UNIVERSITY OF ALBERTA

An Analysis of Selected Process Learning Activities for Their Science Concepts

by

Richard Anthony Radomski ©

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH
IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR
THE DEGREE OF MASTER OF EDUCATION
IN
INDUSTRIAL ARTS EDUCATION

Department of Adult, Career and Technology Education

EDMONTON, ALBERTA

FALL 1992

ISBN 0-315-77188-7

UNIVERSITY OF ALBERTA

RELEASE FORM

NAME OF AUTHOR: Richard Anthony Radomski

TITLE OF THESIS: An Analysis of Selected Process Learning Activities for their Science Concepts

DEGREE FOR WHICH THESIS WAS PRESENTED: Master of Education

YEAR THIS DEGREE GRANTED: 1992

(Signed) Richard Radomski

PERMANENT ADDRESS:

28 Pumphill Mews

Calgary, Alberta

T2V 4V5

DATED August 19, 1992

UNIVERSITY OF ALBERTA

FACULTY OF GRADUATE STUDIES AND RESEARCH

The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research, for acceptance, a thesis entitled AN ANALYSIS OF SELECTED PROCESS LEARNING ACTIVITIES FOR THEIR SCIENCE CONCEPTS, submitted by Richard A. Radomski, in partial fulfillment of the requirements for the degree of Master of Education.

Dr. C. H. Preitz

Dr. J. F. D. Ilott

Dr. W. Brouwer

Date August 19, 1992

ABSTRACT

The major purpose of this study was to analyze selected process learning activities for their scientific concepts. These activities are taken from the Woods, Plastics, and Metals modules found in the Materials Technology Field of Study. The supporting objectives of this study were: to identify science concepts that were inherent in the selected process learning activities; to have junior high Industrial Education teachers verify the science concepts that were associated with six selected process learning activities found in three of the six modules that comprise Materials Technology for the Alberta Multiple Activity Program; to determine the extent that these verified science concepts were taught to the learners and to review the junior high school grades seven, eight and nine science curriculum guides for science concepts that the selected process learning activities could reinforce.

A questionnaire was designed and pilot tested. The questionnaire contained 142 science concepts that were associated with the six selected process learning activities taken from three of the six modules found in the Materials Technology Field of Study. This instrument was mailed to a sample of 50 junior high school Industrial Education teachers from the two largest urban centres in the province. This sample was taken from a population of 152 junior high school Industrial Education teachers.

Of the 50 questionnaires mailed, 37 were used in the study. These instruments were coded and analyzed by computer

using the SPSS Release 4 frequency program to produce the verified science concepts and percent taught by the participants in the study. An analysis of the demographic data resulted in a profile of research participants. These data show the majority of the participants possessed 21 or more years of experience teaching junior high school Industrial Education; received a bachelor of education degree from the University of Alberta; did not have a minor in science; and taught Industrial Education full time.

The results of the study found 53/142 or 37% of the science concepts listed were verified by the participants to be associated with the selected process learning activities. The percent of these verified concepts that were taught by the participants ranged from 10.6% to 30.1% for the six selected process learning activities.

The study gives several recommendations made to selected education groups in the province and it concludes with observations that were made while the research was being conducted.

ACKNOWLEGEMENTS

A sincere appreciation is extended to the many people who assisted the researcher in this study. I wish to extend my sincerest thanks to Dr. C. H. Preitz, thesis supervisor, whose effort and patience made the completion of this study possible. The author of this thesis would like to recognize the other members of the committee, Dr. J. F. D. Ilott and Dr. W. Brouwer for their constructive comments to improve the quality of this report and to Dr. S. Hunka for reviewing the research questionnaire.

An acknowlegement is extended to Dr. Tak Fung, Academic Computing Services, University of Calgary, for his recommendations and assistance with the data input and statistical analysis for the thesis.

Without the cooperation of the school superintendents and Industrial Education teachers in Calgary and Edmonton who participated in the study, its completion would have been impossible. The author would like to acknowledge these professionals for their cooperation.

The assistance provided by the librarians of the H. T. Coutts Library, of the University of Alberta, to the researcher was invaluable and is appreciated.

TABLE OF CONTENTS

CHAPTER PAGE

Related Literature

CHAPTER PAGE

CHAPTER PAGE

LIST OF TABLES

TABLE PAGE

LIST OF FIGURES

LIST OF CHARTS

CHAPTER I

THE PROBLEM

INTRODUCTION

Since the time of the territorial period of the province, some form of "Industrial Arts" has been part of the secondary school program of studies. This subject area has evolved through Manual Training, Manual Arts, Technical Electives, General Shop, Industrial Arts, and the Alberta Multiple Activity Program. The latter is the program that was in place at the time of the study.

The learning environment for Industrial Arts changed from the unit shop to a multiple activity laboratory when the Alberta Multiple Activity Program was introduced by personnel of the Department of Education in 1964. It was in this learning environment that Materials Technology was integrated at the junior high school level. In the *Junior High School Curriculum Guide for Industrial Arts* (1969) one of the major objectives listed in the curriculum guide for the program was "to provide a synthesizing environment for students to apply their academic knowledge in the solutions of practical problems" (p. 3). In subsequent curriculum guides this objective was not explicitly stated but was inferred. Although bonafide research has been conducted that was directed at the reinforcement of mathematics and science principles in the Industrial Education environment, Robinson

(1984) and Manuel (1968), little or no research has been conducted that analyzed the process learning activities used in the Industrial Education laboratory as a vehicle to reinforce science concepts.

PROBLEM STATEMENT

The purpose of the study was to analyze selected process learning activities from the Woods, Plastics, and Metals modules found in the Materials Technology Field of Study for their scientific concepts. These process learning activities were those that were used by junior high school Industrial Education teachers in the province of Alberta to present instructional content to the learner.

SUPPORTING OBJECTIVES

The following supporting objectives were formulated to give support to the problem statement of the research:

to verify science concepts that were inherent in selected process learning activities commonly performed by students in the Metals, Plastics, and Woods areas in the junior high school Industrial Education program.

to review science curriculum guides in grade seven and eight for their science concepts that may be reinforced through the use of process learning activities in a junior high school Industrial Education laboratory.

to review the grade nine science curriculum guide for the science concepts that were related to selected process learning activities that may be used with grade nine students so that these principles may be reinforced as the student completes the learning activity.

SCOPE OF THE STUDY

The scope of the study involved three of the five modules found in the Materials Technology Field of Study of the Junior High School Grades 7-8-9 Industrial Education Curriculum Guide (1982). The modules that were involved in this research included Metals, Plastics, and Woods thus eliminating modules for Leather and Textiles and Earths from the study. The study included all Industrial Education teachers from the two largest urban centres in the province who had the responsibilities for teaching Industrial Education at the junior high school level.

NEED FOR THE STUDY

A review of the literature for the Materials Technology Field of Study in junior high school Industrial Education, shows that there is little written on the teaching and reinforcement of science concepts as students work with process learning activities. This lack of information established a need for this study.

Another need for the study was established when the philosophical framework for Career and Technology Studies

(CTS) was released in mid-1990 by the Curriculum Design Branch of the Department of Education. The philosophical framework for CTS indicates that the Practical Arts subjects will be integrated and that a closer relationship will exist between the core and complementary subjects.

At the time of the study the linkage between the core subject, science, and the complementary subject, Industrial Education was not in place. Although science concepts may have been tangentially taught by Industrial Education teachers, these concepts were not identified nor were they reinforced. As a result of this void a need for this study became apparent.

If Industrial Education students are to become literate in technology, they must have a better understanding of the relationship between science and technology. This relationship can develop through the introduction of concepts in science classes and be reinforced with the process learning activities in Industrial Education. This goal helped to establish an additional need for the study.

SIGNIFICANCE OF THE STUDY

It has been stated by authors such as Pautler (1978), Silvius and Curry (1971), and Silvius and Bohn (1961) who have written university textbooks for preservice teachers in Industrial Education that the purpose of having a student work on a product as a primary learning activity in a junior high school Industrial Arts shop or laboratory was not the product per se but the use of the product as a vehicle in the development of skills in the three learning domains: affective, cognitive, and psychomotor. It has been assumed that these skills would be acquired by the student while working on the process learning activity.

