, decision maker, and consumer. The content can be taught in this method by offering the student learning and doing experiences in these life tasks (Bensen, 1988).

The problem solving method is a content choice method that bases the curriculum on the theory of "process as content." In this method, it is admitted that it is impossible to teach students everything about technology, especially in contemporary society where the gaining of new knowledge is growing exponentially (Fecik, 1995). If the student can understand the process of problem solving, they will be able to solve most technological problems no matter what specific technological content is identified. Waetjen (1989) argued that problem solving is a teaching technique, as well as, a method for selecting curriculum.

The systems approach is the other method for selecting content. Content selection is based on the systems model where the parts of technological systems are studied as part of a system. A system is seen as more than the sum of its parts, because it is an "interacting whole" where if one component of the system is changed, it will have repercussions for the rest of the system.

These methods of curriculum content selection are indicative of the changing focus of industrial arts to technology education. Much of the leadership for curricula change has been provided through the efforts of a select group of industrial arts curriculum experts at the Jackson's Mill Industrial Arts Curriculum Symposium (Hales & Snyder, 1981).

Jackson's Mill Industrial Arts Curriculum Theory (JMIACT) is an example of content selection primarily by the systems method. Accordingly, much of curriculum development in technology education has been based on the systems content selection method. According to the curriculum theory developed at the symposium, the knowledge base for industrial arts should come from the technological domain of knowledge. In Figure 2, the four domains of all knowledge are illustrated as defined by the curriculum theory.

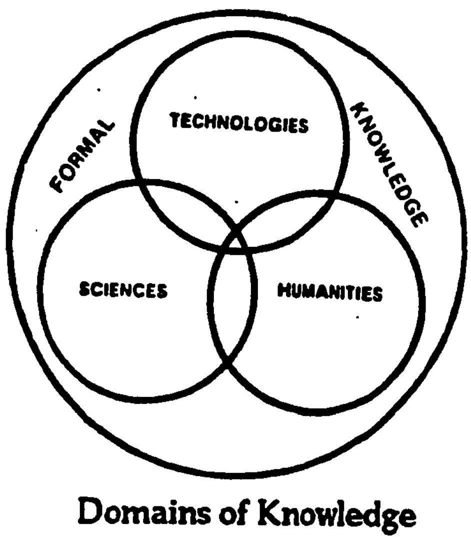


Figure 2. Domains of Knowledge (Hales & Snyder, 1981, p. 6).

Such a view marks the uniqueness of technological knowledge even though the four types of knowledge are intrinsically linked. The diagram also illustrates that formal knowledge, i.e. language, linguistics, mathematics, and logic, provides form and structure to the other domains.

The JMIACT (Hales & Snyder, 1981) also established that there are three types of human adaptive systems: ideological, sociological, and technological. These systems mutually interact with the domains of knowledge to produce changes in the natural and human-made world. An underlying concept illustrated by this model (Figure 3) is that when people discover new knowledge, they are able to adapt their environment better, which in turn gives them the ability to discover new knowledge to give them better and improved ways to adapt (Hales & Snyder, 1981, p. 8).

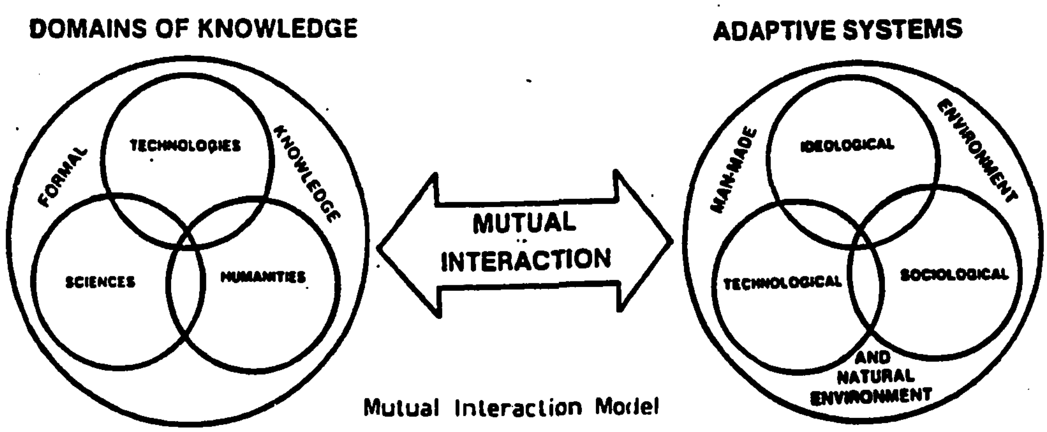


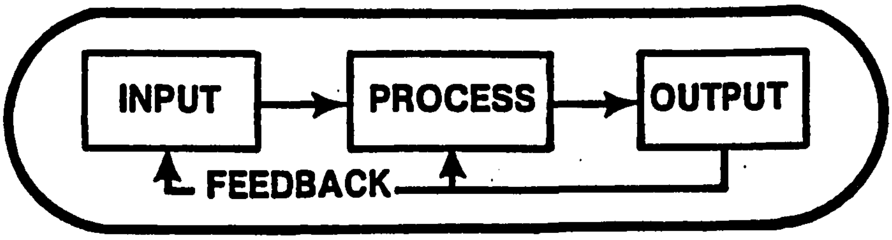
Figure 3. Mutual Interaction Model (Hales & Snyder, 1981, p. 7).

Lauda (1988) explained the meanings of the terms "adaptive" and "systems" in the context of technology education:

> Each of these two words, adaptive and systems, has specific meaning for technology education. Again, it must be emphasized that comprehension of these is essential to comprehend the intent and potential of technology education. . . . The term adaptive refers to the ability to adjust to new or changed circumstances. The human has spent great amounts of energy adjusting to both natural and human-made environments. As our technology continues to expand, additional adjustments will be necessary. Humans are constantly adjusting to the consequences of their creations. For example, we are still trying to adjust to the merits, as well as to the negative consequences, of nuclear power. (pp. 24-25)

Systems are a set of objects or constructs that are interconnected in a dynamic relation. To study one part out of context of the whole may lead to misinterpretation because the interdependence of variables lends structure and cohesion to the system. Alteration of one element of a system will change the system as a whole (Lauda, 1988).

The adaptive systems that have been developed are labeled "human adaptive systems" which means they are unique to humans, constantly changing to accommodate the environment, and are a system. A key idea pointed out by the JMIACT is that any human adaptive system is composed of inputs, processes, outputs, and feedbacks as illustrated by the Universal Systems Model (Figure 4).



Universal Systems Model

Figure 4. The Universal Systems Model (Hales & Snyder, 1981, p. 11).

The study of technology must be systematic because system is needed to analyze the four technological systems used by humans to adapt to their environments: communication, construction, manufacturing, and transportation. Such a systematic model also can be used to develop a technology education model. As stated by JMIACT (Hales & Snyder, 1981),

> The "inputs" to the system provide all needed resources to accomplish the goals of the system. The "processes" are the action which brings about system goals using the inputs (resources). The "outputs" of the system include the ends or goals (products, services, societal impacts). "Feedback" adds an element of control to system operations. Evaluation can be conducted at any position in the system to see if things are going as planned. Corrections can be made in inputs or processes if needed to achieve acceptable outputs from the system. (p. 11)

Consequently, according to JMIACT, the source for technology education content is the human adaptive systems of endeavor. Such a scheme for content inclusion eliminates such organizing schemes as: materials (e.g. metals, woods, plastics); physical phenomena (e.g. energy, power, electricity); and processes (e.g. cutting, finishing). Instead content should be organized around the sub-systems of human endeavor which exist to extend human potential and are identified as communication, construction, manufacturing, and transportation.

These systems have been evolving through the ages to their present level of development. Without the foundation of prior knowledge, innovation in these systems does not happen. The study of industry and technology should take into consideration the time dimension of people's actions in the past and present, and then try to project the future direction. The curriculum interaction model presented in Figure 5, shows the unique relationships explained by the JMIACT between the time dimension (past, present, future); the context dimension (communication, construction, manufacturing, transportation); and the components of the endeavors (inputs, processes, outputs). Essentially what the JMIACT accomplished was the logical derivation of organizers for technology education under the single principle of adaptive systems of endeavor. The organizers identified could then be used to delineate the content by means of taxonometric structures that are based on the technological processes inherent in the adaptive systems of communication, construction, manufacturing, and transportation.

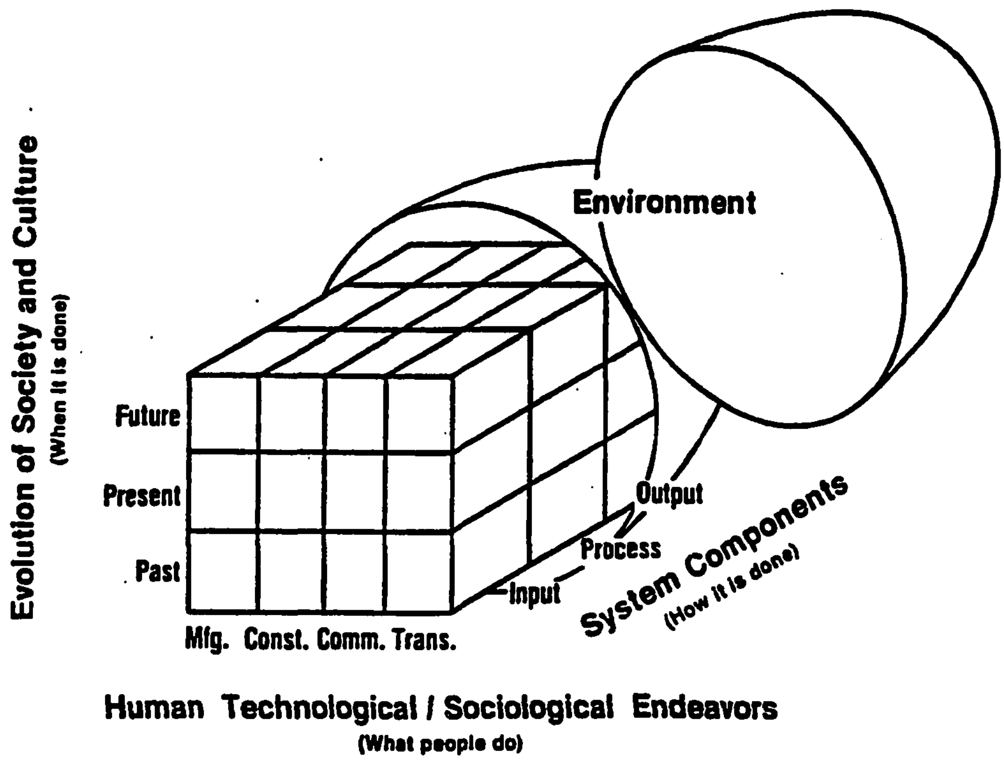


Figure 5. Curriculum Interaction Model (Hales & Snyder, 1981, p.13).

Transitional Characteristics of the Curriculum

Current Trends and Developments

In 1990, a group of 25 technology educators from across the country met for a series of three weekend workshops. The report of their deliberations integrated much of the best of current thinking concerning the role of technology education in contemporary culture. This report, A Conceptual Framework for Technology Education (Savage & Sterry, 1990) presented quite a different approach to designing the curriculum for technology education from the Jackson's Mill project. The group and its work are often called "Jackson's Mill II" because it built upon the framework established by the Jackson's Mill group (Hales & Synder, 1981), but modified that framework and brought it up-to-date.

Savage and Sterry's (1990) conceptual framework for technology education can be considered an interactive framework.

> Human needs and wants lead to the identification of problems and opportunities as addressed by resources and technological knowledge through technological processes to reach valuable solutions that have impacts. This interaction is known as the technical method (see Figure 6), and is the essential model for doing technology. (p. 6)

The Jackson's Mill II technology education curriculum organization was built upon a model of the technological method which integrates the idea of "doing" technology with

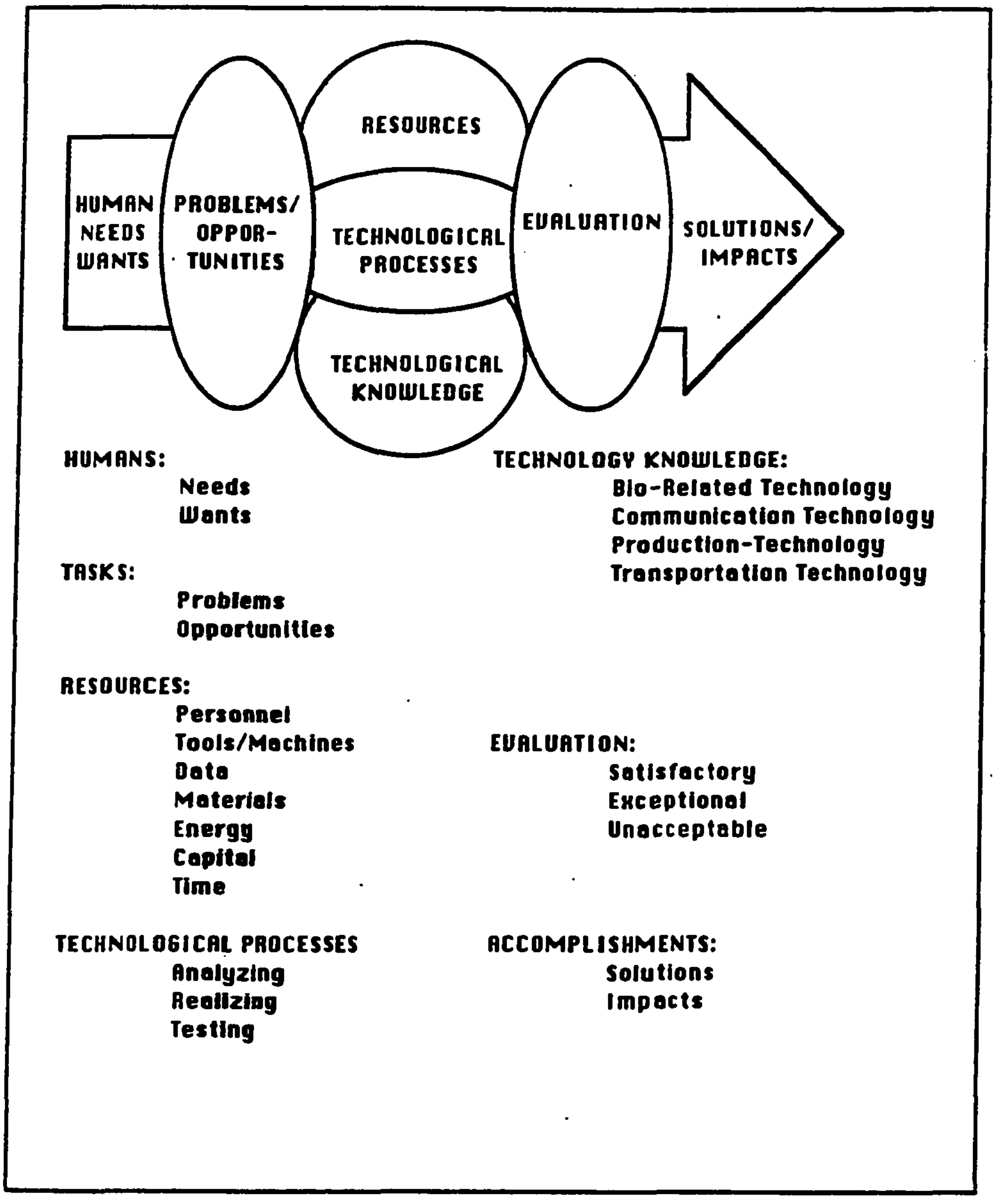


Figure 6. Technological method (Savage & Sterry, 1990, p. 7).

the idea of contributing to the body of knowledge about technology. The human is at the center of the model. Problem solving is seen as the central purpose of the technological method and of technology education.