The results of this study may prove useful to determine to what extent teachers of Industrial Education in the junior high schools identify science concepts found in the process learning activities they use with their students.

Curriculum planners could use the results of this study to either limit the overlap of similar concepts in subject areas that comprise both the Practical Arts and science or to reinforce these concepts.

Future curriculum designers in Alberta Education could use the results of this research to help them develop programs where there would be an integration of science, a core subject, and other subject areas that will form Career and Technology Studies (CTS).

The results of this study may have significance for curriculum developers and planners at Alberta Education. These results may show the relationship that exists between a process learning activity and science concepts found in the completion of the learning activity by a student. These planners may find these results of use to reinforce the content found in Industrial Education as well as in science.

Curriculum personnel in other provinces as well as in other nations of the world may find the results of the study significant as they begin to integrate the subject areas of Industrial Education and science.

Similarly those responsible for the preparation of preservice teachers may find the results of this study significant to them as they revise the program of study used to prepare Industrial Education teachers. These individuals may wish to use the results of this study as a means of integrating both Industrial Education and science.

DELIMITATIONS OF THE STUDY

This study had the following delimitations:

It was delimited to the junior high school Industrial Education teachers who taught this subject area in the Public and Separate Schools in Calgary and Edmonton.

It was delimited to three of the five modules that comprise Materials Technology for grades seven, eight and nine. The three modules included: Metals, Plastics, and Woods.

It was delimited to two process learning activities from each of the three modules selected by the researcher for their science concept analysis.

It was delimited to the concepts in science identified by the researcher.

It was delimited to the accuracy of response made by the participants to the questionnaire.

DEFINITIONS OF TERMS

The purpose of providing definitions of terms related to this study is to establish a common understanding between the researcher and the reader. For the purpose of this study, the following definitions will apply and are considered specific to this study.

Alberta Multiple Activity Program

The Junior High School Grades 7-8-9 Industrial Education Curriculum Guide (1982) defines the Alberta Multiple Activity Program as "an organizational device through which a variety of technology-based, exploratory experiences, can be presented in a minimum of space with a minimum of equipment" (p. 3).

Concept

New Curriculum Perspectives for Junior High Science (1981) states that "interpreting or explaining events in the natural world depends upon forming certain basic relationships of relevant observations" (p. 39). These relationships are called concepts.

The 1978 Curriculum Guide for Junior High School Science defines concept as "a gradually-developing and continuous verbal and mental image which is unique to each student. Concepts are not taught directly by the teacher, but are primarily the result of mental and physical activity on the part of the learner" (p. 16).

Wolman (1982) in the Handbook of Developmental Psychology states "Every concept has two different kinds of content (see Elkind, 1969). The first of these, extensive content, is described by listing the objects that the concept points to or denotes. The second kind of content is referred to as intensive content and has to do with the basis on which a group of things are regarded as belonging together" (p. 16).

Elkind (1969) states "Psychologically speaking, concepts are mechanisms by which we attempt to cope with the multiplicity of nature. By means of concepts, we are able to deal with new events in terms of past experience and thus effect a psychie economy through the avoidance of additional efforts at adaptation" (p. 172).

Industrial Education

The Handbook in Industrial Education for Guidance to Teachers, Counsellors and Administrators (1983), a publication of the Curriculum Branch of Alberta Education, defines Industrial Education as "a program consisting of courses that provide a continuum of experiences, starting with exploratory experiences and activities in the elementary and junior high schools, expanding in the high school to the development of skills in career fields and culminating in on-the-job experience" (p. 2). The Industrial Education continuum will be fully described in the subsequent chapter of this report.

Materials Technology

The Junior High School Grades 7-8-9 Industrial Education Curriculum Guide (1982) a publication of the Curriculum Branch of the Department of Education, defines Materials Technology as "a field of study designed to present to the student an introductory overview of various materials and related industries" (p. 64). This publication further indicates that this field of study is comprised of five modules. These modules include Woods, Metals, Plastics, Earths, and Leathers and Textiles.

Process Learning Activity

Silvius and Bohn (1961) define a project as "a generic term to include all practical aspects such as fabrication of articles, diagnosis and testing activities, experiments, demonstrations, and classroom instructional activities" (p. 272). For the purpose of this study the terms 'process learning activity', 'project' and 'product' will be used interchangeably.

Process as a Product

Most student activities in a multiple activity laboratory involve working with or manipulating tangible or concrete forms. Through a series of sequential steps in which the learner is actively involved, the learner's psychomotor skills are developed; tool manipulations are acquired and other cognitive skills such as concepts or visual perceptions are expanded. The active involvement through which the learner performs the steps helps to establish and broaden his perceptions of reality. The product becomes the process through which learning takes place. For instance the final product in developing an exposed film is the negative. The process in developing the film involves a series of sequential steps that are necessary for the product (film) to become the negative (process). Another example can be the manipulation of a word processing program for a computer. The product can be the printout of the completed document. The process develops the understanding of managing the software program.

Science

Hurd (1981), in the New Curriculum Perspectives for Junior High Science, states that "science is the effort to find explanations or to provide descriptions for phenomena and events in the natural world. These explanations or descriptions may be summarized in statements called natural laws" (p. 28).

Taught

A concept that is presented to a learner in a formal school setting by a teacher.

POPULATION AND SAMPLE

The population for this study included all Industrial Education teachers who taught at the junior high school level for the two largest urban school districts in the province. From that group of 152 teachers, a random sample of 25 teachers was taken from each of the Calgary and Edmonton Public and Separate School Districts. The total number of teachers in the sample were 50. The random sample was generated with the aid of a table of random numbers taken from Introduction to Research in Education by Ary, Jacobs, and Razavieh (1985, pp. 430-431). The procedure used to select the random sample was also taken from these authors. This sample was treated as a cohort.

INSTRUMENTATION

From the review of the literature on instrument design it was decided by the researcher that a questionnaire would be the most appropriate instrument to gather data for this study. Wiersma (1986) mentions that a questionnaire is "a list of questions or statements to which the individual is asked to respond in writing; the response may range from a checkmark to an extensive written statement . . . sometimes referred to as a written, self administered interview" (p. 179).

From reviewing Ary, Jacobs and Razavieh (1990), McMillan and Schumacher (1989), and Keeves (1988) there are many reasons for using this method of collecting data. Some of these reasons are that a questionnaire is relatively economical and has standardized questions. Questions can be focused for specific purposes and anonymity can be assured. It should also be pointed out that a questionnaire has limitations. There is a possibility of a small proportion of questionnaires being returned and it is difficult to check the reliability and validity of the responses.

Wolf (1988), in Educational Research Methodology, and Measurement: An International Handbook, relates that a questionnaire is based on three assumptions. These assumptions are: a) respondents can read and understand the question, b) respondents possess the information to answer the questions, and c) respondents are willing to answer the questions honestly.

The instrument used to collect data was a two part questionnaire. Part I was used to collect demographic information from those involved in the study. The purpose of collecting this information was to prepare a composite profile of teachers involved in the study.

Part II of the data collecting instrument was a list of six selected products, two for each of the modules for Metals, Plastics, and Woods that could be made by junior high school students in their Industrial Education classes. Each process learning activity was analyzed for the major operations used to manufacture or construct the product. According to Fryklund (1970) the four major operations used to make a product are depicting, shaping, forming, and assembly. These operations are considered to be generic so that any manufactured article goes through these four operations as it proceeds through the production line from raw materials to finished product. Each operation was further analyzed for its components. These components are called elements of the operation. Also included in this part of the questionnaire was a list of science concepts that were related to each stated element. From this list participants were asked to check if they "agree", "disagree" or "don't know" that the concept was related to the element and whether or not that concept was "taught" by the teacher when a student was involved in doing that particular process learning activity.

Prior to being used in the study, Part II of the questionnaire was reviewed by a teacher of science to verify the science concepts. The questionnaire was reviewed by a specialist in instrument design from the Faculty of Education, Division of Educational Research Services, University of Alberta. From this review the necessary modifications or changes that were identified were made to the instrument before it was pilot tested.

The procedure used to design the seven column checklist for Part II of the research instrument was for the researcher to identify two process learning activities for each of the three modules: Metals, Plastics, and Woods. The first step for the researcher was to identify the operations that were used to manufacture the process learning activity. These operations were categorized according to those illustrated by Fryklund (1970) in Occupational Analysis Techniques and Procedures. Each operation was then analyzed for the elements that were involved in completing the process learning activity. The operations were placed in column one and their elements became column two of the checklist. Column three consisted of the science concepts that the researcher identified in manufacturing the process learning activity. Columns four, five and six became "Agree", "Disagree", and "Don't know". Column seven was named the "Taught" column.

PILOT STUDY

A pilot study was used to pretest the research instrument. Five junior high school Industrial Education teachers constituted the population of this element for the research. These teachers were not involved in the major data collection phase of the study. The purpose of the pilot study was to determine: if the given instructions were explicit and easy to follow, if the terminology was properly phrased, if the science concepts listed were complete, if any given items were ambiguous or unnecessary, if the allocated length of time it took to complete the instrument was sufficient and if any revisions had to be made to the instrument. This process added to the face validity of the questionnaire.

METHODOLOGY

The following methodology was used to collect data for analysis and to bring the research to its conclusion.

Contact was made with the consultants who are responsible for Industrial Education or Career and Technology Studies for both the public and separate school boards in Calgary and Edmonton. The purpose of this contact was to request that the researcher be provided with a list of Industrial Education teachers who taught grade 7, 8, and 9 Industrial Education in each school jurisdiction. These school jurisdictions were selected to be involved in the study because combined they employ the largest number of junior high school Industrial Education teachers in Alberta.

The list of teachers from both the separate and the public school board in each urban centre was combined resulting in a population of 152 teachers from which a random sample of 25 teachers was taken from each centre until a total of 50 teachers was achieved. The procedure used to select the random sample was that recommended by Ary, Jacobs, and Razayieh (1985) in Introduction to Research in Education.

A request was made of personnel of the Curriculum Design Branch, Alberta Education to provide the researcher with a copy of the "List of the Industrial Education Teachers by School: School Year 91-92". From this list the school address for each member of the research population was identified.

The researcher elected to design a two part questionnaire to collect data for analysis. Part I of this instrument was used to collect demographic data from those involved in the study. Part II of the questionnaire was a check list in the form of a matrix. The checklist consisted of two selected process learning activities from each of the Metals, Plastics and Woods modules which are part of the Material Technology Field of Study for a total of six such activities. These process learning activities were selected by the researcher who is an experienced Industrial Arts teacher with twenty-two years of teaching experience at the junior high school level. The procedure used to design the questionnaire is fully described in a previous section titled 'Instrumentation'. Prior to being used in the major phase of the study the instrument was pilot tested. How the pilot was conducted is fully described in a previous section labelled 'Pilot Study'.

A covering letter to accompany the questionnaire was prepared by the researcher. This letter was sent to those teachers who were selected in the random selection procedure as participants. Part of the letter informed these teachers of the purpose of the study and requested their participation in the research by completing and returning the questionnaire. A portion of this letter informed the participants that the researcher would adhere to research ethics and that all collected data would be treated as privileged information. Participants were also informed that it was their right and privilege to withdraw from the research at any time without prejudice. Included in the content of the letter was a deadline date for the return of the completed instrument. This letter was part of the research package that included a self addressed envelope and a questionnaire with instructions for completion. A copy of this letter can be found in Appendix A, page 200.

A telephone call was made as a follow-up procedure for those participants who did not meet the necessary deadline date given in the initial covering letter. The follow-up was used to increase the percentage of return.

Both the copy of the research design and the research instrument was submitted to the Department of Adult, Career and Technology Ethics Review Committee. The purpose of this review was to ensure that the research design was conducted in accordance with the ethical guidelines established by the university.

The procedures set forth by the Cooperative Activities Program of the Faculty of Education and the Cooperating School Jurisdictions was followed by the researcher. The researcher followed this procedure to receive approval from both school systems in Edmonton to facilitate the involvement of junior high school Industrial Education teachers in the research.

To facilitate the involvement of junior high school Industrial Education teachers in Calgary in the research, the researcher requested permission from the respective consultants of Industrial Education of each jurisdiction to involve these teachers. This request was readily fulfilled.

A research packet consisting of a questionnaire, a covering letter, and a self addressed stamped envelope was mailed to 25 junior high school Industrial Education teachers in both public and separate school systems in Calgary and Edmonton for a total of 50. Initially 27 of the 50 questionnaires were returned for a rate of return of 54%.

Ten days after the deadline date established for the return of completed questionnaires, a follow-up procedure was used with non-responding teachers to increase the rate of return. The first part of the follow-up procedure involved a telephone contact. These teachers were asked if they received the research packet. If they had, they were reminded to return their completed instrument. It was also emphasized to them their importance in the study. Following the phone call, an additional research packet was delivered by the researcher to those participants who indicated they had not received one.

From the follow up procedure an additional 14 questionnaires were received which increased the rate of return to 41/50 or 82%. Thirty seven questionnaires were used for analysis. Four were discarded because they were incomplete.

ANALYSIS OF THE DATA

The returned questionnaires were checked for their completeness. The data collected from each questionnaire was organized into numeric form and placed into a Emacs data file at the Academic Computer Services, University of Calgary. These data were analyzed using the SPSS Release 4 - frequency program. The program counted the number and sums and percentages of times each participant 'agreed', 'disagreed', 'don't know', and 'taught' each variable (concept) in the instrument. To illustrate the respondents' perceptions, tables were constructed from the analyzed data. Comparisons were made among the four columns: 'agree', 'disagree', 'don't know' and 'taught'. From the research findings, conclusions, recommendations and observations were made.

ORGANIZATION OF THE THESIS

The remaining chapters of the thesis have the following organizational pattern. Chapter two is devoted to a review of the related literature and research that has a direct relationship to this study.

Chapter three includes an analysis and presentation of the data that was collected with the research instrument that was specifically designed for this study.

Chapter four provides an interpretation of the data that were analyzed in Chapter three.

Chapter five reports the findings, conclusions, recommendations and observations that result from this investigation.

The appendices to the report include a sample of the research packet consisting of the instrument and the letters of correspondence related to the study. For the benefit of the reader a bibliography of relevant resources used to prepare the research instrument and to organize the review of the related literature section as well as other sections of the report is included.

CHAPTER II

REVIEW OF RELATED LITERATURE AND RESEARCH

INTRODUCTION

The first chapter of this report included: the major problem of the study, why the study was conducted, a description of the research population and research methodology. The content of that chapter also described how the instrument was designed and how the population was selected.

This chapter will be divided into two major sections. The first section will include a review of the literature that is related to this study and the second section will contain the review of the related research. Indices used in report findings of educational research were searched to secure information on studies that were related to the current study. Indices that were searched were The Canadian Education Index, The Educational Index, The Alberta Education Index, Resources in Vocational Education, Technical Education Abstracts, Dissertation Abstracts International (Humanities and Social Sciences), Education Theses, and selected government documents. In addition, an electronic data search was made of The Education Resources Information Centre (ERIC) database using these descriptors: Industrial Arts, secondary schools, science concepts, science, integration, shop curriculum, and school shops. From this search a total of 159 hits were obtained. From analysis of the abstracts of these hits, 21 were selected for detailed review. The remainder were eliminated from the study because they were not relevant. A number of the sources where these 21 hits were listed were in the microfilm file for ERIC maintained in the H. T. Coutts Library of the Faculty of Education, University of Alberta. The information presented in these sources was used by the researcher to form concepts and insights that were written into the content of the various portions of the first section of this chapter.