The model for technology education developed by the Jackson's Mill II group illustrates the ways in which humans identify problems or opportunities in their lives, select resources and use technological processes to solve problems or take advantage of opportunities and assess the outcomes or consequences of the activities. The outcomes or consequences, in turn, create new problems and opportunities for humanity.

The technological processes identified by the Jackson's Mill II group are categorized as: (a) bio-related technology processes, (b) communication technology processes, (c) production technology processes, and (d) transportation technology processes. While the report of the work of the group (Savage & Sterry, 1990) does not provide definitive guidelines for detailed curriculum development, it clearly establishes the case for broadening the scope of technology education to include bio-related technology. In contrast, there is an apparent reduction in the emphasis upon more traditional industrially-related content and activities such as the traditional activities of woodworking and metalworking.

Bio-Technology

The most recent technology education curriculum proposals in the United States include recommendations for instruction in biotechnology or bio-related technology. "Biotechnology draws upon the skills and techniques of chemistry, microbiology, biochemistry, chemical engineering, biology and computer science. It also requires close cooperation with experts in other fields including medicine, nutrition, pharmaceutics, waste management and environmental protection" (Smith, 1988, p. 1).

Environmental Concerns

In recent years, concern about the continuing degradation of the environment has been increasing in the United States and most other industrial nations. While study of the effects of technology upon the environment has been recommended for industrial arts and technology education for many years, few programs have provided activities and units of study related to environmental concerns. Olson (1973) noted:

> The study of technology without concern for its impacts and consequences on the environment is but a study of bolts and nuts. As such it is dangerous. It suggests that man does not see his technology for what it really is, the most powerful force for change he has to contend with. It suggests, too, that he may destroy himself and his planet in his ignorance. (p. 4)

Contemporary technology educators are much more aware of environmental problems than were their predecessors.

While the role of technology as the creator of many environmental problems is studied, technology is also viewed as a potential solution to many environmental crises.

Integration of Mathematics, Science, and Technology

Educators in science and mathematics have expressed increasing interest in the role of technology in their fields and in the use of technological activities to enhance learning in their school subjects. Technology education is an experimental activity-based study of technology. Therefore, this discipline can provide an excellent means for a quality holistic education that can integrate mathematics, science, and technology into a relevant, meaningful, and functional learning experience (Maley, 1985). Moreover, Maley noted that "emphasis on mathematics and science provides a rich opportunity for industrial arts/technology education to establish itself as an important partner in contemporary education" (p. 7).

Johnson (1989) outlined the role of technology from the perspective of the science educator as "doing, making, and implementing things" (p. 1) according to underlying principles of science. Young adults, he says, should have a basic idea of these principles of science, mathematics, and engineering because "technology does not stand apart from the society it serves" (p. 1). With the ever increasing amount of information becoming available, and the accompanying changes, "a major question about this technical world is, 'Who will develop and control the technologies so that they can best serve all citizens?' In the broadest sense, the answer has to be--for a democratic society--a technically literate citizenry" (p. 2).

Curriculum materials that integrate science, mathematics and technology are being developed for middle school students in a project funded by the National Science Foundation at Virginia Polytechnic Institute and State University. Earlier, the National Science Foundation supported a project at Northern Illinois University which integrated high school physics and technology education. The Center for Occupational and Research Development has proposed a Principles of Technology program (CORD, 1990) which is an applied high school physics program that is also considered to be technology education by many school systems across the United States.

The Apple Classrooms of Tomorrow (ACOT) Project is a consortium of researchers, educators, students, and parents who have attempted to implement educational change. The group has been creating innovative learning environments since 1985 under the auspices of the Advanced Technology Group of Apple Computer, Inc. The aim of the group is to use media to best support learning across the curriculum. In 1991, a total of 32 teachers and 650 students were working in ACOT classrooms across the Unites States. Elementary and secondary classes in the project were equipped with computers, printers scanners, laserdisc and videotape players, modems, CD-ROM drives, and hundreds of pieces of software. Dwyer, Ringstaff, and Sandholtz (1991) reported that: (a) student attendance improved in ACOT classrooms, (b) student self-esteem and motivation were high, (c) interaction between students working at the computers was higher than normal, (d) students displayed high levels of technological skill, (e) students showed an ability to learn on their own, (f) collaborative efforts replaced competitive activities, and (g) students were able to teach each other.

Science, Technology, and Society

One of the interesting current movements in the United States is one which brings together scientists, engineers, philosophers, social scientists, and technology educators in conferences and symposiums. Zuga (1991) has described the potential contributions of technology education to the emerging Science-Technology-Society (STS) movement in the United States. She wrote:

> Technology educators bring a knowledge of the disciplinary structure of technology, the realization of relationships among science, social studies, and technology education, and a history of uniting theory and practice through laboratory activity.
>
> Technology educators, however, are steeped in the traditions of their field. They view the creation and

> utilization of technology as an effort that is distinct from science. Because of this predominant view, technology educators do not tend to combine science and technology as if it were one subject or discipline. . . Working together with experts from science and social studies enables interdisciplinary study that reflects upon the connections between and among science, technology, and social studies, and helps us to address the questions concerning our pursuit of science and technology. (p. 265)

Tech-Prep

A recent development in the United States is the rise of programs that are intended to provide specific high school preparation for students who plan to study technical subjects in the community college (grades 13 and 14). These programs for technological preparation (Tech-Prep), formerly called Pre-Vocational Programs, are intended for students of average ability, usually described as the middle 50 percent (between the 25th and 75th percentiles in academic ability).

Tech-Prep programs include preparation in technology areas and provide application-oriented courses in English, mathematics, and science (applied academics) during the high school years (Miller, 1992). Work is under way in most states to develop coordinated programs linking the last two years of high school and the two-year technical programs in the community colleges. The high school programs are usually called "Tech-Prep" programs; the combination of high school and community college programs are called "2+2" programs. The objective of these programs is to provide sound high school preparation and smooth articulation into a technical program in a community college with no repetition or redundancy (Hull & Parnell, 1991).

The role of technology education in the Tech-Prep movement varies widely from state to state. In states where technology education is closely aligned with vocational industrial education and technical education, technology education is an integral part of the Tech-Prep movement. In states where technology education is separate from vocational education, there is relatively little involvement of technology education in the Tech-Prep initiative at this time.

Technology education courses are being used in some American schools as an integral part of a Tech-Prep program. For example, the "Gold Seal Tech-Prep Program" in Danville, Virginia provides technology education courses during all four years of senior high school in addition to the courses needed for college preparation (Lewis, 1992). A course in technological systems is provided for 9th grade students. Communication technology and manufacturing technology courses are taught in 10th grade. Students in grade 11 study basic technical drawing. In 12th grade, students choose two of the technology education courses that are available: architectural drawing, graphic communications, metals technology, photography, and woods technology. The courses in this program represent a mixture of traditionally-organized technology education courses (like woods technology) and contemporary courses (like technological systems).

Students who graduate from the Gold Seal Tech-Prep Program are eligible to enter a wide variety of technical programs in community colleges and are qualified to pursue a bachelor's degree at a four-year institution upon completion of their two years at a community college.

Rationale for Energy Education

Very little mention of energy education was made before 1977 in the professional literature. According to Greenwald and Hahn (1977), "The energy crisis began shortly after oil production in the United States had peaked. By 1975, the U.S. was importing approximately forty percent of its energy" (p. 214).

The need for energy education is evident now more than ever. Gierke (1978) stated, "Many citizens are convinced that the energy crisis is a fabrication of the energy companies; designed for profit motives" (p. 6). Boyer (1977) quoting a Gallup poll noted: "If Americans were taking an examination on the energy problem, many of them would flunk. One-half of the public--52%--know that America must import oil to satisfy its current energy demands" (p. 57).

The energy shock of the 1970s made people realize that there was a lack of public understanding of the basic energy issue and that no systematic instruction about energy was being offered in the schools. Steinbrink and Jones (1980) felt that the educational burden of the energy problem will fall on the schools and that the paramount challenge of the energy dilemma is to change people through education. They further noted that schools have an urgent responsibility to include energy topics at all grade levels and in all appropriate content areas.

The conservation practices that emanated from the energy crisis of 1973 cannot continue without some ongoing knowledge and information. Comprehending this, schools began to include energy conservation education as part of their curriculum (Steinbrink & Jones, 1980).

Hofman and Miller (1979) argued that student-citizens must not only understand the need for wise use of energy, but also be equipped to make choices among energy options and be aware of energy career opportunities. They concluded by stating that the final test of the success of energy education will be the behavior of these student-citizens in the 1980s and beyond.

Brancato (1979), chairman of the White House Task Force on Energy Conservation, wrote: "There is an immediate need to develop programs in schools which address both energy awareness and energy efficiency and conservation. The energy issue is here to stay and demands the investment of time and resources now" (p. 26). He pointed out that citizens' attitudes and behavior concerning energy must change and that a new energy ethic must be created. There is a need for the educational community to incorporate new issues, such as energy education, that will be long-lasting and important. He also stressed the need for the educators of the country to educate and inform their youth of ways to confront these energy-related problems (Brancato, 1979).

Petrock (1981) suggested that energy education is important and necessary in order to meet the multifaceted challenge that this energy transition presents. This challenge requires an informed citizenry capable of making responsible decisions about the development and use of alternative energy supplies. These types of decisions have various political, economic, social, and environmental consequences. Petrock also proposed that energy be considered a basic theme throughout the formal and informal education systems, since energy issues are immediate, serious, and pervasive.

According to Petrock (1981), six objectives comprise a comprehensive energy education program as follows:

1. To enable people to understand the nature and importance of energy.

2. To provide information about changing supply and demand factors for various energy sources.

3. To prepare people to consider the individual and societal implications of different energy sources at the local, regional, national, and international levels.

4. To provide information about conservation.

5. To prepare people for potential energy supply distributions.

6. To prepare people to be energy conscious in their careers.

The Michigan Energy Extension Service studied the role that the educational system might play in the effort to promote energy conservation. Kushler (1979) explained the rationale for this as follows:

1. Efforts targeted at high school age youth could produce immediate energy savings both as a result of their own actions and as a result of actions they might influence their families to take.

2. Efforts targeted at students prior to their assumption of full adult roles and responsibilities could help instill an "energy ethic" which could have a lasting impact in terms of wise future decisions concerning energy use.

3. An additional advantage is that the educational system provides a reliable and proven means to reach a large

number of persons efficiently and with less cost than many other possible options.

During the past crises, society has turned toward educators for assistance in preparing students for new roles in the work force, and in adapting to new ethics and behaviors consistent with evolving societal goals, needs, and policies (Bottinelli, 1979).

Educators should begin to prepare students to cope with the future of the new energy era and instruct adults in energy fundamentals. Education alone cannot turn society into an energy-literate people. Education must elicit the assistance of business, industry, and governmental agencies (Bottinelli, 1979). In any approach to energy education, students must see the roles of their parents, business, industry, and government in the important decisions about energy in the world. Each of these groups should be utilized in any energy education program (Glass, 1983).

Rationale for Transportation Education

Transportation was established by curriculum experts in the Technology Education profession as one of the four major organizing themes for content knowledge necessary to develop technology literacy. All the materials and objects seen in home or work place have been transported to their locations. This includes all the materials used in construction of a dwelling, as well as, the materials used to manufacture the vehicle that transported the materials to the dwelling. The nature of transportation in society is further explained by Coyle, Bardi, and Cavinato (1986) in the following statement:

> Transportation is one of the tools required by civilized man to bring order out of chaos. It reaches into every phase and facet of our existence. Viewed in historical, economic, environmental, social, and political terms, it is unquestionably the most important industry in the world. Without transportation, you cannot operate a grocery store or win a war. The more complex life becomes, the more indispensable are the elements of transportation systems. (p. 4)

Talley (1983) provides insight into the importance of transportation by stating that "life in a modern city would be impossible without adequate transportation to bring to it the goods needed for its existence as well as to provide for the movement of goods and individuals within its boundaries" (p. 2). The development of the residential suburbs and the changes that go with them is a direct response to the freeway system that made them possible. Transportation in our time has caused changes in the way we live, the people we know, the location of our cities and their shape, the environment, the economic system, and the political system (Talley, 1983). Yu (1982) also noted the influence of transportation on all structures of society with the following statements:

> Transportation is a principal component of the economic, social, cultural, and political structures of our society and thus a vital factor in a civilization. The economic development of any geographic area, whether it is a nation, region, state, or city, will find transportation a very important influence.... Parts of the world that have developed economically the earliest and fastest are those where there had been developed adequate transportation. (p. 1-2)

The growth of air transportation is an obvious example of how transportation has heavily influenced the structures of society. For instance, it is possible for people who live in Florida to take a three-day weekend vacation to ski in the mountains of Colorado. It is also possible to take a vacation to distant countries and be exposed to and influenced by different cultures. The overnight delivery service from coast to coast has only served to make one even less patient and place more demanding expectations on such services. Some examples of the impact of air transportation are: the jobs created, the cultural exchange, the relocation of homes to make room for airports, the constant sound of aircraft in the sky no matter how remote the location, the loss of lives due to transportation related accidents, and the opportunity to have fresh imported fruits and vegetables from distant parts of the world (Schwaller, 1989).

We live in a society where transportation is so much a part of our lives that we have taken it for granted. "Picture life without transportation; consider how people's lives would change if their environments extended no farther than as far as they could walk" (Stephenson, 1987, p. 12).

These realizations about transportation are only the "the tip of the iceberg" of what must be understood by youth today. This idea is brought out emphatically by the former secretary of the U.S. Department of Transportation, John Volpe (1970) with the following remarks: "It is essential that young people confidently understand the transportation systems that are so large a part of their daily lives. This is especially true if we are to make those systems responsive to public needs and human objectives" (p. 5).

All people are involved in the decision making processes concerning transportation that affects the structure of our transportation systems. They are classified by Stephenson (1987) as "carriers, users, the government, and other interested parties such as taxpayers and non-users affected by environmental or other transportation-caused problems" (p. 6). Stephenson noted that so many groups with so many conflicting expectations results in confusion and "decisions, strategies, and trade-offs will be made; the challenge is to make the best ones" (p. 7).

Wrong decisions will be made unless all people from every walk of life are informed about the role of transportation in their lives. There will continue to be inefficient use of our natural resources, increased time expenditure for our transportation needs, and higher costs for transporting people and cargo to the desired destination. Therefore, transportation is a critical element of the school curriculum and is a fundamental necessity for all students.