The review of the literature section will consist of three major subsections. The first subsection will include the overview of the development of Industrial Arts in Alberta from 1900 to the present day. The history will be followed by a subsection on the use of trade and job analysis to identify instructional content. The third subsection will report an analysis of the curriculum guides for junior high school Industrial Education and for science grades 7-8-9. The second section includes a review of the research that is related to the current study.

RELATED LITERATURE

An Overview of the Development of Industrial Arts in Alberta

The history of Industrial Arts as a subject in the schools of Alberta has evolved through several discrete terms that were in vogue at different times. This evolutionary process has been in a constant state of flux and thus has overlapping periods of development. Manual Training, a term first adopted, was introduced to Albertans during the late territorial period of the province in 1900. Since its genesis, the following terms have replaced the term Manual Training.

Manual Training	1900 - 1914
Manual Arts	1914 - 1934
Technical Education	1936 - 1944
Technical Electives	1936 - 1944
Industrial Arts	1944 - 1969
Industrial Education	1969 - 1983
Practical Arts	1977 - 1990
Career and Technology Studies (Mathew, 1991, p. 5)	1990,

Manual Training 1905 - 1914

An important turning point in the history of Manual Training was reached in 1868, when Della Vos and his associates at the Imperial Technical School, Moscow, made a teaching analysis of the tool processes and construction methods employed in the Mechanical Arts (Bennett, 1937, p.14). This was the first time that educators of practical education used scientific principles in analyzing the mechanic arts and developed courses of instruction based on these principles of analysis (Bennett, 1937, p. 47).

Della Vos and his associates developed a system of teaching in a school setting, practical skills which previously were passed down from craftsman to apprentice. At the Institute they developed educational theories about the Manual Training system of instruction. One theory about Manual Training was that it was a form of education designed to develop perception and intuition as well as the hands of the learner (Bennett, 1937, p. 229). Students became highly skilled in the use of hand tools through repetitive use of exercises.

Educators in North America became aware of this program and its procedures when it was first exhibited in 1876 at the Centennial Exposition that was held in Philadelphia. Manual Training became readily accepted in the United States by educators such as Runkle and Woodward. It was through their influence and efforts that Manual Training quickly spread through the post secondary educational system in the United States.

Fifteen years later, the Halifax School Board was the first school district in Canada to establish a Manual Training school. In 1891, this program was employed in the Alexandra School, Halifax. The program was for boys who were thirteen years of age. The spread of Manual Training to other areas in Canada during the first decade of the twentieth century was attributed to Dr. James Robertson, an educator who persuaded Sir William MacDonald, a philanthropist, to donate 1.5 million dollars for the extension and the promotion of practical education in Canada's public schools. These monies were used to establish a Manual Training program in each province as well as in the Northwest Territories from which Alberta became a province in 1905. In total twenty one of these centres were established from Prince Edward Island to British Columbia. One of the sites selected to be involved in the MacDonald Training Plan was Nose Creek near Calgary. The experiment in Alberta began in 1901 and ended in 1903. Manual Training in Alberta was initially made available to boys from grades six to eight with Woodworking and Blacksmithing the most common activities in the program. It appears that because of the success of Manual Training in the upper elementary grades, high schools began to offer practical courses in addition to academic courses.

School districts that participated in this three year plan were informed that funding of Manual Training after the plan ended would be their responsibility. Educators in Calgary considered the plan a success and integrated it into the educational structure of the Calgary Public School Board. Manual Training was subsequently adopted by other school boards in the province. "In 1908 the Edmonton School Board introduced Manual Training into its schools and used Woodworking and Blacksmithing as learning activities" (Preitz et al., 1983, not paginated). Eight years later, in 1916, the Calgary Board of Education established a secondary school

Manual Training centre. In 1926, the Department of Education made Manual Training part of the Secondary School Curriculum. In addition to Woodworking and Blacksmithing, the following courses were added: Drafting, Cabinet Work, Woodturning, Carpentry, Sheetmetal, and Machine Shop.

Manual Arts 1913 - 1934

Because instructional methods used in the Manual Training program were restricted to exercises with no utilitarian purpose and were lacking in design, teachers began to modify the program to include design and to use the project instead of an exercise block as a learning activity. The project had some elements of design and when completed had some useful purpose to the learner.

These teachers were extremely critical of what they were teaching and were of the opinion that the scope of Manual Training was too narrow because of the emphasis on making exercise blocks of wood. The shift to Manual Arts from Manual Training placed emphasis on the aesthetic and creative side of the project instead of the skill side. Thus Manual Training evolved into a course which came to be known as Manual Arts.

In 1926, secondary schools, with the approval of the Department of Education, began to offer courses called Manual Arts I and II. Manual Arts I became a program for the upper elementary school learner, grades 7 and 8. This course included studies in Drafting, Cabinet Work, Wood Turning and Carpentry. Manual Arts II became a secondary school program, grades 9, 10, 11, and 12, which also included Drafting along with Forging, Sheet Metal, and Machine Shop. Students were expected to apply elements of design in drafting the product they were to make. They were also encouraged to use other types of materials for planning and designing their work.

Manual Arts was part of the structure of education in the province until 1936. Prior to that year, education was structured so that grades one to eight were classified as grade school and grades nine to twelve were classified as high school. In 1936, the Department of Education adopted the principle of the intermediate school and restructured education so that the system became a 6-3-3 system of education. Thus instead of having elementary school from grades 1 - 8 and high school from 9 - 12, elementary school was changed to include grades 1 - 6, intermediate school consisted of grades 7 - 9, and high school consisted grades 10 - 12. In 1949, to avoid confusion the term 'intermediate school' was changed to junior high school.

Another major change took place with the high school program in 1936 when the credit system which was based on the Carnegie unit was introduced. Requirements for a high school diploma became based on a student earning 100 or more credits. Another change in the high school that took place was the introduction of the core program. All high school courses were classified into two groups, compulsory and elective. Manual Arts I and II became elective courses.

Technical Education 1913 - 1936

Technical Education, as a form of practical education was brought into the schools of the two major population centres early in the twentieth century. During this time, in Calgary and Edmonton courses were developed that had a heavy vocational orientation and were taught at special technical high schools. The technical courses available in these high schools were: Woodwork, Metal, Electricity, and Motor Mechanics. Edmonton had a separate technical high school until 1940 when the program was disbanded by an edict of the school board. In Calgary, the demise of technical education came in 1936 when the school board made the decision to consolidate the academic program, the technical education program, and the business education program into one school which became known as a composite high school. The first composite high school in Alberta was Western Canada High School in Calgary.

Technical Electives 1936 - 1949

Technical electives were introduced into high schools to provide students a progam emphasizing vocational development greater than the Manual Arts program could offer. Technical electives included courses in: Metalwork I, Woodwork I, Electricity, Printing, and Arts and Crafts I. These courses were optional. Students enrolled in a technical elective would spend one half of the school day in a classroom studying an academic subject and the remaining half of the day in a shop.

These technical courses were taught by teachers who had a special teaching certificate. In addition to having this certificate, they were certified journeymen. They received the special certificate by taking additional coursework at the Provincial Institute of Technology and Art (now S.A.I.T.). These teachers were trade oriented and taught their courses in a Unit Shop. Educationalists in the province considered this program to be pseudo-vocational education.

General Shop 1939 - 1945

In 1938 the term General Shop began to replace the term Manual Arts. With the name change came a change in philosophy. The following statement from Regulations Relating to the Program of Studies and Annual Examinations for High Schools for the Year Ending June 30, 1939 points out the difference between General Shop and Manual Arts.

> The essence of the General Shop is individuality. Few subjects are more adaptable in catering to individual differences among students. Ideally if an instructor could be secured who was versatile enough, each student at the same time might work at a different project, using a different medium. Practically, the projects should be related closely to the students personal interests, which should be the dominating influence in the choices made subject to the ability of the student and the

> limitations of the shop, and always subject to the judgement of the instructor. (pp. 127-128)

During the 1938-39 school year, the Manual Arts program became General Shop in the secondary schools of the province. At the Intermediate Level, General Shop I consisted of the following areas: Drafting, Woodwork, Metal, Automotives and Farm Mechanics. General Shop II at the senior high school level consisted of Drafting, Woodworking, Metalwork, Electricity, Farm Mechanics, Gas Engines and Plastics.

In 1940, the Department of Education completely revised the program of study that required compulsory academic subjects and technical electives that included: Woodwork, Metalwork, Automotives, and Arts and Crafts. (Department of Education, 40th Annual Report, 1944, pp. 10-12).

According to Preitz, et al., (1983) "the provincial supervisor for Technical Education in 1949, indicated that 'Manual Training days' were over and that a new direction was needed for this form of education" (not paginated). Consequently, the term "Industrial Arts" began to gain greater use by the educationalist in the province. By 1945, Industrial Arts had been approved as a subject by the Department of Education.

Industrial Arts 1945 - 1968

It appears that Tingley, Supervisor of General Shop with the Department of Education, introduced the term "Industrial Arts" sometime in the early 40's. The concept associated with this term was to have a considerable impact on the course design for this subject area for the next 40 years. In a paper titled A Concept of Industrial Arts and its Significance in a Progressive Educational Program, Tingley (1945) wrote

> The complexity of the industrial age in which we live demands that if the individual is to cope intelligently with the environment in which he lives, the school should provide a rich enough range of experiences to give at least a reasonable spread of technical knowledge. Herein lies a fertile field for Industrial Arts. We have been so concerned with the production of 'things' or projects, that many of our Industrial Arts units have lacked richness. As education comes to concern itself more and more with real situations, this much-needed objective will be achieved in greater measure. (p. 34)

If the central theme of Manual Training was skill development, then the central theme of Industrial Arts became exploratory experiences for the learner. At the high school level there was constant debate among educationalists, curriculum designers and developers in the province as to whether Industrial Arts should be for exploratory experiences or for vocational skill development. From the minutes of the meeting of the Industrial Arts Curriculum Sub-Committee of the Department of Education held on April 14 and 15, 1959, the debate became: "Is the purpose of the grade 11 and 12 shop courses primarily vocational, technical, or part of general education" (Department of Education Archives, 1959). The debate was not resolved. The debate of Technical Electives came to a head in Calgary in 1961 when Harvey Bliss, chairman of the Calgary Public School Board was quoted by the Calgary

Herald, (April 8, 1961) as saying:

> As the curriculum is laid out now, the course is not being used for the purpose for which it was intended and it does not seem to lead anywhere. The students don't get any credit on the high school shop courses when they enter the Southern Alberta Institute of Technology and I don't think industry gives much recognition to them.

The problem resolved itself when the federal government passed the Technical and Vocational Training Assistance Act in 1960. Thus cost shared grant money became available to build Vocational Education facilities and programming of Vocational Education courses became well defined. Industrial Arts received no funds through this Act. Its programming was to be totally funded by the local school board.

At the junior high school level the objective of Industrial Arts was never hotly debated. There was agreement that the major objective of the junior high school program was exploratory. All course development was compatible with general education objectives. What was open to discussion was the medium, or the number of media, students were to be exposed to and the activities to be associated with the various media. Preitz, et al., (1983) states "From 1950 to 1960, Industrial Arts at the junior high school level was taught in a General Shop and the program was largely exploratory" (not paginated). The materials used in the Industrial Arts courses at this level were similar to the materials used in the local trades. The approach used in program development became increasingly more multi-activity, in which the student worked with more than one medium and had a choice of projects to be made. Students in the same class could work with different learning activities in different areas of the shop.

Alberta Plan 1962 - 1968

Two events took place in 1962 that had an impact on the direction and design of Industrial Arts courses and the learning environment in schools where these courses would be conducted. The first event was the transfer of the Industrial Arts teacher preparation program from the Calgary Campus of the University of Alberta to its Edmonton Campus. The second major event was the establishment of the Division of Industrial and Vocational Education within the Faculty of Education of the University. As a result of the Technical Vocational Training Assistance Act of the Federal Government, Dr. H. R. Ziel was appointed to chair this Division.

Under Dr. Ziel's leadership the instructional content for Industrial Arts was expanded to include the common technologies of a productive society, as well as including content from manufacturing industries. Ziel held the belief that the learning environment where Industrial Arts was taught should be a multiple activity laboratory. His rationale held that in a productive society, all occupations are interrelated and no occupation in that society can stand alone.

The concept of Industrial Arts for both junior and senior high school as articulated by Ziel and his staff, was that it should consist of four phases. Students would progress through phases one and two in junior high school and continue through phases three and four in high school.

This program first became known as the Ziel Plan. Later the name was changed to the Alberta Plan on the suggestion of G. H. Silvius who had been invited from Wayne State University to serve as a visiting professor in the Department of Industrial and Vocational Education. While in Edmonton Silvius had the opportunity to observe the pilot program at Hillcrest Junior High School. This program served a dual capacity: to prepare university students with a skill base by allowing these students to practice teach Industrial Arts with junior high school students and to serve students of the school with an Industrial Arts facility.

The Alberta Multiple Activity Program, or Alberta Plan, was introduced in 1963. The learning environment for this program was a multiple activity laboratory where three or more materials and technologies were taught concurrently by a single teacher. The materials that were taught included: Woods, Plastics, Metals, Earths and the machine tools and hand tools to work or process these materials. The technologies included: Computer Technology, Power Technology, Electronic Technology, Mechanical Technology, Testing Technology, and Graphic Communications (Cochran, 1970, p. 74). The laboratory was divided into several sections with each section independent of the other. These sections were referred to as areas. Each area had a complete complement of required hand tools, special machine tools, and supplies for the learner to complete a learning activity. Each area was self-sustaining thus limiting inter-area traffic and maximizing the student time in the laboratory. Each section contained four to six learners who worked on specific learning activities. When a group of students completed the learning activities in one area they would rotate to another area as a group and begin with activities in a new technology. They would continue until they had progressed through three modules (Preitz, 1973, p. 90).

Contemporary curriculum guides for the junior high school Industrial Arts program were first released in 1964 with subsequent releases in 1965, 1969, 1976, and 1982. Instructional content found in the 1982 curriculum guide for junior high school Industrial Education consisted of four sections each referred to as a Field of Study. The Materials Technology Field of Study consisted of the following modules: Metals, Woods, Plastics, Earths, Leathers and Textiles. The other three Fields of Study that constituted the curriculum were: Power Technology, Graphic Communication Technology, and Synthesizing. The modules in the Power Technology Field of Study included: Power Mechanics, Electricity, Electronics, and Computers. Graphic Communications Technology included: Printing, Photography, and Technical Drawing. Synthesizing included: Industrial Simulation, Student Contracting, and Developmental Research. The learning activities in the Synthesizing Field of Study were not to be attempted until the learner had experience with the other modules that made up the other three Fields of Study. Synthesizing enabled the student to bring together his/her accumulated knowledge through simulation and student contracting modules (Alberta Education Junior High School Grades 7-8-9, Industrial Education Curriculum, 1982, p. 4).

A module is made up of a number of theoretical and practical learning activities that can be taught to a learner in nine to twelve weeks. Once the multiple activity concept for offering Industrial Arts content in Alberta became established only minor modifications have been made to the Junior High School Curriculum guides since 1965. In 1982 the Curriculum Branch of Alberta Education revised the Junior High School Grades 7-8-9 Industrial Education Curriculum Guide. No changes were made to the learning environment where Industrial Education would be taught nor were there any changes made to the instructional content.

The characteristics of the Alberta Plan that made it a forerunner in its time were: (1) it shifted the instructional content from an occupational base to a technological base; (2) it de-emphasized the student activity or project as a learning vehicle to teach a process or an operation; and (3) the learning environment of the program to be offered was in a multiple activity laboratory.