Technology Education in Taiwan

The Educational System

The core of the educational system in Taiwan (Figure 7) is the nine-year national education program which is compulsory and comprised of a six-year elementary school program and a three-year junior high school program. Beyond the junior high, there are two parallel three-year institutions: a senior high school and a senior vocational school. Junior college includes three patterns: a two-year program, a three-year program, and a five-year program. The university program continues for four to seven years, depending on variations within departments and colleges. The technical college offers two kinds of programs: a two-year program for junior college graduates and a four-year program for senior vocational school graduates. At the graduate level, the minimum length of a master's degree is two years, with an additional two years as the minimum required to earn a doctorate. Entrance examinations are

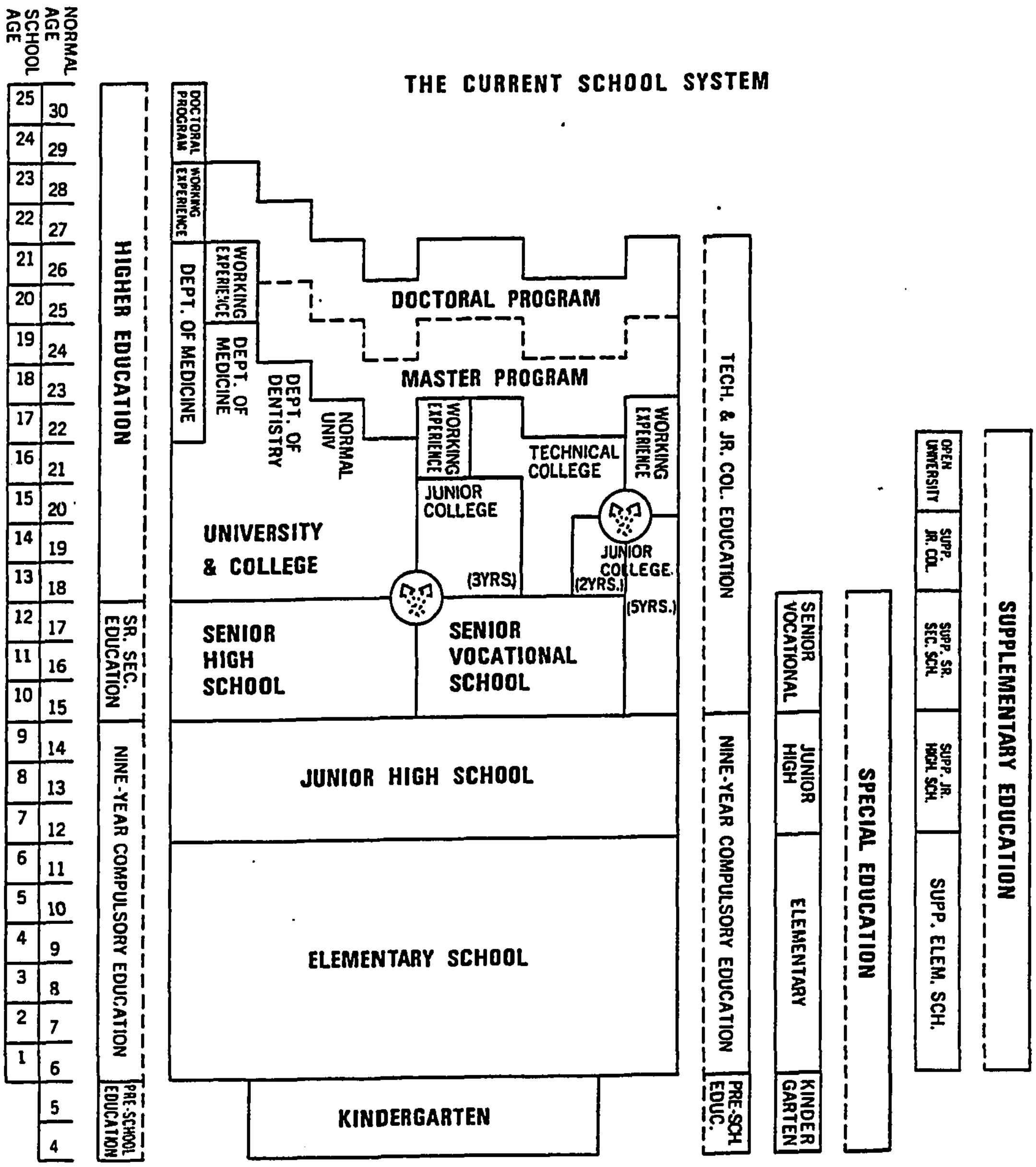


Figure 7. The structure of the educational system of Taiwan. (Ministry of Education, 1995, p. 1)

required for admission to schools, colleges, and universities beyond the level of the nine-year national education program (Lin, 1985).

The Status of Technology Education

In 1962, Taiwan began to implement Industrial Arts in junior high and high schools to replace the "Work" course. The curriculum standards of "Work" were first developed and promulgated by the government in 1929. The major contents of this course were agriculture, handicraft, and home making in the three-decade period between 1929 and 1962. Every school assigned boys to learn agriculture and handicraft and girls to learn handicraft and home making (Chu, 1992). The purpose of the change in name from "Work" to Industrial Arts was a reflection of a change in content which also reflected a change from an agricultural to an industrial based society at that time. The department of Industry Education (now Industrial Technology Education) at National Taiwan Normal University, the first Technology Education related department in higher education, was founded in 1953 with the assistance of some American specialists. The second department was founded at Kaohsiung Normal University in 1969. Since that time, American industrial arts theory and practice have tremendously influenced technology education in Taiwan through frequent exchanges of Sino-American professional personnel and literature. Now, at least one-half of the faulty members of these two departments have studied in the United States. Therefore, the development of technology education in the United States deeply influences Taiwan's technology education at all levels of the educational system.

In Taiwan, curriculum for elementary, junior high, and high school is promulgated by the Ministry of Education. Curriculum standards for schools nationwide have been revised about every 10 to 12 years since the 1960s. The current curriculum standards used by junior high, which were promulgated in 1983 and have been implemented since August 1984, dictate that students in grades seven to eleven must select either industrial arts or home economics for a two-hour weekly study. In fact, schools usually assign boys to industrial arts programs and girls to home economics. The content items included in the junior high level are as follows (Ministry of Education, 1983): (a) Introduction to Industrial Arts, (b) Blueprint Reading and Planning, (c) Ceramics, (d) Woodworking, (e) Plastics Shop, (f) Metalworking, (g) Electricity Shop, (h) Graphic Communication, (i) Construction and Livelihood, (j) Manufacturing Industry, (k) Information Industry, (l) Audio-visual Communication, and (m) Energy and Power.

Referring to the content above, industrial arts education in Taiwan is now undoubtedly industry-based and technology-oriented. The curriculum focus is in transition from traditional industrial arts to contemporary technology education and its content items appear to mix broad occupational areas with industry clusters.

In 1994, Technology Education Curriculum Standards was promulgated by the Ministry of Education to replace the old Industrial Arts curriculum and the new curriculum will be implemented nationwide in 1997. The new curriculum is not just a change of name, but the content is also altered totally. The new curriculum will reflect an orientation which is centered on a study of the technological world and will be focused mainly on the solution of daily problems. The major areas of study in the new Technology Education Curriculum are as follows (Ministry of Education, 1994): (a) Technology and Life, (b) Information and Communication, (c) Construction and Manufacturing, and (d) Energy and Transportation.

The main subjects assigned under the Energy and Transportation area are: (a) Exploration of Energy and Transportation Systems, (b) Application of Energy, and (c) Transportation Methods (Ministry of Education, 1994).

All boy and girl students from grade 7 to 11 will be required to take Technology Education and Home Economics, which is the other huge change in the instructional system of the new curriculum. This means that the current industrial arts enrollment will broaden from being boys to both boys and girls in the new technology education program (Ministry of Education, 1994). The new curriculum also declares the equality of roles between male and female in the workplace and daily life.

The Status of Energy and Transportation Education

Energy is the main source of the development of economics and society. Everything such as industry, transportation, and people's daily activities needs a great amount of energy. Furthermore, the degree of dependence on energy is greatly increased when the living standard improves and the growth of the economy accelerates. In Taiwan in the two decades from 1966 to 1986 the GNP was 5.62 times higher than before, and the use of energy was 5.57 times higher reflecting a simultaneous increase (Energy Commission, 1992). If there is any shortage in the regular supply of energy, not only does it have a profound negative impact on industry, but it also withers economic development. Thus, it can be concluded that energy has a far-reaching impact on the growth of economics and industry (Matare, 1989).

During the process of the economic development of a country, the amount of energy consumption and the ways energy is consumed are interconnected due to the structure of the global economy (Mehta, 1989). For example, twice during the global energy crises people sensed that there is a close connection between energy and the political situation. Above all, energy policy is a leading force in influencing economic policy.

In Taiwan, production industries consume approximately 60% of energy, followed by transportation, housing and business (Energy Commission, 1992). Gradual growth in the use of energy in industry is supported by government policy to foster growth of the economy. Also, due to the increasing income of people, as well as, improved living conditions, the rate of energy use has increased on a large scale. Therefore, it should be noted that government energy policy should promote energy conservation that extends from the field of industry to the whole people (Mehta, 1989).

Both environmental protection and energy are important concerns in the Six-Year National Development Plan. For the sake of solving the extremely serious air-pollution problem in urban areas, energy use policy in the future should take environmental protection into account. At present, because of the increased consciousness of the people of Taiwan concerning environmental protection, the considerations of whether energy is consumed safely and whether the energy used causes pollution have been receiving a great amount of attention (Energy Commission, 1992). These considerations are the source of the conflicts between the manufacturing and construction industries and local residents and groups advocating environmental protection. Thus, indeed, there is a great need in the near future for communicating with people efficiently and beginning energy education.

After evaluating the global energy situation and the current conditions in Taiwan, the government became aware of the fact that the problem of energy in Taiwan is worsening. As a result, in December 1990, "The Energy Policy in the Taiwan Area" was announced and Energy Education was listed as the sixth item (Energy Commission, 1992). The two purposes of energy education are as follows: to cultivate students' correct concepts of energy and habits of energy conservation; and to establish a common concern and knowledge of energy conservation in all people in Taiwan (Energy Commission, 1992).

As far as education is concerned, a great consideration is the satisfaction of the individual's different needs. Energy education is a challenge to educators because there is a great range of individual interest and ability. This ranges from formal education, to people seeking informal education, to the government informing and influencing attitudes in society. In addition to this, the contents of education should be varied to accommodate different skilled and professional areas.

Seminars and workshops which have been held to help facilitate the implementation of the energy education component by the educational system are described in the subsequent passage. From 1991 on, under the support of the Energy Commission of the Ministry of Economic Affairs (ECMOEA), the National Taiwan Normal University has held many meetings and workshops among different levels of educators, such as the Workshop of Energy Education for Teachers in Elementary and High School, the Conference of Energy Education for Principals of Elementary and High school, and the Seminars of Energy Education for Elementary School (Energy Commission, 1995). During the discussions about energy education, all participants agreed that in order to implement and publicize energy education in schools, a first priority is to provide teaching materials that are appropriate for the various grade levels. Therefore, the ECMOEA made plans and budgeted funds for the design and development of teaching materials for energy education at every level in the schools (Energy Commission, 1995).

Taiwan is one of world's most densely populated areas, with an export-oriented economy heavily dependent on shipping by air and sea to deliver goods to overseas markets. Twenty-one million people on this small island all rushing to get to their destination, means that transportation is a crucial factor that not only directly influences the daily lives of the people, but also affects the long-term economic development of this island. For these reasons, the government continues to invest huge sums of money and large quantities of land and manpower to develop a fully-integrated transportation network throughout Taiwan. The emerging network has five essential components: railways, harbors and shipping, civil aviation, freeways and highways, and metropolitan traffic systems (Ministry of Transportation & Communication, 1995).

Water transportation is of vital importance to the trade-oriented economy of Taiwan. There are five major harbors located north to south on this island. Kaohsiung Harbor is now the third largest harbor in the world in terms of volume of container cargo processed, handling over 5 million TEUs (20-foot Equivalent Units; cargo measured in terms of a standardized 20-foot long container) in 1995. Taiwan as a whole ranks third in cargo loading and unloading in the world, after the United States and Japan. Moreover, Taiwan's fleet of cargo containers now has the largest delivery capability in the world (Ministry of Transportation & Communications, 1995).

There are two international airports in Taiwan--Chiang Kai-shek and Hsiaokang International Airport. In addition, 13 domestic airports are distributed over the island and 12 domestic airlines offer convenient air transportation service for travelers (Ministry of Transportation & Communications, 1995).

There are innumerable railways, highways, and freeways throughout this island that link every city and village. People can travel to any destination in just a few hours. However, as public opinion weighs more and more heavily in all matters pertaining to society and politics in Taiwan, increasing environmental awareness is greatly influencing all phases of transportation policy-making and project construction. Therefore, appropriate transportation education will offer people enough related knowledge in order to make adequate decisions and be wise citizens.

Summary

Technology is increasingly affecting the way we live and the purpose of those responsible for developing technology is oriented toward making an easier way of life. The main purpose of technology education is to offer students enough knowledge and skills to adapt to a technological world and make a better way of life.

Technology education has been developed from the Sloyd educational system, Russian system, manual training, manual arts, and industrial arts during the past 200 years. When the AIAA changed its name to the ITEA in 1985 this signified that the discipline had entered a new era.

Technological literacy has been defined by many experts from many different aspects. Most of them advocate that the ability of problem solving is the core of technological literacy. Moreover, the study of technology must be systematic because organization is needed to analyze the four technological systems used by humans to adapt to their environment: communication, construction, manufacturing, and transportation.

The energy crisis gave rise to a necessity to pay attention to energy conservation, and schools began to include energy education as part of their curriculum. The growth of land, marine, and air transportation has heavily influenced the structures of society. The new situation which resulted from changes in transportation had an impact on such things as: the jobs created, the cultural exchange, the relocation of home, and environmental pollution. These realities caused people to face the facts and adapt.

Taiwan needs a technology education curriculum that is adapted to the unique realities of its society and culture. American technology education is a very important model that can influence the development of Taiwan's technology education curriculum, but it cannot be totally transplanted. In Taiwan the educational system is closely guided by the

Ministry of Education through strict curriculum standards. These standards must be followed in every school. Therefore, it is imperative that Taiwan develop its own technology education curriculum of which Energy and Transportation is an important component.

In order to develop a new technology education curriculum, there is a need for curriculum guidelines. The curriculum guidelines would help fill the gap between the curriculum standards and instruction. This includes identifying the appropriate content, which is necessary because the curriculum standards are brief and very general. To identify the content, three groups, teachers, managers, and faculty would need to be consulted. Such practical information would facilitate effective implementation of the new curriculum standards.

CHAPTER III

METHODOLOGY

The steps in this study related to methodology included (a) identification of the content of Energy and Transportation, (b) development of the survey instrument, (c) identification of the experts, (d) instrument validation and pilot testing, (e) population and sample, (f) data collection, and (g) data analysis.

Identification of the Content of Energy and Transportation

The first draft of the list of items of major importance to be included in the curriculum for E&T in Taiwanese junior high school was developed through a review of the literature by the researcher. Thirty-seven specific content items were identified and divided into ten categories that included: sources of energy, uses of energy, costs of energy, energy conservation practices, energy conversion processes, power, land transportation, marine transportation, air and space transportation, and environmental concerns.

In order to discuss and ascertain the content of E&T, nine experts were interviewed by the researcher. The content items developed from the literature review were shown to the experts individually and their opinions were solicited. After the interviews, the revised draft of content items was developed. Eleven of the 37 items were combined into six and ten items were added from the suggestions of the experts. Then the revised draft was sent to the experts for validation, and there were slight changes made in which ten categories were merged into nine, based on their opinions. The input of the experts which was used to develop the list of content items resulted in its expansion to include 42 items for the T&E component of junior high schools in Taiwan (see Appendix A).

Development of the Survey Instrument

The questionnaire method of data collection was used for this study. The reasons for using this method are as follows: (a) it can be completed in a simple and forthright manner in a short time, (b) it can be used for a large population with low cost, (c) it is a non-intrusive method, and (d) it can minimize bias (McClelland, 1994). In addition, a mail survey allows the researcher access to samples that might be hard to reach in person or by telephone (Fraenkel & Wallen, 1993).

In order to determine the level of perceived importance and knowledge by respondents, two groups of five-point Likert Scales were used since this technique is widely used in various kinds of studies (Ary, Jacobs, & Razavieh, 1996).

As with any kind of mail survey instrument, it is necessary to gain a high response rate to be able to generalize the findings of the study to the population being surveyed. Many studies have been completed which indicate that the non-respondents would respond differently to a questionnaire than the respondents did. This has been identified by researchers as "non-response bias." The following suggestions by Babbie (1973) and Parasuraman (1991) were kept in mind when developing the questionnaire to ensure a good response rate:

1. The items must be clear.

2. The questionnaire should be spread out and uncluttered.

3. The demographic data should be collected at the end of the questionnaire.

4. The appearance of the questionnaire should be of high quality.

5. Follow-up letters, questionnaires, and phone calls should be used to improve the response rate.

Once the above concerns were considered, the actual survey instrument was assembled by the researcher. The instrument was composed of two major parts. One part of the questionnaire contained the previously identified E&T content items. The five-point Likert scale used in this part ranged from one (very low) to five (very high). The other portion of the instrument was used to collect specific demographic information about participants regarding their background.