Industrial Education 1969 - 1983

In 1969, personnel of Alberta Education placed Industrial Arts and Vocational Education under the generic title of "Industrial Education". Although each program was taught in either a laboratory or shop the objectives of these two programs were different. Industrial Arts worked within the goals of general education while the goals of Vocational Education were the development of specific job related skills for an occupation. The Industrial Arts program was taught by a certified teacher who was a generalist but the Vocational Education program was taught by a teacher who possessed a journeyman certificate or the equivalent, plus working experience as well as a teaching certificate.

The need for reorganization of these two programs gave birth to the Industrial Education concept. Two factors that drew attention to the need for reorganization were money and accountability. Mathew (1984) wrote:

> The economic feasibility of retaining courses with low student enrolments was being questioned by educational administrators because of associated costs. Taxpayers in the province also wanted greater accountability from these administrators as to how wisely their tax dollar was being spent. (p. 111)

Low student enrolments in Vocational Education particularly in grades eleven and twelve were due to 15 or 20 credit blocks. Students in the academic stream could not fit such a course into their timetable and still manage to fulfil the necessary requirements for a high school diploma (Mathew, 1984, pp. 110-111). Many teachers in the field became aware of the need to change the structure of Vocational Education. The person instrumental in the development of the Industrial Education concept was J. D. Harder, who prior to entering Wayne State University, was Supervisor of Industrial Arts, Department of Education. When he returned to the department his designation was changed to Inspector of High Schools, Industrial Education. Through his leadership, meetings were organized by the Department of Education to discuss the problems and concerns of Vocational Education. On November 25, 1969, the Industrial Education Committee, a standing Committee of the Curriculum Branch, held its first meeting. Some of the items that were discussed at that meeting were:

> -The development of skill clusters rather than specific occupations
> -Break large credit blocks of vocational courses into a series of five or ten credit blocks which could become parts of a comprehensive program
> -Reduce total credit assignment for vocational education courses so students on matriculation patterns can also complete a vocational program in three years.
> (Mathew, 1984, p. 113)

This Committee later wrote a report that recommended that Industrial Arts and Vocational Education be restructured (Mathew, 1984, p. 115). From further meetings and discussions a rationale was developed which gave rise to the Industrial

Education concept. The Handbook in Industrial Education for Guidance to Teachers Counsellors and Administrators (1983) defined Industrial Education as

> a program consisting of courses that provide a continuum of experiences, starting with exploratory experiences and activities in the elementary and junior high school, expanding in the high school to the development of skills in career fields, and culminating in on-the-job experience. (p. 2)

The Industrial Education Program took nearly four years to develop. Industrial Arts and Vocational Education became courses under Industrial Education. This five phase program provided an articulated career education ladder for students from kindergarten through high school and into the world of work. The Familiarization Phase in the elementary grades gave students the opportunity to learn to use tools and materials that could be integrated with learning activities in other subjects. The second phase, called the Exploratory Phase, was the existing junior high school Industrial Arts multiple activities program which provided the student with an overview of several material and technology fields of study. Phase three was for high school, and provided two tracks - the Orientation and Preparation Phases. The Orientation Phase met the needs of those students who wished only to develop an awareness of the interrelationship and dependency of technologies upon each other. The program for this track was Industrial Education 10, 20, 30 (Industrial Arts). The Preparation Phase was focused to accommodate students who wished to develop entry level competencies in the 17 selected trade areas that were recognized by the Department of Education. This program was the Industrial Education 12, 22, 32 series of courses which prepared students with occupational level skills and knowledge that would allow them to enter the work world. Occupation, the last phase employed the student working in some aspect of industry or attending some form of post-secondary education (Industrial Education Manual for Guidance to Teachers, Counsellors and Administrators, 1983, pp. 8-24).

The Industrial Education concept would prove to be the beginning of the consolidation of practical education that would continue for the next two-and-a half decades.

In summary, at the junior high school level, Industrial Arts was renamed Industrial Education. At the senior high school level Vocational Education was placed within the parameters of general education. Industrial Arts and Vocational Education although separate tracks fell under the umbrella of Industrial Education. To distinguish Vocational Education courses from Industrial Arts courses, numeric designators were provided on curriculum guides. The numeric designators given to previous Industrial Arts courses were Industrial Education 10, 20, 30. Numeric designators for provincially developed Vocational Education courses were Industrial Education 12, 22, 32 or for locally developed courses Industrial Education 15, 25, 35.

Practical Arts 1977 - 1983

The first time that the term Practical Arts was used in a publication of the Curriculum Branch of Alberta Education was in the fall of 1977. The Associate Director of Curriculum, Industrial Education, J. D. Harder, prepared a discussion paper for the Curriculum Policies Board. The name of that paper was "Alberta Education and Diploma Requirements". The paper reviewed programming that was in place as it related to the goals of basic education and suggested an alternative program plan (Alberta Education, Alberta Education and Diploma Requirements, 1977, p. 1). In discussing the elective plan (courses) for grades 10, 11, and 12 one of the group of courses Harder suggested were the Practical Arts. Under the title Practical Arts he included: Industrial Education, Home Economics Education, and Business Education and suggested that the student have the privilege to elect one of these courses (Alberta Education, Alberta Education and Diploma Requirements, 1977, p. 21).

Secondary Education Review

The changing Albertan economy in the early 80's became an important player in what the people of Alberta felt secondary education should be. The public began to feel a greater stress from competition in the global marketplace and began to articulate the need to make education more accountable. Business, universities, and the public in general felt that students were not adequately fluent in the basic skills after completing high school. On February 9, 1984, David King, Minister of Education announced a major review of secondary education. The review, according to Alberta Education (1985) was intended to "develop a better understanding of the secondary educational system of Alberta; and provide for a framework upon which to improve the current secondary education system" (Secondary Education in Alberta, 1985, p. 1). The government appointed a committee that was given the mandate to gather information and provide recommendations for action to improve the content and delivery of secondary education in Alberta.

The review proceeded in a number of ways. One was through a newspaper style questionnaire that was distributed to over 850,000 households in the province. Over 10,000 completed questionnaires were returned by Albertans (Secondary Education in Alberta, 1985, p. 3). Other Albertans prepared briefs, wrote letters, or phoned the office of the Advisory Committee. A representative group of students were asked about their views on the objectives of secondary education (Secondary Education in Alberta, 1985, p. 3). These activities in sum total resulted in Secondary Education in Alberta, a policy statement of the provincial government released in June 1985, regarding the future of secondary education in Alberta. The policy statement provided a framework for restructuring and improving the instructional programs of secondary education. According to the policy statement the new instructional program was to consist of a strong set of compulsory core or mandatory courses, and a challenging set of complementary (optional or elective) courses, from which the student could select.

On January 21, 1986, Alberta Education released an Action Plan for implementing the direction established in the Policy Statement on Secondary Education. With reference to the complementary courses at the junior high level the Secondary Education Action Plan (1986) made the following statement "In September 1986, junior high school students will be required to take a minimum of three complementary courses each year" (p. 4). In this official publication it was announced that a schedule for the development, field testing, and implementation of complementary courses would be made public in September 1986 (p. 2).

Alberta Education released an Information Bulletin addressed to the school superintendents and junior high school principals on February 14, 1986. The purpose of this bulletin was to inform these school administrators of the changes that were to be made to the junior high school handbook for the 1986-87 school year, effective September 1986. Through this bulletin these school administrators were informed that instructional hours for the junior high school would include:

> A minimum of 950 hours of instruction at each grade level will be expected. A minimum 650 hours shall be allotted to core courses and a minimum of 225 hours should be allotted to complementary courses,

> based on a recommended minimum of 75 hours per course. (Information Bulletin, 1986, N.P.)

This Bulletin continued by defining instructional time "as time scheduled for purposes of instruction, examinations, and other student activities where direct student-teacher interaction and supervision are maintained" (Information Bulletin, 1986, N.P.).