After the questionnaire was developed, it was submitted to the dissertation advisory committee for review and recommendations. The approved instrument was then translated into Chinese and the translation was verified by Dr. Taifa Yu, who is a professor on the committee and is proficient in both English and Chinese.

Identification of the Experts

Expert opinion is always needed, especially when the information is not in a form that is ready for use. In order to appropriately identify the important content of E&T for Taiwanese junior high schools, it was critical to have suggestions from experts. In selecting expert panelists, the main concern was that they were professionals that specialize in the area of E&T. The standard for selecting these experts was that they have published books or journal articles related to energy and transportation in approximately the last three years. This standard was also approved by the dissertation advisory committee. Then nine experts were chosen referring to the selection standard, this group was comprised of five university faculty members, two industrial managers, and two technology teachers. The insight and input of these experts indeed improved the quality of this research.

Instrument Validation and Pilot Testing

Before implementing a survey, a pilot test of the questionnaire should be conducted by any researcher to assure validity. Basically every questionnaire could be changed in some way to make it easier for the respondents to complete by decreasing ambiguity and making it clearer and easier to read (Fowler, 1984). Therefore, the questionnaire was sent for validation to five university faculty members who teach in the department of industrial technology education. These five validators were asked to answer all the questions on the questionnaire and give comments about the appropriateness and clarity of the content. Some modifications in the wording used and the format of the questionnaire were made according to the validators' suggestions.

A pilot test was conducted after the first-step of the validation. Fifteen individuals from the target groups were randomly selected to complete the revised questionnaire. The researcher analyzed the results from the feedback of the pilot test and found that there was no structural problem, but some words were changed in order that the respondents could more easily read and understand it.

The research involved human subjects, therefore, authorization had to be obtained from the Human Subjects Review Board of the Graduate College before the survey was conducted. The permission to carry out the research was granted by the Chairperson of the Review Board at the University of Northern Iowa on December 14, 1995 (see Appendix B).

Population and Sample

This study was comprised of three population groups as follows: (a) junior high school technology education teachers, (b) industrial managers who work in energy and power, manufacturing, construction, and transportation firms, and (c) industrial technology education faculty in the teacher preparation universities.

There are approximately 2,000 technology education teachers who teach at public and private junior high schools in Taiwan. The sample for this study consisted of 400 of these teachers stratified and randomly selected from the north, south, east, and central parts of Taiwan, with 100 teachers from each geographic part.

The second group was drawn from members of the Chinese Engineer Association. There are about 15,000 members and 550 of them serve as general managers or division managers in industrial firms concerned with energy and power, manufacturing, construction, and transportation. Two hundred managers, 50 from each type of industry, were randomly selected to respond to this survey by using a random number table.

There are only two departments of industrial technology education at the university level in Taiwan. One is at the Taiwan Normal University located in Taipei, which has 22 full-time faculty who teach in this department. Another is at the Kaohsiung Normal University located in Kaohsiung, which has 21 full-time faculty serving in the department. This study surveyed all 43 faculty members of these two departments as the third group.

Data Collection

The initial questionnaire was sent to the sample after it was revised from the pilot test. Three steps were followed in the data collection process.

1. The first wave of mailings was sent on February 2, and included a cover letter (see Appendix C), a survey instrument (see Appendix D), and a self-addressed stamped envelope. The cover letter introduced the purpose of the study, and made a statement on the confidentiality of individual responses.

2. Each questionnaire was coded to identify individual respondents to assist the researcher in mailing follow-up

letters only to those who had not responded. The first follow-up began February 16, two weeks after the initial mailing, with an additional questionnaire and stamped, self-addressed return envelope sent to each subject who had not returned the questionnaire at that time.

3. The second follow-up began March 1, two weeks after the second mailing, with a questionnaire and attached stamped return envelope sent to each subject who had not returned the questionnaire.

The survey was completed on March 15, 1996, after three waves of mailing. There were 266 questionnaires received from the teacher group, 112 from the manager group, and 38 from the faulty group. The return rates were 66.5% for the teacher group, 56% for the manager group, and 88.4% for the faculty group.

According to Babbie (1973) and Fowler (1984), a 50% or more response rate is sufficient for valid data analysis. The response rate of the three groups of this study exceeded 50%. Consequently, the return rate was considered acceptable for the study.

Data Analysis

After the returned questionnaires were organized and the data were collected, the Statistical Package for Social Science (SPSS) computer program was used to do the statistical analysis. A number of methods were used to analyze the data.

1. A frequency distribution was used for analysis of the demographic information from the three groups (teachers, managers, and faculty).

2. A mean score was used for each item on each scale of the content of E&T.

3. An ANOVA was performed on the mean scores for the perceived importance level of E&T content, as rated by teachers, managers, and faculty.

4. Another ANOVA was performed on the mean scores for the perceived knowledge level of E&T content, as rated by individuals in each of the three groups.

5. One more ANOVA was used to compare ratings for each item on each scale by each of the three groups.

6. Following the example of Howell (1989), the Fisher's Least Significant Difference Procedure was used for all significant ANOVAs found in previous stages to identify the significant differences between each of two groups on the items that had been detected by the ANOVAs below the .05 level. Three $\underline{t}$ tests at the .05 and the .01 level were used to identify any significant differences between teachers and managers, managers and faculty, and faculty and teachers.

7. On each content item a dependent-sample $\underline{t}$ test was used to identify the significant differences between the

teachers perceived knowledge level and its perceived importance (Hurlburt, 1994). The reason for calculating the data from the teacher group is that the results will be offered to the Taiwanese government as a reference that can be used to plan in-service teacher training programs. There was no need to compare the difference between the perceived knowledge level and its perceived importance for the manager group and faculty group. Industrial managers and university faculty will not need in-service training concerned with teaching junior high technology education.

CHAPTER IV

DATA PRESENTATION AND ANALYSIS

The findings for this study were derived from an analysis of the collected data. In order to facilitate the presentation of the findings, seven sections are included: (a) description of responses, (b) demographic information, (c) perceived importance of the content of energy and transportation, (d) differences in perceived importance of E&T content, (e) perceived knowledge level of the content of energy and transportation, (f) differences in perceived knowledge level of E&T content, and (g) differences between the perceived importance and knowledge level of the teachers.

Description of Responses

The first wave of mailing, comprised of 643 questionnaires, was sent to the subjects which included 400 TE teachers, 200 industrial managers, and 43 university faculty members. Responses were received from 205 of the subjects surveyed before February 16, 1996. Then a follow-up mailing which consisted of 438 questionnaires was mailed to the subjects who had not responded. Another 143 subjects responded to the follow-up before March 1.

In order to increase the feedback from respondents, a second follow-up letter with an additional questionnaire was sent to the people who failed to respond to the first wave and follow-up mailing. An additional 68 instruments were returned by March 15. The returned questionnaires totaled 416, consisting of 266 TE teachers, 112 industrial managers, and 38 university faculty members. However, 21 of the returned questionnaires were unusable for data analysis because of missing values on too many questions. Therefore, the total usable instruments amounted to 395, or 61.4% of the sample. The distribution of the respondents is shown in Table 1.

Demographic Information

The demographic data of participants in the three groups was composed of (a) title, (b) sex, (c) age, (d) education. Furthermore, the TE teachers were asked questions regarding the number of years of their teaching experience and the geographic location of their schools. The managers were asked to identify the type of industry in which they worked.

Occupation Distribution

The subjects were asked to identify which of three titles applied to them. The directions were to check only

Table 1

Response Rates

	Teacher	Manager	Faculty	Total
First mailing (2/2)	400	200	43	643
Responses (2/2-2/16)	122	55	28	205
1st follow-up (2/16)	278	145	15	438
Responses (2/16-3/1)	105	32	6	143
2nd follow-up (3/1)	173	113	9	295
Responses (3/1-3/15)	39	25	4	68
Total responses	266	112	38	416
Response rates	66.5%	56.0%	88.4%	64.7%
Unusable responses	10	11	0	21
Usable responses	256	101	38	395
Usable rate	64.0%	50.5%	88.4%	61.4%

Note. The numbers inside the parentheses indicate the dates of mailing and the duration of time allowed for receiving the responses. The survey was carried out in 1996.

one item. However, three respondents checked two items. The questionnaires were coded by number and this allowed a follow-up by phone to clarify which of the titles applied to them. This follow-up found that they are full-time managers and also teach in junior high schools part-time. Therefore, these three respondents were categorized as managers. This resulted in a total of 395 usable questionnaires which were composed of 256 TE teachers, 101 industrial managers, and 38 faculty members.

Sex Distribution

The sex distribution of the three groups is shown in Table 2. The numbers of male and female teachers were almost equal (51.5% for males and 48.5% for females). The majority of industrial managers (93.1%) and faculty members (94.7%) surveyed were male. It was found that in Taiwan very few females work in the technology area and serve as managers or faculty members.

Table 2

Sex Distribution of Respondents

Sex	Teacher		Manager		Faculty		Total	
	No.	%	No.	%	No.	%	No.	%
Male	132	51.5	94	93.1	36	94.7	262	66.3
Female	124	48.5	7	6.9	2	5.3	133	33.7
Total	256	100	101	100	38	100	395	100

Age Distribution

The age distribution is shown in Table 3. The majority of TE teachers are between 26 and 45 years old (55.9%). However, most managers range in age from 36 to 55 (67.3%), and the majority of faculty members are also from 36 to 55 years old (76.3%). No faculty member and only one manager is under 25. Therefore, most of them are middle aged. The teachers' ages are more equally distributed in every stage.

Table 3

Age Distribution of Respondents

Age	Teacher		Manager		Faculty		Total	
	No.	%	No.	%	No.	%	No.	%
Under 25	12	4.6	1	1.0	0	0	13	3.3
26 - 35	85	33.2	26	25.7	4	10.5	115	29.1
36 - 45	58	22.7	37	36.6	13	34.2	108	27.3
46 - 55	51	19.9	31	30.7	16	42.1	98	24.8
Above 55	50	19.5	6	5.9	5	13.2	61	15.4
Total	256	100	101	100	38	100	395	100

Education

The level of education for the three groups is displayed in Table 4. The majority of TE teachers hold a Bachelor degree (57%). The remaining teachers graduated from high school and junior college (41%). Most of the managers possess a Bachelor or Master degree (73.2%). Most of the faculty have earned a Doctorate (63.2%).

Table 4

Education Level of Respondents

Education Level	Teacher		Manager		Faculty		Total	
	No.	%	No.	%	No.	%	No.	%
High school & junior college	105	41.0	22	21.7	0	0	127	32.2
Bachelor	146	57.0	48	47.5	2	5.2	196	49.6
Master	5	2.0	26	25.7	12	31.6	43	10.9
Doctorate	0	0	5	5.0	24	63.2	29	7.3
Total	256	100	101	100	38	100	395	100

Years of Teaching Experience of Teachers

The number of teachers who have taught less than five years is very slightly larger than the other categories of teaching time. However, the distribution of years of teaching experience is almost evenly apportioned among the categories. The number of years of teaching experience is displayed in Table 5.

Geographic Location of Schools

The questionnaire was mailed to teachers grouped by the stratified random sampling method. One hundred questionnaires were sent to teachers in each geographic area in which their schools are located. The group of teachers from northern Taiwan had more responses (30.8%) and the group of teachers from eastern Taiwan and isolated islands had fewer responses (17.8%). The distribution of geographic location is displayed in Table 6.

Table 5

Years of Teaching Experience of Teachers

Years of teaching experience	Number	%
Less than 5 years	43	16.9
5 to 10 years	40	15.7
11 to 20 years	78	30.7
21 to 30 years	76	29.9
More than 30 years	17	6.7
Total*	254	100

Note. * There were two missing values in the responses.

Table 6

Geographic Location of Schools

Geographic location	Number	%
Northern Taiwan	78	30.8
Central Taiwan	63	24.9
Southern Taiwan	67	26.5
Eastern Taiwan & isolated islands	45	17.8
Total*	253	100

Note. * There were three missing values in the responses.

Distribution of the Type of Industry

The distribution of the responses from industrial managers who work for firms in the areas of energy and power, manufacturing, construction, and transportation is almost equal. The statistics are shown as Table 7.

Table 7

Distribution of the Type of Industry

Type of industry	Number	%
Energy & Power	23	22.8
Manufacturing	27	26.7
Construction	26	25.7
Transportation	25	24.8
Total	101	100

Perceived Importance of the Content of Energy and Transportation

The important content items of Energy and Transportation were developed based on a review of the literature and expert opinion. Forty-two items were placed in nine categories, including (a) source of energy, (b) energy converters, (c) costs of energy, (d) energy conservation practices, (e) transmission of energy, (f) land transportation, (g) marine transportation, (h) air and space transportation, and (i) careers (see Appendix A).

In the questionnaire, the perceived importance of E&T content was rated on a five-point Likert Scale, with "1" being of very low importance, "2" being of low importance, "3" representing moderate importance, "4" being of high importance, and "5" representing very high importance. The findings related to level of importance of E&T content as reflected by the responses of the three groups are presented as follows.

The Teacher Group

The most important categories were found to be energy conservation practices (M = 4.28), careers (M = 3.70), and land transportation (M = 3.51). The least important, as rated by the teachers, were transmission of energy (M = 2.86), air and space transportation (M = 3.38), and costs of energy (M = 3.40), as shown in Table 8.

The most important E&T content items were identified as techniques for conservation (M = 4.31), principles of conservation (M = 4.24), and automobiles and trucks (M = 4.23). The least important items were inland waterway transportation (M = 2.25), gas turbine engines (M = 2.47), and jet and rocket engines (M = 2.65), as shown in Appendix E. There is a 2.06 difference between the high (M = 4.31) and low (M = 2.25) means for importance levels of E&T content items.

Table 8

Ranking of Importance Levels of E&T Content Categories by Teachers

Ranking	Categories of E&T content	Mean
1	Energy conservation practices	4.28
2	Careers	3.70
3	Land transportation	3.69
4	Sources of energy	3.67
5	Marine transportation	3.51
6	Energy converters	3.44
7	Costs of energy	3.40
8	Air and space transportation	3.38
9	Transmission of energy	2.86
	Mean of the nine categories	3.51

Note. Scale value from 1 = very low to 5 = very high.

The Manager Group

The highest ranked categories of E&T content were energy conservation practices (M = 4.58), careers (M = 4.33), and costs of energy (M = 3.98). The least important, as rated by the managers, were air and space transportation

($\underline{M}$ = 3.53), transmission of energy ($\underline{M}$ = 3.56), and energy converters ($\underline{M}$ = 3.63), as shown in Table 9.

Table 9

Ranking of Importance Levels of E&T Content Categories by Managers

Ranking	Categories of E&T content	Mean
1	Energy conservation practices	4.58
2	Careers	4.33
3	Costs of energy	3.98
4	Sources of energy	3.83
5	Land transportation	3.81
6	Marine transportation	3.64
7	Energy converters	3.63
8	Transmission of energy	3.56
9	Air and space transportation	3.53
	Mean of the nine categories	3.77

Note. Scale value from 1 = very low to 5 = very high.

The most important content items were techniques for conservation ($\underline{M}$ = 4.60), principles of conservation ($\underline{M}$ = 4.56), and automobiles and trucks ($\underline{M}$ = 4.09). The least important items were inland waterway transportation ($\underline{M}$ = 2.14), jet and rocket engines ($\underline{M}$ = 2.41), and external combustion engines ($\underline{M}$ = 2.99), as shown in Appendix E.

There is a 2.46 significant difference between the high (M = 4.60) and low (M = 2.14) means for importance levels of E&T content items.

The Faculty Group

The highest ranked categories of E&T content were energy conservation practices (M = 4.44), careers (M = 4.11), and sources of energy (M = 3.81), as shown in Table 10. The least important content categories, as rated by

Table 10

Ranking of Importance Levels of E&T Content Categories by Faculty

Ranking	Categories of E&T content	Mean
1	Energy conservation practices	4.44
2	Careers	4.11
3	Costs of energy	3.92
4	Sources of energy	3.81
5	Transmission of energy	3.61
6	Land transportation	3.48
7	Air and space transportation	3.48
8	Energy converters	3.37
9	Marine transportation	3.27
	Mean of the nine categories	3.63

Note. Scale value from 1 = very low to 5 = very high.

faculty members, were found to be marine transportation ($\underline{M}$ = 3.27), energy converters ($\underline{M}$ = 3.37), and air and space transportation ($\underline{M}$ = 3.48).