The effect on enrollment for the complementary courses at the junior high school level was negligible as a result of the Minister's Policy Statement. The same did not hold true of the complementary courses at the senior high school level because of the increased amount of time devoted to the academic basics. When the policy statement was first implemented in the 1987-88 school year, 58 credits were directed to core courses while 42 credits were allocated to complementary courses to meet the requirements of 100 credits for the Advanced Diploma at the senior high school level. In the following school year 1988-89 the number of credits was increased to 72 from 58 for core courses while the number of credits for complementary courses was reduced to 28 from 42. For the 1989-90 school year the number of credits remained the same for both core and complementary courses. The number of credits allocated to complementary courses continued to decrease in the 1989-90 school year to 24 for complementary courses and 76 credits for core courses (Alberta Education, Guide to Senior High School Handbook, 1989-90, p. 16). As a result of the continued emphasis on the core subjects, enrollment in the complementary subjects at the high school level showed a steady decline.

This decline in enrollment became a concern to school administrators particulary those who provided leadership to the major school boards in Calgary and Edmonton and other cities and towns in the province. As a result both the separate and public school boards in Calgary and Edmonton called for a review of the Practical Arts in their systems.

Practical Arts Review

A review of the Practical Arts at the provincial level was initiated by personnel of the Department of Education in September 1988. Sharon Prather of the Curriculum Design Branch was appointed project manager. The mandate of the review was "to propose new directions to the present Practical Arts programs for Alberta's secondary school students, now and over the next decade" (Alberta Education, A Vision for Alberta's Secondary Practical Arts Program, 90 11 20, p. 6). The Practical Arts programs involved in the review included: Industrial Education (Industrial Arts and Vocational Education); Home Economics Education; Business Education; and Work Experience Education. The following documents from Alberta Education provided a framework for the Review process: Secondary Education Review Policy Statement (June, 1985) and the New High School Diploma Requirements (January, 1988). The review was conducted in two phases. Phase I began in April

1989. It was to establish directions for change in the Practical Arts for the next decade. To determine the direction for change an extensive information base was established. This information base included: an extensive review of the literature, background papers were prepared, an analysis was made of the related curricular initiatives internal to and external to Alberta, and an audit and profile of present programs was completed. This review resulted in the release of the following three documents to all stakeholders: A Status Report On the Practical Arts Programs, Trends and Issues Affecting Practical Arts, and Proposed Directions for Change. The last publication "outlined the philosophy, expected learner and program outcomes, and seventeen initiatives for curriculum development and program implementation" (Alberta Education, A Vision for Alberta's Secondary Practical Arts Program, 90-11-20, p. 6).

After the Vision had been validated by stakeholders, a report summarizing the responses to the proposed changes was prepared. The Vision for Alberta's Secondary Practical Arts Programs consolidated the "initiatives outlined in the 'Proposed Directions for Change' and reflects recommendations received from the stakeholders groups, committees and Alberta Education personnel" (Alberta Education, A Vision for Alberta's Secondary Practical Arts Program, 90-11-20, p. 6). A companion document Framework for Change provided an outline and guidelines for changing the present (1990) Practical Arts programs in the secondary schools of the province. This framework provided the philosophy and the basis for future curriculum development of the new program.

The title for the new program was chosen to be Career and Technology Studies (CTS). In addition to keeping the key principles of the present programs, CTS will reflect the interdependence of career planning in personal and work life and competencies in managing technology (Alberta Education, Framework for Change: Career and Technology Studies in Secondary Schools in Alberta, 90-10-22, p. 2).

Phase II of the Practical Arts project will be to implement the Directions for Change.

Career and Technology Studies 1990 -

The philosophical foundation for Career and Technological Studies is to "help students manage technology efficiently and effectively and to develop knowledge, skills and attitudes to meet, with confidence, the challenges of daily living and the world of work" (Alberta Education, Career and Technology Studies: Building For The Future, 91-09-27, p. 2).

The curriculum for CTS "will be developed with a common rationale, philosophy, general learning expectations and structural framework. The curriculum for the program will be organized into Areas of Study, Strands, and Foundation and Expansion Modules, each of which will have required and elective learning expectations" (Alberta Education, Career and

Technology Studies: Building for the Future, 91-06-12, p. 1). To design curriculum, a number of development strategies will be used by the Curriculum Branch. Among these strategies may be focus groups located throughout the province - these groups will meet for intensive short-term consultations in an area where their expertise is required; contracts with individuals; contracts with school systems; or programs will be purchased that were developed elsewhere with the right to modify (Alberta Education, Career And Technology Studies: Building For the Future, 91-09-27, p. 2). The Curriculum Branch of Alberta Education has under contract, school districts and individuals who are conducting predevelopment projects for the different Areas of Study. These contracts were initiated in December 3, 1990 and are expected to be completed by March 3, 1991.

The matrix for Program Organization for Career and Technology Studies consists of three columns. The first column is titled Areas of Study and lists eight Areas of Study which is a grouping that involves similar basic, portable and occupational - specific skills, for instance, Personal and Community Studies. This Area of Study is broken down into Strands in the second Column. A Strand is a grouping of modules within a career area - personal life and work skills. The Strand for Personal and Community Studies includes these six strands: Cosmetology, Family Studies, Food Studies, Health Sciences, Legal Studies, and Tourism Studies. The third column of the matrix lists the current provincially developed and locally developed courses that would be affected by the curriculum change. For example, the proposed Cosmetology Strand will impact the present 12,22,32 series of courses for Beauty Culture. It is proposed that a module would consist of 25 hours of instruction. Figure 1, page 50 shows the matrix for Program organization for Career and Technology Studies.

Figure I

PROGRAM ORGANIZATION

Areas of Study	Proposed Strands/Courses	Course Affected*
Personal and Community Studies	Cosmetology Family Studies Food Studies Health Sciences Legal Studies Tourism Studies	Beauty Culture 12-22-32 Food Preparation 12-22-32 Food Studies 10-20-30 Health & Personal Development 10 Health Services 12-22-32 Home Economics 7-8-9 (Family) Home Economics 7-8-9 (Foods) Law 20-30 Personal Living Skills 10-20-30
Communication Studies	Media Technologies Presentation and Communication Visual Communications	Electronics 22-32 Graphic Arts 22-32 Industrial Ed. 7-8-9 (Electronics) Industrial Ed. 7-8-9 (Visual Com.) Industrial Ed. 10-20-30 (Visual Com.) Visual Communications 12-22-32
Management and Marketing Studies	Business Management Marketing/Retailing	Business Studies 9 Basic Business 20-30 Marketing 20-30 Office Procedures 20-30 Production Science 30
Information Management Studies	Financial Management Information Processing	Accounting 10-20-30 Business Calculations 20 Business Communications 20 Computer Literacy 10 Computer Processing 10-20-30 Computer Studies 7-8-9 Dicta Typing 20 Record Keeping 10 Shorthand 20-30 Typewriting 9 Typewriting 10-20-30 Word Processing 30
Design and Innovation Studies	Design Studies Enterprise and Innovation Fashion and Design Living Environments	Clothing & Textiles 10-20-30 Drafting 10-20 Drafting 12-22-32 Home Economics 7-8-9 (Clothing)
Construction Fabrication Studies	Construction Technologies Electricity/Electronics Fabrication Studies	Building Construction 12-22-32 Electricity/Electronics 12 Electricity 22-32 Industrial Ed. 7-8-9 (Materials) Industrial Ed. 10-20-30 (Materials) Industrial Ed. 10-20-30 (Electricity/ Electronics) Machine Shop 12-22-32 Piping 12-22-32 Sheet Metal 12-22-32 Welding 12-22-32
Transportation Studies	Mechanics Transporting Goods Transporting People	Automotives -22-32 Auto Body 12-22-32 Driver & Traffic Safety Ed. 10 Industrial Ed. 7-8-9 (Power) Industrial Ed. 10-20-30 (Power Tech.) Mechanics 12 Related Mechanics 22-32
Natural Resource Studies	Agriculture Management Energy Management Environmental Management	Agriculture 10-20-30 Horticulture 12-22-32

Taken from: Career and Technology Studies:

Building for the Future p. 3

OCCUPATIONAL ANALYSIS

It appears that the first attempt to analyze a trade was in 1868 by Della Vos and his associates at the Imperial Technical School at Moscow (Bennett, 1937, p. 14). Bennett (1937) goes on to state "there seems to be no available evidence that any adequate analysis of the mechanical arts was made until 1868 when the Russian system of workshop instruction was devised by Della Vos and his associates for use in the Imperial School in Moscow" (p. 14). The effect of having manual skills analyzed and their elements placed in sequential order was that they could be taught as readily as skills in other academic subjects.