The most important content items were identified as techniques for conservation ($\underline{M}$ = 4.54), principles of conservation ($\underline{M}$ = 4.33), and fuel cells ($\underline{M}$ = 4.25). The least important items were inland waterway transportation ($\underline{M}$ = 2.07), gas turbine engines ($\underline{M}$ = 2.35), and external combustion engines ($\underline{M}$ = 3.02), as shown in Appendix E. There is a 2.47 significant difference between the high ($\underline{M}$ = 4.54) and low ($\underline{M}$ = 2.07) for importance levels of content items.

Agreement on Importance of Content

The data reported in this section was not a part of the research questions, but is presented for informational purposes. The mean for the perceived importance of E&T content, as rated by the each of three groups, is shown in Table 11. The most important categories were found to be energy conservation practices ($\underline{M}$ = 4.37), careers ($\underline{M}$ = 3.90), and sources of energy ($\underline{M}$ = 3.72). The least important were transmission of energy ($\underline{M}$ = 3.11), air and space transportation ($\underline{M}$ = 3.43), and energy converters ($\underline{M}$ = 3.48).

The most important content items were identified as techniques for conservation ($\underline{M}$ = 4.41), principles of

Table 11

Ranking of Importance Levels of E&T Content Categories as the Mean of the Three Groups

Ranking	Categories of E&T content	Mean
1	Energy conservation practices	4.37
2	Careers	3.90
3	Sources of energy	3.72
4	Land transportation	3.70
5	Costs of energy	3.60
6	Marine transportation	3.52
7	Energy converters	3.48
8	Air and space transportation	3.43
9	Transmission of energy	3.11
	Mean of the nine categories	3.59

Note. Scale value from 1 = very low to 5 = very high.

conservation ($\underline{M}$ = 4.33), and automobiles and trucks ($\underline{M}$ = 4.19). The least important content items were inland waterway transportation ($\underline{M}$ = 2.20), gas turbine engines ($\underline{M}$ = 2.63), and jet and rocket engines ($\underline{M}$ = 2.71), as shown in Appendix E. There is a 2.21 significant difference between the high ($\underline{M}$ = 4.41) and the low ($\underline{M}$ = 2.20) means for the importance level of E&T content items. Also, a quick visual inspection of the means in Appendix E shows reasonable agreement among the groups.

Differences in Perceived Importance of E&T Content

One-way analysis of variance (ANOVA) is used to analyze one independent variable with two or more levels (Hurlburt, 1994). ANOVA was used in this study to analyze ratings of perceived importance and perceived knowledge level for each E&T item, as identified by each of the three groups. For the perceived importance of content items, there were 21 significant differences found among the three groups at the .05 level. The Fisher's Least Significant Difference Procedure was used with three *t* tests between any two groups at the .05 and the .01 level. This method can be used to determine if differences exist between any two groups when making comparisons among three groups. There were 33 significant differences between groups identified, as shown in Appendix F.

The most significant difference was found between the teacher group and the manager group. There were 14 items of significant difference at the .05 or the .01 level out of the total of 42 content items. In the category of careers, every item showed significant differences. There were three items of significant difference in each of the categories concerning sources of energy and energy converters. Two significant differences were found in each of the categories concerning costs of energy and transmission of energy, and one significant difference in the land transportation category.

There were 10 items that were significantly different between managers and faculty members. Three items in the category of sources of energy were significantly different. Two items each in the categories of energy converters and transmission of energy were significantly different. One significant difference was found in each of the categories of land transportation, marine transportation, and air and space transportation.

Nine significant differences were found between the faculty and teacher group. Three items in the category of transmission of energy were significantly different. Two significant differences were found in each of the categories of energy converters and careers, and one in each of the categories of sources of energy and costs of energy (see Appendix F).

Perceived Knowledge Level of the Content of Energy and Transportation

The perceived knowledge level of the content of E&T was rated by TE teachers, industrial managers, and faculty members. The findings for each group are presented by category and item as follows.

The Teacher Group

The highest rated categories of perceived knowledge levels by the teacher group were land transportation (M = 2.84), energy conservation practices (M = 2.71), and sources of energy (M = 2.59). The lowest rated categories included air and space transportation (M = 1.96), careers (M = 2.02), and marine transportation (M = 2.12), as shown in Table 12.

Table 12

Ranking of Perceived Knowledge Levels of E&T Content Categories by the Teacher group

Ranking	Categories of E&T content	Mean
1	Land transportation	2.84
2	Energy conservation practices	2.71
3	Sources of energy	2.59
4	Costs of energy	2.48
5	Energy converters	2.31
6	Transmission of energy	2.30
7	Marine transportation	2.21
8	Careers	2.02
9	Air and space transportation	1.96
	Mean of the nine categories	2.37

Note. Scale value from 1 = very low to 5 = very high.

The highest levels of content items were automobiles and trucks ($\underline{M}$ = 3.24), internal combustion engines ($\underline{M}$ = 3.16), and generators and motors ($\underline{M}$ = 3.14). The lowest levels of content items included fuel cells ($\underline{M}$ = 1.62), inland waterway transportation ($\underline{M}$ = 1.74), and space transportation ($\underline{M}$ = 1.76), as shown in Appendix G. There was a 1.62 difference between the highest ($\underline{M}$ = 3.24) and lowest ($\underline{M}$ = 1.62) regarding the perceived knowledge level of the content of E&T.

The Manager Group

The highest rated categories of perceived knowledge levels of E&T content by the managers were costs of energy ($\underline{M}$ = 3.33), land transportation ($\underline{M}$ = 3.12), and energy conservation practices ($\underline{M}$ = 2.73). The lowest rated categories were air and space transportation ($\underline{M}$ = 2.02), energy converters ($\underline{M}$ = 2.34), and marine transportation ($\underline{M}$ = 2.46), as shown in Table 13.

Industrial managers identified the highest levels of perceived knowledge of E&T content items as energy crises ($\underline{M}$ = 3.85), economic costs ($\underline{M}$ = 3.46), and automobiles and trucks ($\underline{M}$ = 3.28). The lowest items were fuel cells ($\underline{M}$ = 1.58), helicopters ($\underline{M}$ = 1.76), and space transportation ($\underline{M}$ = 1.83), as shown in Appendix G. There is a 2.27 difference between the highest ($\underline{M}$ = 3.85) and the lowest ($\underline{M}$ = 1.58) for the content items.

Table 13

Ranking of Perceived Knowledge Levels of E&T Content Categories by the manager group

Ranking	Categories of E&T content	Mean
1	Costs of energy	3.33
2	Land transportation	3.12
3	Energy conservation practices	2.73
4	Sources of energy	2.67
5	Transmission of energy	2.51
6	Careers	2.48
7	Marine transportation	2.46
8	Energy converters	2.34
9	Air and space transportation	2.02
	Mean of the nine categories	2.56

Note. Scale value from 1 = very low to 5 = very high.

The Faculty Group

The highest rated content categories of perceived knowledge levels were costs of energy (M = 3.28), land transportation (M = 2.97), and sources of energy (M = 2.79). The lowest categories were air and space transportation (M = 2.12), marine transportation (M = 2.22), and energy converters (M = 2.33), as shown in Table 14.

The highest levels of perceived knowledge of content items, as rated by the faulty members, were energy crises (M

= 3.81), generators and motors (M = 3.42), and automobiles and trucks (M = 3.34). The lowest items were helicopters (M = 1.69), inland waterway transportation (M = 1.71), and fuel cells (M = 1.74), as shown in Appendix G. There was a 2.12 difference between the highest (M = 3.81) and the lowest (M = 1.69) for content items.

Table 14

Ranking of Perceived Knowledge Levels of E&T Content Categories by the Faculty Group

Ranking	Categories of E&T content	Mean
1	Costs of energy	3.28
2	Land transportation	2.97
3	Sources of energy	2.79
4	Energy conservation practices	2.73
5	Careers	2.66
6	Transmission of energy	2.52
7	Energy converters	2.33
8	Marine transportation	2.22
9	Air and space transportation	2.12
	Mean of the nine categories	2.57

Note. Scale value from 1 = very low to 5 = very high.

Agreement on Perceived Knowledge Level of Content

The data reported in this section was not a part of the research questions, but is presented for informational purposes. The highest rated categories of perceived knowledge level based on mean values were land transportation ($\underline{M}$ = 2.92), costs of energy ($\underline{M}$ = 2.77), and energy conservation practices ($\underline{M}$ = 2.72). The lowest rated categories were air and space transportation ($\underline{M}$ = 1.99), careers ($\underline{M}$ = 2.20), and marine transportation ($\underline{M}$ = 2.22), as shown in Table 15.

The highest perceived knowledge levels of the items were automobiles and trucks ($\underline{M}$ = 3.26), energy crises ($\underline{M}$ = 3.19), and generators and motors ($\underline{M}$ = 3.15). The lowest knowledge levels were fuel cells ($\underline{M}$ = 1.62), space transportation ($\underline{M}$ = 1.78), and inland waterway transportation ($\underline{M}$ = 1.79), as shown in Appendix G. There was a 1.64 difference between the highest ($\underline{M}$ = 3.26) and lowest ($\underline{M}$ = 1.62) regarding perceived knowledge level of E&T content. A quick visual inspection of the means shows reasonable agreement among the groups.

Differences in Perceived Knowledge Level of E&T Content

The largest number of significant differences were found between teachers and managers and faculty members and teachers. The smallest number of significant differences

Table 15

Ranking of Perceived Knowledge Levels of E&T Content Categories as the Mean of the Three Groups

Ranking	Categories of E&T content	Mean
1	Land transportation	2.92
2	Costs of energy	2.77
3	Energy conservation practices	2.72
4	Sources of energy	2.63
5	Transmission of energy	2.37
6	Energy converters	2.32
7	Marine transportation	2.22
8	Careers	2.20
9	Air and space transportation	1.99
	Mean of the nine categories	2.44

Note. Scale value from 1 = very low to 5 = very high.

were found between the managers and faculty members, as shown in Appendix H. When the ANOVA was used to compare the three groups, 13 items had significant differences at the .05 level.

Nine significant differences were found between the teacher and manager groups regarding perceived knowledge level of E&T content. Two significant differences were found in each of the categories of energy converters, costs of energy, and careers. The categories of transmission of energy, land transportation, and marine transportation each had one item that was significantly different.

Only three significant differences were found between managers and faculty members. One item in each of the categories of land transportation, marine transportation, and air and space transportation was found to have significant differences.

There were also nine significant differences found between the faculty and teacher groups. Two were found in each of the categories of sources of energy, costs of energy, and careers. The categories of energy converters, transmission of energy, and air and space transportation each had one item that was significantly different (see Appendix H).

Differences Between the Perceived Importance and Knowledge Level of Teachers

A dependent *t* test was used to compare the ratings of perceived importance and knowledge level of the teacher group because the data was collected from the same sample. The importance level of each of the content items was compared with the knowledge level of each item and it was found that the mean of the importance level of every item is higher than that of the knowledge level. This means that teachers need additional knowledge to fill these gaps.

Twenty-four significant differences were found at the .05 level, with 16 of them reaching the .01 level (see Table 16 and Appendix I).

Table 16

The Content Items Which Were Significantly Different Between the Importance Level and Knowledge Level of the Teacher Group

Content of E&T	Probability
A. Sources of Energy	
1. Solar	0.03*
3. Biomass	0.03*
4. Ocean	0.01**
6. Geothermal energy	0.04*
10. Nuclear energy	0.01**
B. Energy Converters	
11. Principles of energy conversion	0.01**
12. Effectiveness of energy conversion	0.04*
18. Fuel cells	0.01**
19. Solar cells	0.01**
C. Costs of Energy	
20. Economic costs	0.01**
22. Energy crises	0.03*

(table continues)

Content of E&T	Probability
D. Energy Conservation Practices	
23. Principles of conservation	0.01**
24. Techniques and strategies for conservation	0.01**
F. Land Transportation	
31. Pipelines	0.02*
G. Marine transportation	
32. Ship structure and machinery	0.01**
34. Ocean transportation	0.01**
35. Seaports and shipping procedures	0.01**
H. Air and Space Transportation	
36. Light aircraft structure	0.01**
37. Commercial airplanes	0.02*
38. Helicopters	0.01**
39. Airport terminals and facilities	0.03*
40. Space transportation	0.01**
I. Careers	
41. Careers in the energy field	0.01**
42. Careers in the transportation field	0.01**

Note. * $p < .05$ ** $p < .01$

Every item in the categories of energy conservation practices, air and space transportation, and careers showed significant differences. Most of the items were significantly different in the categories of costs of energy (2 of 3) and marine transportation (3 of 4). Five significant differences were found in the category of sources of energy (5 of 10), four in energy converters (4 of 9), and one in land transportation (1 of 3). No significant difference was found in the category of transmission of energy. Ten items from 13 total items concerning transportation areas were found to be significantly different. The ratio is much higher than that of the energy areas in which 14 items out of a total of 29 items were found to be significantly different (see Appendix I).

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

The data concerning Energy and Transportation (E&T) content for junior high school Technology Education (TE) was collected from the three groups which included: the junior high TE teachers, the industrial managers, and the university faculty members in Taiwan. The analysis of data provided the basis for the following summary, conclusions, and recommendations.

Summary

The major purposes of this study were to identify the appropriate content for the E&T unit to be used at junior high schools in Taiwan and to provide the Taiwanese government needed information to be used in planning in-service teacher training. In order to accomplish these purposes, the following research questions were developed to guide the study:

1. What should be the scope and elements of the content of the E&T unit within junior high level TE in Taiwan as determined by a review of the literature and a panel of experts?

2. How do TE teachers, teacher educators, and industrial managers rate the level of importance of specific content areas for the E&T unit?

3. What differences in perception exist among TE teachers, teacher educators, and industrial managers concerning the importance of the content of E&T?

4. What is the current perceived level of knowledge of the content of the E&T unit possessed by TE teachers?

5. What discrepancies exist between how teachers rate their knowledge of a topic and how they rate the importance of that topic?

Nine important categories of E&T content were identified after a review of the related literature and validated by the expert panel in Taiwan. These categories are comprised of (a) sources of energy, (b) energy converters, (c) costs of energy, (d) energy conservation practices, (e) transmission of energy, (f) land transportation, (g) marine transportation, (h) air and space transportation, and (i) careers. There were 42 E&T content items included within these nine categories (see Appendix A). Based on these content items, the survey instrument (see Appendix D) was developed and validated by the advisory committee in the University of Northern Iowa.

There were two parts in the questionnaire. The first part was designed to gather information concerning E&T

content items as rated by the three groups; each item included two Likert Scales for the perceived importance level and the perceived knowledge level. The second part included seven items to generate demographic information.

There were 416 (64.7%) responses out of a total 643 subjects after two follow-up mailings. The number of usable responses for this study was 395 (61.43%) since 21 of the 416 responses were found to be unanswered or to have improper responses. To detect perceptual differences among the three groups ANOVAs were used. Furthermore, Fisher's "Least Significant Difference" procedure at the .05 and the .01 level was used to identify the significant differences between any two groups on the items that had been detected by the ANOVAs below the .05 level. A dependent t test was used to examine the significant differences between the teachers perceived knowledge level and its perceived importance.

Most of the industrial managers (93.1%) and faculty members (94.7%) were male, but the numbers of male and female teachers were almost equal. The majority of TE teachers hold a Bachelor degree (57%); most of the managers possess a Bachelor or Master degree (73.2%); and most of the faculty have earned Doctorates (63.2%). The group of teachers from northern Taiwan had more responses (30.8%) and the teachers from eastern Taiwan and isolated islands had fewer responses (17.8%).

Conclusions

Based on the statistical analysis of data in chapter four, the conclusions of this study were formulated as follows.

Conclusions Related to the Level of Importance of E&T Content

1. The most important category of E&T content, as identified by the teachers, managers, and faculty was energy conservation practices, followed by careers and sources of energy. For a country with over 95% imported energy, both the government and the people are concerned most with how to implement energy conservation policies and practices in order to reduce reliance on imported energy. This concept was reflected in the opinions of the respondents and is also supported in related reports from Lin (1993) and Tien (1993).

The economy of Taiwan must rely on manpower because of the lack of natural resources. Every teacher and parent is most concerned that their students and children get an appropriate job in this highly competitive society. The career exploration issue was also a subject of importance for the teachers, managers, and faculty. This finding was also supported in articles by Lee (1995), Tien (1993), and Yu (1993).

The items in which the means of each respondent group exceeded the 4.0 level (very important) include techniques for conservation, principles of conservation, automobiles and trucks, solar cells, ocean transportation, internal combustion engines, nuclear energy, and solar energy. In addition to the items regarding energy conservation, the need for transportation for the island nation (automobiles and ocean transportation) and the contemporary and future need for energy (internal combustion engines, solar cells, solar energy, and nuclear energy) were also emphasized.

2. The least important categories, as identified by the means of each respondent group, were transmission of energy, air and space transportation, and energy converters. The items with grand means under 3.0 (low importance) are inland waterway transportation, gas turbine engines, and jet and rocket engines. Rivers and lakes in Taiwan are not suitable for waterway transportation and using them would not create the efficiency needed (Energy Commission, 1995).

3. The means of each respondent group for 39 out of 42 items exceeded 3.0 (important). This basically showed that most of the respondents agreed that these items should be included within the E&T component in Taiwanese junior high schools. Their opinions also supported the beliefs of the

expert panel and authors from the literature review. However three items were not identified as being important for implementation in E&T programs.

4. In general, the three groups rated the same three important categories (with one exception) as being most important for E&T content. In addition, the teacher group rated the category of transmission of energy as least important, the managers air and space transportation, and the faculty marine transportation. However, all of the three groups rated inland waterway transportation as the least important item.

Conclusions Related to the Knowledge Level of E&T Content

1. In all three groups, eight out of a total of nine categories were rated between a moderate level and low level. The ninth category was just below the low level. This indicated that basically the respondents felt that their knowledge concerning E&T content was deficient.

2. The category with the highest perceived knowledge level, as rated by the manager and faculty groups, was costs of energy, but the teachers rated land transportation the highest. Furthermore, the three groups rated air and space transportation as their lowest knowledge level category.

3. Eight out of a total of 49 items were rated as exceeding 3.0 by the three groups as their highest knowledge level items. These included automobiles and trucks, energy

crises, generators and motors, petroleum, coal, internal combustion energy, hydroelectric energy, and rails. Most of these items concern everyday life or are the focus of news in the media.

4. Seven items were rated under 2.0 by the three groups including fuel cells, space transportation, inland waterway transportation, helicopters, jet and rocket engines, solar cells, and gas turbine engines. Most of these items involve new technology or technology that is not used by the society of the respondents (i.e., inland waterway transportation).

5. Nine significant differences were found between the teacher and manager group, as well as, between the faculty and teacher group. However, only three significant differences were found between managers and faculty members. This phenomenon may be attributed to the fact that managers and faculty members have attained similar educational levels or advanced degrees (see Table 4).

Conclusions Related to Differences Between the Importance Level and Knowledge Level of the Teacher Group

1. The most important categories of E&T content as rated by the teachers were energy conservation practices, careers, and land transportation. They rated land transportation, energy conservation practices, and sources of energy as the highest knowledge level categories. This reflects the fact that in most of the categories (2 out of

3), that they perceived as having a high knowledge level of, they also believed to be important.

2. The least important categories were transmission of energy, air & space transportation, and costs of energy. The lowest knowledge level categories were air and space transportation, careers, and marine transportation. It should be mentioned that the category of careers was rated as one of the most important categories, but teachers rated themselves as being very low in knowledge level in this area.

3. Of the total 42 content items rated by the teachers, the average importance level was 3.51, but the knowledge level was 2.37. Thirty-four items rated for importance level exceeded 3.0, however, only 7 items rated for knowledge level were rated beyond 3.0. This shows a huge discrepancy between the ratings by the teachers of importance level and knowledge level. The necessity for in-service training of E&T content is readily apparent as critical.

4. Ten items from 13 total items concerning transportation were found to be significantly different between importance level and knowledge level. The ratio is much higher than that of energy areas in which 14 items out of a total of 29 items were found to be significantly different. This shows that in-service teachers training in

the transportation area is more urgent than in the energy area.

Recommendations Based on the Study

The results of this study can contribute to the literature on appropriate Energy and Transportation content for junior high school Technology Education in Taiwan. Based upon the findings and conclusions of this study, the following recommendations were formulated:

1. The necessity for most TE teachers to receive in-service training in the E&T area is very urgent since the knowledge level of teachers is much lower than their rating of the perceived importance level.

2. The transportation component should be taught prior to the energy component in the in-service training because the findings of the study show that teachers need knowledge of transportation more urgently than that of energy.

3. It is recommended that technology teacher educators who teach courses related to energy and transportation consider the implications found in this study concerning important content for junior high technology education to reconceptualize their curriculum.

4. The Taiwanese Ministry of Education should establish teacher certificate renewal requirements to inspire TE teachers to participate in the in-service training.

5. It is recommended that the experience of the development of technology education in the United States be considered as a major source of information and ideas during promotion of a thoughtful program of innovation.

6. Technology education is always in a state of transition; hence, it will be necessary to conduct continuing studies in the future to update the content of E&T, as well as, the contents of technology education.

7. The Ministry of Education in Taiwan or the Bureaus of Education of local governments should identify the important content for E&T, as well as, technology education and publish a curriculum guideline, and not just promulgate curriculum standards which have not been as specific.

8. The government should expand technology education from junior high and high school to elementary school, this will benefit students by providing instruction in basic technological concepts in the early years of education.

9. An exchange program should be developed which will include inviting scholars in the technology education field from the United States and other countries, as well as, sending Taiwanese teachers, faculty members, and administrators to the U.S. and other countries to study technology education.

10. Establish an in-service TE teacher training center in order to enhance teachers' knowledge and teaching skills.

11. Encourage TE teachers to participate in professional organizations, conventions and seminars in order to provide them with a stronger background in the technology education field.

12. The learning activities of E&T should be designed based on projects concerning everyday life and should reflect the needs of the Taiwanese social environment.

Recommendations for Future Study

This study was limited to investigating the appropriate junior high E&T content that is suited to the contemporary environment of Taiwan. More studies are needed to improved technology education. The recommendations for future study are made as follows.

1. The subjects of this study included TE teachers, industrial managers, and university faculty from the field of technology education and industry. In order to provide a comprehensive view concerning E&T content, other groups such as: parents, administrators, graduate students, and technicians could be included in a future study.

2. Replicate this study of appropriate junior high E&T content at three year intervals to verify the findings of this study, and to determine if changes occur.

3. Replicate this study in senior high E&T content because the senior high schools in Taiwan will additionally implement the new E&T component in 1997.

4. Replicate this study in the other areas of technology education, such as technology and life, information and communication, and manufacturing and construction, in the junior and senior high level.

5. When replicating this study, also determine agreements among groups using correlation coefficients.

6. Based on this study, learning activities should be researched and developed which would appropriately guide student learning in the area of Energy and Transportation.

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Appendix A

The Important E&T Content Identified for Junior High School Technology Education in Taiwan

The Important E&T Content Identified for Junior High School Technology Education in Taiwan

A. Sources of Energy

1. Solar
2. Wind
3. Biomass
4. Ocean
5. Hydroelectric energy
6. Geothermal energy
7. Coal
8. Petroleum
9. Natural gas
10. Nuclear energy

B. Energy Converters

11. Principles of energy conversion
12. Effectiveness of energy conversion
13. Internal combustion engines
14. Gas turbine engines
15. Jet and rocket engines
16. External combustion engines
17. Generators and motors
18. Fuel cells
19. Solar cells

C. Costs of Energy

20. Economic costs

21. Social costs

22. Energy crises

D. Energy Conservation Practices

23. Principles of conservation

24. Techniques and strategies for conservation

E. Transmission of Energy

25. Electrical

26. Fluid

27. Mechanical

28. Control and regulation

F. Land Transportation

29. Automobiles and trucks

30. Rails

31. Pipelines

G. Marine Transportation

32. Ship structure and machinery

33. Inland waterway transportation

34. Ocean transportation

35. Seaports and shipping procedures

H. Air and Space Transportation

36. Light aircraft structure

37. Commercial airplanes

38. Helicopters

39. Airport terminals and facilities

40. Space transportation

I. Careers

41. Careers in the energy field

42. Careers in the transportation field

Appendix B

Approval Letter

The University of Northern Iowa

December 14, 1995

Chang-Cheng Chen
307 F Street
Cedar Falls, IA 50613

Dear Chang-Cheng Chen:

Your project, "An Investigation of the Energy and Transportation Component for Junior High School Technology Education Programs in Taiwan.", which you submitted for human subjects review on 12/08/95 has been determined to be exempt from further review under the guidelines stated in the UNI Human Subjects Handbook. You may commence participation of human research subjects in your project.

Your project need not be submitted for continuing review unless you alter it in a way that increases the risk to the participants. If you make any such changes in your project, you should notify the Graduate College Office.

If you decide to seek federal funds for this project, it would be wise not to claim exemption from human subjects review on your application. Should the agency to which you submit the application decide that your project is not exempt from review, you might not be able to submit the project for review by the UNI Institutional Review Board within the federal agency's time limit (30 days after application). As a precaution against applicants' being caught in such a time bind, the Board will review any projects for which federal funds are sought. If you do seek federal funds for this project, please submit the project for human subjects review no later than the time you submit your funding application.

If you have any further questions about the Human Subjects Review System, please contact me. Best wishes for your project.

Sincerely,

Norris M. Durham, Ph.D.
Chair, Institutional Review Board

cc: Dr. David A. Walker, Associate Dean
Dr. John T. Fecik

Graduate College 1 Seerley Cedar Falls, Iowa 50614-0702 (319) 273-2748 FAX: (319) 273-2243

Appendix C

Cover Letters

February 1, 1996

Dear teacher:

Successful implementation of the Energy and Transportation (E&T) component of Technology Education will contribute to the future success of educational programs which will improve individual citizens and the country as a whole. A research study is being conducted for a doctoral dissertation to identify and determine the appropriate content of the E&T unit in the junior high schools in Taiwan. The results of this study will provide educational planners and administrators with practical information that can be used to design and implement the new curriculum.

You have been chosen because you are involved with the energy and transportation industry as a technology education teacher. In order that the results accurately represent a wide range of opinions, it is very important that each questionnaire be completed and returned. Responding should take only a short time, but it is critical to the success of the study. You are urged to complete the questionnaire and return it in the enclosed envelope by February 16, 1996.

You may be assured that your responses will remain completely confidential. Your name and specific demographic information will not appear in the dissertation. The questionnaire will be destroyed after the statistics have been calculated. If you are interested in receiving a summary of the results, please contact the researcher at the address in Taiwan.

Your cooperation is greatly appreciated.

Sincerely,

Chang-Cheng Chen
D.I.T. Candidate
Industrial
University of Northern Iowa

Advisor:
Dr. John T. Fecik
Department of
Technology, UNI

Address in Taiwan:
134 Ta Tung 1st Rd., Kaohsiung, Taiwan

February 1, 1996

Dear manager:

Successful implementation of the Energy and Transportation (E&T) component of Technology Education will contribute to the future success of educational programs which will improve individual citizens and the country as a whole. A research study is being conducted for a doctoral dissertation to identify and determine the appropriate content of the E&T unit in the junior high schools in Taiwan. The results of this study will provide educational planners and administrators with practical information that can be used to design and implement the new curriculum.

You have been chosen because you are involved with the energy and transportation industry as a manager. In order that the results accurately represent a wide range of opinions, it is very important that each questionnaire be completed and returned. Responding should take only a short time, but it is critical to the success of the study. You are urged to complete the questionnaire and return it in the enclosed envelope by February 16, 1996.

You may be assured that your responses will remain completely confidential. Your name and specific demographic information will not appear in the dissertation. The questionnaire will be destroyed after the statistics have been calculated. If you are interested in receiving a summary of the results, please contact the researcher at the address in Taiwan.

Your cooperation is greatly appreciated.

Sincerely,

Chang-Cheng Chen
D.I.T. Candidate
Industrial
University of Northern Iowa

Advisor:
Dr. John T. Fecik
Department of
Technology, UNI

Address in Taiwan:
134 Ta Tung 1st Rd., Kaohsiung, Taiwan

February 1, 1996

Dear professor:

Successful implementation of the Energy and Transportation (E&T) component of Technology Education will contribute to the future success of educational programs which will improve individual citizens and the country as a whole. A research study is being conducted for a doctoral dissertation to identify and determine the appropriate content of the E&T unit in the junior high schools in Taiwan. The results of this study will provide educational planners and administrators with practical information that can be used to design and implement the new curriculum.

You have been chosen because you are involved with the energy and transportation industry as a university faculty. In order that the results accurately represent a wide range of opinions, it is very important that each questionnaire be completed and returned. Responding should take only a short time, but it is critical to the success of the study. You are urged to complete the questionnaire and return it in the enclosed envelope by February 16, 1996.

You may be assured that your responses will remain completely confidential. Your name and specific demographic information will not appear in the dissertation. The questionnaire will be destroyed after the statistics have been calculated. If you are interested in receiving a summary of the results, please contact the researcher at the address in Taiwan.

Your cooperation is greatly appreciated.

Sincerely,

Chang-Cheng Chen
D.I.T. Candidate
Industrial
University of Northern Iowa

Advisor:
Dr. John T. Fecik
Department of
Technology, UNI

Address in Taiwan:
134 Ta Tung 1st Rd., Kaohsiung, Taiwan

敬愛的工藝教師：

處於現今科技高度發展的時代，科技教育的有效實施，對於個人、社會與國家，將有很大的貢獻。本研究是爲了探討國民中學生活科技中，能源與運輸課程之主要內涵，研究結果將提供學校教師在實施課程的參考。

由於您是從事科技教育之播種者，且具有豐富的教學經驗，您的寶貴意見對於本研究十分重要，填答所附問卷，只需花幾分鐘時間，但卻是決定本研究成功與否的主要關鍵，如果方便的話，是否請您在2月10日以前，將填妥的問卷寄回。

本研究所有問卷，將以匿名方式處理，並在統計工作完成之後一併銷燬。假如您對本研究的結果有興趣，請與本人聯絡，待研究完成後，將奉上一份摘要報告以供參考。謝謝您的合作！

敬 頌

春 祺

美國北愛荷華大學工業科技研究所

指導教授：約翰．費希克博士

博士候選人：陳長振

敬上

中華民國八十五年二月二日

敬愛的經理：

處於現今科技高度發展的時代，科技教育的有效實施，對於個人、社會與國家，將有很大的貢獻。本研究是為了探討國民中學生活科技中，能源與運輸課程之主要內涵，研究結果將提供學校教師在實施課程的參考。

由於您是從事發展〝台灣經濟奇蹟〞的工作，並卓有成就，您的寶貴意見對於本研究十分重要，填答所附問卷，只需花幾分鐘時間，但卻是決定本研究成功與否的主要關鍵，如果方便的話，是否請您在2月10日以前，將填妥的問卷寄回。

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敬　頌

春　祺

美國北愛荷華大學工業科技研究所

指導教授：約翰・費希克博士

博士候選人：陳長振

敬上

中華民國八十五年二月二日

敬愛的教授：

處於現今科技高度發展的時代，科技教育的有效實施，對於個人、社會與國家，將有很大的貢獻。本研究是為了探討國民中學生活科技中，能源與運輸課程之主要內涵，研究結果將提供學校教師在實施課程的參考。

由於您任教於高等學府，從事科技教育師資培育工作，您的寶貴意見對於本研究十分重要，填答所附問卷，只需花幾分鐘時間，但卻是決定本研究成功與否的主要關鍵，如果方便的話，是否請您在 2 月 10 日以前，將填妥的問卷寄回。

本研究所有問卷，將以匿名方式處理，並在統計工作完成之後一併銷燬。假如您對本研究的結果有興趣，請與本人聯絡，待研究完成後，將奉上一份摘要報告以供參考。謝謝您的合作！

敬 頌

春 祺

美國北愛荷華大學工業科技研究所

指導教授：約翰．費希克博士

博士候選人：陳長振

敬上

中華民國八十五年二月二日

Appendix D

Questionnaire

QUESTIONNAIRE

Part I Content of Energy and Transportation

Directions

The following items deal with content for the Energy and Transportation (E&T) unit in junior high school Technology Education programs. Please circle the number that best describes your thoughts regarding the content of E&T. These questions are composed of two parts which are, (1) your perception of the importance of the item and (2) your perception of the level of your own knowledge of the item.

The survey is designed to identify the important areas to be covered in a unit with a limited amount of time. Therefore, when evaluating the importance of the items take into account the fact that the time allocated for this unit is a total of 24 hours of teaching time.

1 = Very low
2 = Low
3 = Moderate
4 = High
5 = Very high

	Perceived importance	Perceived knowledge level
A. Sources of Energy		
1. Solar	1 2 3 4 5	1 2 3 4 5
2. Wind	1 2 3 4 5	1 2 3 4 5
3. Biomass	1 2 3 4 5	1 2 3 4 5
4. Ocean	1 2 3 4 5	1 2 3 4 5
5. Hydroelectric energy	1 2 3 4 5	1 2 3 4 5
6. Geothermal energy	1 2 3 4 5	1 2 3 4 5
7. Coal	1 2 3 4 5	1 2 3 4 5
8. Petroleum	1 2 3 4 5	1 2 3 4 5
9. Natural gas	1 2 3 4 5	1 2 3 4 5
10. Nuclear energy	1 2 3 4 5	1 2 3 4 5
B. Energy Converters		
11. Principles of energy conversion	1 2 3 4 5	1 2 3 4 5
12. Effectiveness of energy conversion	1 2 3 4 5	1 2 3 4 5
13. Internal combustion engines	1 2 3 4 5	1 2 3 4 5
14. Gas turbine engines	1 2 3 4 5	1 2 3 4 5

15. Jet and rocket engines	1 2 3 4 5	1 2 3 4 5
16. External combustion engines	1 2 3 4 5	1 2 3 4 5
17. Generators and motors	1 2 3 4 5	1 2 3 4 5
18. Fuel cells	1 2 3 4 5	1 2 3 4 5
19. Solar cells	1 2 3 4 5	1 2 3 4 5
C. Costs of Energy		
20. Economic costs	1 2 3 4 5	1 2 3 4 5
21. Social costs	1 2 3 4 5	1 2 3 4 5
22. Energy crises	1 2 3 4 5	1 2 3 4 5
D. Energy Conservation Practices		
23. Principles of conservation	1 2 3 4 5	1 2 3 4 5
24. Techniques and strategies for conservation	1 2 3 4 5	1 2 3 4 5
E. Transmission of Energy		
25. Electrical	1 2 3 4 5	1 2 3 4 5
26. Fluid	1 2 3 4 5	1 2 3 4 5
27. Mechanical	1 2 3 4 5	1 2 3 4 5
28. Control and regulation	1 2 3 4 5	1 2 3 4 5
F. Land Transportation		
29. Automobiles and trucks	1 2 3 4 5	1 2 3 4 5
30. Rails	1 2 3 4 5	1 2 3 4 5
31. Pipelines	1 2 3 4 5	1 2 3 4 5
G. Marine Transportation		
32. Ship structure and machinery	1 2 3 4 5	1 2 3 4 5
33. Inland waterway transportation	1 2 3 4 5	1 2 3 4 5
34. Ocean transportation	1 2 3 4 5	1 2 3 4 5
35. Seaports and shipping procedures	1 2 3 4 5	1 2 3 4 5
H. Air and Space Transportation		
36. Light aircraft structure	1 2 3 4 5	1 2 3 4 5
37. Commercial airplanes	1 2 3 4 5	1 2 3 4 5
38. Helicopters	1 2 3 4 5	1 2 3 4 5

39. Airport terminals and facilities	1 2 3 4 5	1 2 3 4 5
40. Space transportation	1 2 3 4 5	1 2 3 4 5

I. Careers

41. Careers in the energy field	1 2 3 4 5	1 2 3 4 5
42. Careers in the transportation field	1 2 3 4 5	1 2 3 4 5

Part II Demographic Information

Please place an (x) in the appropriate space for each of the following questions:

A. Please indicate your title (check only one).
( ) 1. Junior high school teacher
( ) 2. Industrial manager
( ) 3. University faculty

B. Sex
( ) 1. Male
( ) 2. Female

C. Age
( ) 1. 25 and under
( ) 2. 26-35
( ) 3. 36-45
( ) 4. 46-55
( ) 5. Above 55

D. What is the highest degree you have earned?
( ) 1. Bachelor
( ) 2. Master
( ) 3. Doctorate
( ) 4. Others ___________

Questions E & F are just for teachers.

E. Years of teaching experience.
( ) 1. Less than 5 years
( ) 2. 5-10 years
( ) 3. 11-20 years
( ) 4. 21-30 years
( ) 5. More than 30 years

F. Geographic location of your school.
( ) 1. Northern Taiwan
( ) 2. Central Taiwan
( ) 3. Southern Taiwan
( ) 4. Eastern Taiwan & isolated islands

Question G is just for managers.

G. What type of industry do you work for?
( ) 1. Energy & Power
( ) 2. Manufacturing
( ) 3. Construction
( ) 4. Transportation

國中生活科技課程能源與運輸內涵調查問卷 P.1

第一部份　能源與運輸內涵

填答說明：

在下列四十二項國中生活科技課程能源與運輸內涵中，請就您認爲該項內涵對於能源與運輸課程的〝重要程度〞，以及您目前對該項內涵的〝了解程度〞，分別在各項右側的量表中，圈選最適當的一個數字——由 1 至 5，分別代表非常低至非常高。

依據國中課程標準，在未來新課程實施時，能源與運輸部份共分配二十四節上課時間，在圈選各項目的重要程度時，請酌作考量。謝謝！

	重要程度					了解程度				
	1 非常低	2 低	3 中等	4 高	5 非常高	1 非常低	2 低	3 中等	4 高	5 非常高
A 能源的類別										
1. 太陽能	1	2	3	4	5	1	2	3	4	5
2. 風能	1	2	3	4	5	1	2	3	4	5
3. 生質能	1	2	3	4	5	1	2	3	4	5
4. 海洋能	1	2	3	4	5	1	2	3	4	5
5. 水力	1	2	3	4	5	1	2	3	4	5
6. 地熱	1	2	3	4	5	1	2	3	4	5
7. 煤	1	2	3	4	5	1	2	3	4	5
8. 石油	1	2	3	4	5	1	2	3	4	5
9. 天然氣	1	2	3	4	5	1	2	3	4	5
10. 核能	1	2	3	4	5	1	2	3	4	5
B 能的轉換										
11. 能的轉換原理	1	2	3	4	5	1	2	3	4	5
12. 能的轉換效率	1	2	3	4	5	1	2	3	4	5
13. 內燃機	1	2	3	4	5	1	2	3	4	5
14. 燃氣渦輪機	1	2	3	4	5	1	2	3	4	5
15. 噴射引擎與火箭	1	2	3	4	5	1	2	3	4	5
16. 外燃機	1	2	3	4	5	1	2	3	4	5
17. 馬達與發電機	1	2	3	4	5	1	2	3	4	5
18. 燃料電池	1	2	3	4	5	1	2	3	4	5
19. 太陽電池	1	2	3	4	5	1	2	3	4	5

	重要程度					了解程度				P.2
C 能源的成本										
20. 經濟成本	1	2	3	4	5	1	2	3	4	5
21. 社會成本	1	2	3	4	5	1	2	3	4	5
22. 能源危機	1	2	3	4	5	1	2	3	4	5
D 節約能源實務										
23. 能源節約原理	1	2	3	4	5	1	2	3	4	5
24. 節約技巧與策略	1	2	3	4	5	1	2	3	4	5
E 動力的傳輸										
25. 電力	1	2	3	4	5	1	2	3	4	5
26. 流體動力	1	2	3	4	5	1	2	3	4	5
27. 機械能	1	2	3	4	5	1	2	3	4	5
28. 動力的控制	1	2	3	4	5	1	2	3	4	5
F 陸路運輸										
29. 汽車	1	2	3	4	5	1	2	3	4	5
30. 鐵路運輸	1	2	3	4	5	1	2	3	4	5
31. 管線運輸	1	2	3	4	5	1	2	3	4	5
G 水路運輸										
32. 輪船的構造	1	2	3	4	5	1	2	3	4	5
33. 內陸水路運輸	1	2	3	4	5	1	2	3	4	5
34. 海洋水路運輸	1	2	3	4	5	1	2	3	4	5
35. 港口與運送程序	1	2	3	4	5	1	2	3	4	5
H 空中與太空運輸										
36. 小型飛機構造	1	2	3	4	5	1	2	3	4	5
37. 商業客機	1	2	3	4	5	1	2	3	4	5
38. 直昇機	1	2	3	4	5	1	2	3	4	5
39. 機場設備	1	2	3	4	5	1	2	3	4	5
40. 太空運輸	1	2	3	4	5	1	2	3	4	5
I 生計輔導										
41. 與能源有關的行業	1	2	3	4	5	1	2	3	4	5
42. 與運輸有關的行業	1	2	3	4	5	1	2	3	4	5

第二部份　個人基本資料 P.3

請在下列各類個人資料括弧內勾選合適項目

一. 您的身份是：

( ) 1. 國中教師
( ) 2. 企業界經理
( ) 3. 大學教師

二. 性別：

( ) 1. 男性
( ) 2. 女性

三. 年齡：

( ) 1. 25 歲以下
( ) 2. 25 — 35 歲
( ) 3. 36 — 45 歲
( ) 4. 46 — 55 歲
( ) 5. 55 歲以上

四. 教育程度：

( ) 1. 學士
( ) 2. 碩士
( ) 3. 博士
( ) 4. 其他__________

《國中教師請填五六兩題》

五. 教學年資：

( ) 1. 5 年以下
( ) 2. 5 — 10 年
( ) 3. 11 — 20 年
( ) 4. 21 — 30 年
( ) 5. 30 年以上

六. 任教學校所在地區：

( ) 1. 台灣北部地區
( ) 2. 台灣中部地區
( ) 3. 台灣南部地區
( ) 4. 東部與離島

《企業經理請填第七題》

七. 您服務的企業屬於：

( ) 1. 能源與動力有關行業
( ) 2. 製造業
( ) 3. 營建業
( ) 4. 運輸業

Appendix E

The Level of Importance of E&T Content

Appendix E

The Level of Importance of E&T Content

No.	Important Content of E&T	Teacher	Rank	Manager	Rank	Faculty	Rank	M*
24	Techniques for conservation	4.31	1	4.60	1	4.54	1	4.41
23	Principles of conservation	4.24	2	4.56	2	4.33	2	4.33
29	Automobiles and trucks	4.23	3	4.09	10	4.17	7	4.19
19	Solar cells	4.09	6	4.21	6	4.17	8	4.13
34	Ocean transportation	4.08	7	4.23	4	3.85	21	4.10
13	Internal combustion engines	4.11	5	3.96	17	4.24	4	4.08
10	Nuclear energy	4.14	4	3.94	18	3.86	20	4.06
1	Solar energy	4.08	8	3.82	27	4.21	5	4.03
11	Principles of energy conv.	4.03	9	3.86	21	4.11	9	3.99
4	Ocean energy	3.93	10	4.02	15	3.86	19	3.95
35	Seaports and shipping proc.	3.93	11	4.16	7	3.34	33	3.93
7	Coal	3.89	12	4.03	14	3.63	30	3.90
22	Energy crises	3.79	14	4.14	8	4.05	11	3.90
41	Careers in the energy field	3.65	20	4.42	3	4.18	6	3.90
17	Generators and motors	3.83	13	4.06	12	3.87	18	3.89
42	Careers in the transportation	3.74	17	4.23	5	4.04	12	3.89
16	External combustion engines	2.74	39	2.99	40	3.02	40	3.83
32	Ship structure and machinery	3.76	16	4.02	16	3.81	24	3.83
8	Petroleum	3.78	15	3.86	22	3.92	15	3.81
2	Wind energy	3.73	18	3.86	23	3.96	13	3.79
18	Fuel cells	3.51	24	4.08	11	4.25	3	3.73

Appendix E (continued)

No.	Important Content of E&T	Teacher	Rank	Manager	Rank	Faculty	Rank	M*
36	Light aircraft structure	3.64	21	3.83	26	3.91	16	3.71
9	Natural gas	3.68	19	3.54	33	4.06	10	3.68
12	Effectiveness of energy conv.	3.52	23	3.93	19	3.82	23	3.65
20	Economic costs	3.43	26	4.06	13	3.75	26	3.62
26	Pipelines	3.41	27	4.10	9	3.08	39	3.55
40	Space transportation	3.57	22	3.45	34	3.64	29	3.55
5	Hydroelectric energy	3.25	29	3.84	25	3.54	31	3.43
37	Commercial airplanes	3.25	30	3.87	20	3.24	36	3.41
30	Rails	3.44	25	3.25	36	3.19	37	3.37
3	Biomass	3.15	32	3.76	28	3.69	27	3.36
21	Social costs	2.98	34	3.74	29	3.96	14	3.27
6	Geothermal energy	3.09	33	3.65	30	3.41	32	3.26
39	Airport terminals & facility	3.18	31	3.42	35	3.30	34	3.25
38	Helicopters	3.27	28	3.06	39	3.29	35	3.22
26	Fluid transmission	2.85	37	3.64	31	3.83	22	3.15
25	Electrical transmission	2.86	36	3.58	32	3.66	28	3.12
27	Mechanical transmission	2.94	35	3.16	37	3.81	25	3.08
28	Control and regulation	2.77	38	3.85	24	3.13	38	3.08
15	Jet and rocket engines	2.65	40	2.41	41	3.88	17	2.71
14	Gas turbine engines	2.47	41	3.14	38	2.35	41	2.63
33	Inland waterway transport.	2.25	42	2.14	42	2.07	42	2.20

Note. M*: Mean of the three groups.

Appendix F

Significant Differences of Importance Level Among Surveyed Groups

Appendix F

Significant Differences of Importance Level Among Surveyed Groups

No.	Important Content of E&T	Teacher		Manager		Faculty		F	* p<.05;	** p<.01	
		M	SD	M	SD	M	SD	Prob.	T-M	M-F	F-T
1	Solar energy	4.08	0.64	3.82	1.22	4.21	0.73	0.01		*	
2	Wind energy	3.73	1.12	3.86	1.06	3.96	0.88	0.43			
3	Biomass	3.15	0.74	3.76	0.95	3.69	0.75	0.01	*		*
4	Ocean energy	3.93	0.94	4.02	1.16	3.86	0.93	0.07			
5	Hydroelectric energy	3.25	1.05	3.84	1.24	3.53	0.96	0.01	*		
6	Geothermal energy	3.09	1.13	3.65	1.04	3.41	1.10	0.01	*		
7	Coal	3.89	1.10	4.03	1.12	3.63	0.88	0.01		*	
8	Petroleum	3.78	0.94	3.86	1.21	3.92	0.92	0.07			
9	Natural gas	3.68	1.06	3.54	1.13	4.06	0.94	0.01		*	
10	Nuclear energy	4.14	1.12	3.94	1.20	3.86	0.93	0.08			
11	Principles of energy conv.	4.03	1.03	3.86	1.16	4.11	0.85	0.14			
12	Effectiveness of conv.	3.52	1.14	3.93	1.05	3.82	0.74	0.01	*		
13	Internal comb. engines	4.11	1.16	3.96	1.18	4.24	0.93	0.09			
14	Gas turbine engines	2.47	1.03	3.14	0.96	2.35	0.92	0.02	*	**	
15	Jet and rocket engines	2.65	0.95	2.41	1.07	3.88	0.97	0.01		**	**
16	External comb. engines	2.74	0.87	2.99	1.14	3.02	1.03	0.07			
17	Generators & motors	3.83	1.06	4.06	1.13	3.87	0.86	0.14			
18	Fuel cells	3.51	1.24	4.08	1.21	4.25	1.04	0.01	*		**
19	Solar cells	4.09	1.10	4.21	1.06	4.17	0.74	0.22			
20	Economic costs	3.43	1.06	4.06	1.07	3.75	0.85	0.01	*		
21	Social costs	2.98	1.03	3.74	0.94	3.96	0.77	0.01	**		**

Appendix F (continued)

No.	Important Content of E&T	Teacher		Manager		Faculty		F	* p<.05; ** p<.01		
		M	SD	M	SD	M	SD	Prob.	T-M	M-F	F-T
22	Energy crises	3.79	0.97	4.14	0.95	4.05	0.69	0.07			
23	Principles of conservation	4.24	0.95	4.56	1.12	4.33	0.82	0.10			
24	Techniques of conservation	4.31	0.86	4.60	0.92	4.54	0.88	0.08			
25	Electrical transmission	2.86	1.23	3.58	1.14	3.66	0.93	0.01			**
26	Fluid transmission	2.85	0.74	3.64	0.83	3.83	0.75	0.01	**		**
27	Mechanical transmission	2.94	0.96	3.16	1.04	3.81	0.86	0.01		*	**
28	Control and regulation	2.77	0.87	3.85	0.96	3.13	0.73	0.01	**	**	
29	Automobiles and trucks	4.23	0.94	4.09	1.18	4.17	0.86	0.35			
30	Rails	3.44	0.98	3.25	0.87	3.19	0.93	0.16			
31	Pipelines	3.41	1.12	4.10	1.18	3.08	0.79	0.01	*	**	
32	Ship structure & machinery	3.76	1.03	4.02	1.06	3.81	0.92	0.24			
33	Inland waterway transport.	2.25	0.86	2.14	1.12	2.07	0.74	0.13			
34	Ocean transportation	4.08	1.14	4.23	1.05	3.85	0.88	0.06			
35	Seaports & shipping proc.	3.93	1.04	4.16	1.06	3.34	0.93	0.01		**	
36	Light aircraft structure	3.64	1.22	3.82	1.16	3.91	0.71	0.17			
37	Commercial airplanes	3.25	0.78	3.87	0.96	3.24	0.84	0.02	*	*	
38	Helicopters	3.27	0.89	3.06	1.04	3.29	0.67	0.09			
39	Airport terminals & facil.	3.18	1.06	3.42	1.21	3.30	0.65	0.13			
40	Space transportation	3.57	0.87	3.45	1.03	3.64	0.85	0.38			
41	Careers in energy field	3.65	0.74	4.42	0.96	4.18	0.89	0.01	**		*
42	Careers in transportation	3.74	0.92	4.23	0.89	4.04	0.78	0.02	*		*

Note. T: Teacher M: Manager F: Faculty

Appendix G

The Knowledge Level of E&T Content

Appendix G

The Knowledge Level of E&T Content

No.	Knowledge Level of E&T	Teacher	Rank	Manager	Rank	Faculty	Rank	M*
29	Automobiles and trucks	3.24	1	3.28	3	3.34	3	3.26
22	Energy crises	2.84	9	3.85	1	3.81	1	3.19
17	Generators and motors	3.14	3	3.07	8	3.42	2	3.15
8	Petroleum	3.11	4	3.15	5	3.18	7	3.13
7	Coal	3.07	5	3.21	4	3.17	8	3.12
13	Internal combustion engines	3.16	2	3.04	10	2.93	10	3.11
5	Hydroelectric energy	3.03	7	3.15	6	3.21	6	3.08
30	Rails	3.06	6	2.94	12	3.02	9	3.03
1	Solar energy	2.96	8	2.84	14	2.74	13	2.91
9	Natural gas	2.75	11	3.06	9	3.26	5	2.88
2	Wind energy	2.83	10	2.78	15	2.65	17	2.80
24	Techniques for conservation	2.73	12	2.87	13	2.92	12	2.78
23	Principles of conservation	2.69	13	2.59	20	2.54	21	2.65
20	Economic costs	2.17	24	3.46	2	3.29	4	2.61
27	Mechanical transmission	2.54	15	2.73	16	2.66	16	2.60
11	Principles of energy conv.	2.64	14	2.32	25	2.24	33	2.52
21	Social costs	2.42	17	2.69	17	2.74	14	2.52
12	Effectiveness of energy conv.	2.43	16	2.69	18	2.35	28	2.49
31	Pipelines	2.23	22	3.14	7	2.54	22	2.49
34	Ocean transportation	2.32	19	3.02	11	2.26	31	2.49
35	Seaports & shipping proc.	2.30	21	2.57	21	2.47	23	2.39

Appendix G (continued)

No.	Knowledge Level of E&T	Teacher	Rank	Manager	Rank	Faculty	Rank	M*
28	Control and regulation	2.18	23	2.64	19	2.47	24	2.33
16	External combustion engines	2.33	18	2.26	29	2.37	26	2.32
25	Electrical transmission	2.31	20	2.21	31	2.35	27	2.29
26	Fluid transmission	2.16	25	2.46	23	2.61	20	2.28
42	Careers in the transportation	2.08	29	2.53	22	2.67	15	2.25
32	Ship structure and machinery	2.10	27	2.32	26	2.42	25	2.19
10	Nuclear energy	2.05	31	2.18	32	2.92	11	2.17
36	Light aircraft structure	2.10	28	2.32	27	2.28	30	2.17
41	Careers in the energy field	1.96	34	2.42	24	2.64	18	2.14
4	Ocean energy	2.14	26	1.94	36	2.26	32	2.10
37	Commercial airplanes	2.05	32	2.03	35	2.62	19	2.10
39	Airport terminals & facility	2.07	30	2.15	33	2.21	34	2.10
6	Hydroelectric energy	1.96	35	2.32	28	2.16	35	2.07
3	Biomass	2.01	33	2.06	34	2.32	29	2.05
14	Gas turbine engines	1.84	37	2.23	30	2.06	36	1.96
19	Solar cells	1.85	36	1.93	37	1.95	37	1.88
15	Jet and rocket engines	1.82	39	1.93	38	1.95	38	1.86
38	Helicopters	1.84	38	1.76	41	1.69	42	1.81
33	Inland waterway transport.	1.74	41	1.93	39	1.71	41	1.79
40	Space transportation	1.76	40	1.83	40	1.79	39	1.78
18	Fuel cells	1.62	42	1.58	42	1.74	40	1.62

Note. M*: Mean of the three groups.

Appendix H

Significant Differences of Knowledge Level

Among Surveyed Groups

Appendix H

Significant Differences of Knowledge Level Among Surveyed Groups

No.	Important Content of E&T	Teacher		Manager		Faculty		F	* p<.05; ** p<.01		
		M	SD	M	SD	M	SD	Prob.	T-M	M-F	F-T
1	Solar energy	2.96	1.22	2.84	1.05	2.74	1.32	0.43			
2	Wind energy	2.83	1.04	2.78	1.13	2.65	1.21	0.50			
3	Biomass	2.01	0.73	2.06	0.96	2.32	1.11	0.06			
4	Ocean energy	2.14	0.86	1.94	1.14	2.26	1.06	0.06			
5	Hydroelectric energy	3.03	0.94	3.15	1.16	3.21	0.96	0.41			
6	Geothermal energy	1.96	1.16	2.32	1.22	2.16	1.25	0.06			
7	Coal	3.07	1.21	3.21	1.04	3.17	1.15	0.33			
8	Petroleum	3.11	1.06	3.15	1.23	3.18	1.05	0.64			
9	Natural gas	2.75	0.94	3.06	1.12	3.26	0.86	0.01			*
10	Nuclear energy	2.05	1.14	2.18	1.20	2.92	1.22	0.01			**
11	Principles of energy conv.	2.64	0.98	2.32	0.94	2.24	1.13	0.02	*		*
12	Effectiveness of conv.	2.43	1.13	2.69	1.05	2.35	1.22	0.17			
13	Internal comb. engines	3.16	1.07	3.04	1.21	2.93	1.14	0.24			
14	Gas turbine engines	1.84	1.04	2.23	1.14	2.06	1.06	0.03	*		
15	Jet and rocket engines	1.82	1.03	1.93	0.94	1.95	0.96	0.64			
16	External comb. engines	2.33	0.97	2.26	1.04	2.37	0.89	0.55			
17	Generators & motors	3.14	1.14	3.07	1.22	3.42	0.97	0.07			
18	Fuel cells	1.62	0.96	1.58	1.14	1.74	1.06	0.12			
19	Solar cells	1.85	1.14	1.93	1.21	1.95	1.13	0.47			
20	Economic costs	2.17	1.13	3.46	0.91	3.29	1.07	0.01	**		**
21	Social costs	2.42	1.06	2.69	1.15	2.74	1.04	0.06			

Appendix H (continued)

No.	Important Content of E&T	Teacher		Manager		Faculty		F	* p<.05; ** p<.01		
		M	SD	M	SD	M	SD	Prob.	T-M	M-F	F-T
22	Energy crises	2.84	1.02	3.85	0.93	3.81	1.12	0.01	**		**
23	Principles of conservation	2.69	0.98	2.59	1.13	2.53	1.20	0.27			
24	Techniques of conservation	2.73	1.15	2.87	0.96	2.92	1.14	0.18			
25	Electrical transmission	2.31	1.26	2.21	1.15	2.35	1.21	0.28			
26	Fluid transmission	2.16	0.97	2.46	1.07	2.61	1.10	0.02			*
27	Mechanical transmission	2.54	1.15	2.73	1.18	2.66	1.06	0.19			
28	Control and regulation	2.18	1.22	2.64	1.04	2.47	1.16	0.03	*		
29	Automobiles and trucks	3.24	1.10	3.28	0.87	3.34	0.94	0.74			
30	Rails	3.06	0.95	2.94	1.06	3.02	0.98	0.62			
31	Pipelines	2.23	1.16	3.14	1.12	2.54	0.96	0.01	**	*	
32	Ship structure & machinery	2.10	1.03	2.32	1.06	2.42	1.21	0.07			
33	Inland waterway transport.	1.74	1.06	1.93	1.08	1.71	1.15	0.16			
34	Ocean transportation	2.32	1.16	3.02	1.14	2.26	1.07	0.01	**	**	
35	Seaports & shipping proc.	2.30	0.90	2.57	1.09	2.47	1.13	0.08			
36	Light aircraft structure	2.10	1.20	2.32	1.12	2.28	0.87	0.32			
37	Commercial airplanes	2.05	0.98	2.03	1.04	2.62	1.21	0.01		*	*
38	Helicopters	1.84	1.16	1.76	1.07	1.69	1.13	0.30			
39	Airport terminals & facil.	2.07	0.96	2.15	0.89	2.21	1.08	0.36			
40	Space transportation	1.76	0.87	1.83	0.84	1.79	0.90	0.84			
41	Careers in energy field	1.96	1.25	2.42	1.23	2.64	0.96	0.01	*		*
42	Careers in transportation	2.08	0.98	2.53	1.09	2.67	1.21	0.01	*		*

Note. T: Teacher M: Manager F: Faculty

Appendix I

Significant Differences Between the Importance level and Knowledge Level of the Teacher Group

Appendix I

Significant Differences Between the Importance Level and Knowledge Level of the Teacher Group

No.	Content of E&T	Importance Level		Knowledge Level		I. - K.	t
		M	SD	M	SD	Diff.	Prob.
1	Solar energy	4.08	0.64	2.96	1.22	1.12	0.03*
2	Wind energy	3.73	1.12	2.83	1.04	0.90	0.12
3	Biomass	3.15	0.74	2.01	0.73	1.14	0.03*
4	Ocean energy	3.93	0.94	2.14	0.86	1.79	0.01**
5	Hydroelectric energy	3.25	1.05	3.03	0.94	0.22	0.74
6	Geothermal energy	3.09	1.13	1.96	1.16	1.13	0.04*
7	Coal	3.89	1.10	3.07	1.21	0.82	0.33
8	Petroleum	3.78	0.94	3.11	1.06	0.67	0.57
9	Natural gas	3.68	1.06	2.75	0.94	0.93	0.11
10	Nuclear energy	4.14	1.12	2.05	1.14	2.09	0.01**
11	Principles of energy conv.	4.03	1.03	2.64	0.98	1.39	0.01**
12	Effectiveness of conversion	3.52	1.14	2.43	1.13	1.09	0.04*
13	Internal combustion engines	4.11	1.16	3.16	1.07	0.95	0.08
14	Gas turbine engines	2.47	1.03	1.84	1.04	0.63	0.58
15	Jet and rocket engines	2.65	0.95	1.82	1.03	0.83	0.07
16	External combustion engines	2.74	0.87	2.33	0.97	0.41	0.64
17	Generators & motors	3.83	1.06	3.14	1.14	0.69	0.35
18	Fuel cells	3.51	1.24	1.62	0.96	1.89	0.01**
19	Solar cells	4.09	1.10	1.85	1.14	2.24	0.01**
20	Economic costs	3.43	1.06	2.17	1.13	1.26	0.01**
21	Social costs	2.98	1.03	2.42	1.06	0.56	0.43

Appendix I (continued)

No.	Content of E&T	Importance Level M	Importance Level SD	Knowledge Level M	Knowledge Level SD	I. - K. Diff.	t Prob.
22	Energy crises	3.79	0.97	2.84	1.02	0.95	0.03*
23	Principles of conservation	4.24	0.95	2.69	0.98	1.55	0.01**
24	Techniques of conservation	4.31	0.86	2.73	1.15	1.58	0.01**
25	Electrical transmission	2.86	1.23	2.31	1.26	0.55	0.43
26	Fluid transmission	2.85	0.74	2.16	0.97	0.69	0.34
27	Mechanical transmission	2.94	0.96	2.54	1.15	0.40	0.44
28	Control and regulation	2.77	0.87	2.18	1.22	0.59	0.37
29	Automobiles and trucks	4.23	0.94	3.24	1.10	0.99	0.06
30	Rails	3.44	0.98	3.06	0.95	0.38	0.25
31	Pipelines	3.41	1.12	2.23	1.16	1.18	0.02*
32	Ship structure & machinery	3.76	1.03	2.10	1.03	1.66	0.01**
33	Inland waterway transport.	2.25	0.86	1.74	1.06	0.51	0.39
34	Ocean transportation	4.08	1.14	2.32	1.16	1.76	0.01**
35	Seaports & shipping proc.	3.93	1.04	2.30	0.90	1.63	0.01**
36	Light aircraft structure	3.64	1.22	2.10	1.20	1.54	0.01**
37	Commercial airplanes	3.25	0.78	2.05	0.98	1.20	0.02*
38	Helicopters	3.27	0.89	1.84	1.16	1.43	0.01**
39	Airport terminals & facility	3.18	1.06	2.07	0.96	1.11	0.03*
40	Space transportation	3.57	0.87	1.76	0.87	1.81	0.01**
41	Careers in energy field	3.65	0.74	1.96	1.25	1.69	0.01**
42	Careers in transportation	3.74	0.92	2.08	0.98	1.66	0.01**

Note. * $p < .05$ ** $p < .01$ I.: Mean of Importance K.: Mean of Knowledge