The Russian System developed manual dexterity and hand tool skills through the use of exercises which had no utilitarian function. Analysis of content or process meant being able to separate the whole into simple component parts, each component part to be easily mastered by the learner. The system, used by Della Vos could be considered to be the forerunner of the trade and job analysis.

Industrial educators early in the twentieth century realized the need to analyze the trades to be taught for their instructional content so that teaching units could be identified, selected, and organized. Three early developers in the United States of the analysis concept for the trades were C. R. Allen, R. W. Selvidge, and V. C. Fryklund. Allen was a scientist and teacher who worked for United States Ship

Building Emergency Fleet Corporation during World War I who identified and reported techniques for making an analysis of a trade in The Instructor, the Man, and the Job published in 1919. Selvidge, a mechanical engineer who later taught engineering workshops, clarified in his book How to Teach a Trade (1923), the process of instructional analysis developed by Allen. Selvidge began the analysis with the term "job" which could be thought of as an instructional unit that could be separated into simpler parts called operations which were the parts that needed to be taught to one learning the trade (Fryklund, 1942, p. 40).

This system of identifying instructional content proved to be dynamic and continued to appear in vocational and general education literature in the first half of the twentieth century. In 1942 Frykland worked closely with Selvidge to further refine and simplify the analysis process. This author developed a more functional classification for informational topics resulting from the analysis procedure. Fryklund (1942) described these informational topics in Trade and Job Analysis which was published in the middle years of World War II. Fryklund (1942) in Trade and Job Analysis also defined trade and job analysis as "a technique of which the essential elements of an occupation are identified and listed for instructional purposes" (p. 3). This was important to those associated with Vocational Education and Industrial Arts because it provided a way for those involved to use the results of the analysis to systemize instruction. Fryklund placed all trades into two categories; custom trades or service trades. The procedure used by the analyst to analyze each trade is slightly different because of a difference in function. According to Fryklund "custom trades involve the production of things and service trades involve repair, overhaul, or installation" (p. 8). Terms that are central to Fryklund's analysis of a trade or job are: job, operations, elements, and related information. Fryklund accepted Allen's definition of job which was 'the work one does and gets paid for'. Any job is made up of a series of sequential operations that must be completed to get the job done. The term operation as defined by Fryklund (1942) is "a unit of work in a job that involves the making, servicing, or repairing of something" (p. 42). An operation involves shaping, forming, assembling, or depicting. It is a means of identification and it defines exactly what is to be taught (p. 43). Operations consist of elements which are sub-tasks that are sequential which must be performed by the learner, learning a trade. Unfortunately Fryklund did not provide a definition for the term element. However the author did provide an analogy between mathematics and a trade element when he wrote: "just as these essential elements in mathematics can be thought of as constant so are the essential elements of a trade: they always exist . . . the essential elements are rather constant. They are constant with the history of the trade, but the projects or jobs are changing" (p. 49).

Even though students learn the manipulative phase of an activity by 'doing', this phase of trade training cannot be done in isolation. Doing must be integrated with the 'knowing'. Fryklund (1970) stated "Either alone would be meaningless . . . the shop instructor, for example must teach any information that belongs in an integrated way in the operations" (p. 82). He further stated "It is important that there be clear understanding of what information topics are in order to (1) clarify and simplify the analysis assignment (2) clarify the teaching assignments for shop teachers and related teachers and coordinators" (p. 83). From the analysis procedure, three types of information are generated: Related Information referred to as Technical Information, General Information, and Guidance Information. Related Information is 'must know' type of information; the other two types of information are 'nice to know' but not necessary for one learning a trade. Technical Information is "the information that the workman should know and which should be taught by the shop teacher to a learner of a given trade while teaching that trade" (p. 55). Technical Information is considered to be "must know" information, that is information a tradesman must know in order to become skilled. This type of information allows the skilled tradesman to communicate with another skilled tradesman on an equal basis. As a result of the analysis Fryklund recommended that instruction be composed of units and that these units consist of parts which should be cumulative. It is most important in the manner and sequence which these parts are presented to the learner. Fryklund (1942) stated "In any worth-while creative activity, order, regularity, and sequence are necessary to growth and development" (p. 7).

Industrial Arts teachers in their preservice preparation have learned to use occupational or instructional analysis for identifying and organizing teachable content found in a process learning activity. According to Silvius and Bohn (1961) an instructional analysis is:

> the process by which educators study a trade subject such as welding or an industrial arts activity such as plastics and identify the repetitive operations and the informational content to be taught to a learner, whose goal is to become proficient or develop understanding in such a subject or activity. The manipulative phases of industrial education are organized as operations with each operation further broken down by listing procedures and other essential data for teaching purposes. Content informational in character and not included in the breakdown of operations can be organized in an instructional analysis as informational topics. (p. 192)

Fryklund (1970) spoke of the project:

> Projects of some kind are basic, and likely will be so for many years to come. Production is industry, industry is production; therefore the project should remain important as an educational device. It lends itself to a visible and logical approach to education in problem-solving. Use of the project is emulated by other areas, which attests to the respect paid to it. (p. 11)

The results of an instructional analysis is often used by Industrial Education teachers to develop some type of instructional material used with an instructional delivery system to individualize instruction. These instructional materials might include operation sheets, job sheets, information sheets, assignment sheets, Articulated Instruction Development Booklets (AID), Pictorial Programmed Instructional Texts (PPI), or Learning Activity Packages (LAP).

For the purpose of this research occupational analysis was the procedure used to identify the operations and their elements for the six projects that were used in the research instrument which consisted of seven columns. Column one contained the operation i.e., 'Depicting'. The elements of the operation were placed in column two.

ANALYSIS OF THE CURRICULUM GUIDES

Review of the Contemporary Industrial Education Curriculum Guides

1964 Curriculum Guide

A strong centralized Department of Education in Alberta that came from the territorial government has always provided curriculum guides for all subject areas including Industrial Education. Portions of the curriculum guides for Manual Training can be found in early annual reports for the Department of Education. More recently that department has made it a practice to place a skeletal form of the curriculum guide in the Program of Studies to legitimize the curriculum guide because the Program of Studies drawn by the Department of Education is considered to be a legal document. The Program of Studies is issued under authority of the Minister of Education pursuant to Section II of the School Act. The Junior High School Program of Studies contains the official statement concerning the courses that are available at that level (Alberta Education, Junior High School Grades 7-8-9 Industrial Education Curriculum Guide, 1982, p. 1). Although a curriculum guide is considered to be a service publication by personnel of the Curriculum Branch of Alberta Education, the information contained in the guide is prescriptive insofar as it duplicates that material contained in the Program of Studies.

In the past three decades contemporary curriculum guides that contained the Alberta Multiple Activity Program have consisted of three major components: a philosophical framework with supporting objectives, a guide to instructional content to be taught, and a list of additional resources a teacher might use to support instruction. These guides were generally designed by a committee of selected teachers from various school jurisdictions throughout the province. The Junior High School Industrial Education Ad Hoc Committee in 1963 worked to prepare the 1964 Junior High School Curriculum Guide for Industrial Arts under the guidance of the Department of Education personnel.

When the Alberta Multiple Activity Program replaced

General Shop for Industrial Arts, a new curriculum guide had to be developed. The former program brought with it an emphasis on the materials and technologies prevalent in a productive society. It was based on the premise that no profession or occupation can operate in a vacuum (Cochran, 1970, p. 74). A central ingredient for an Industrial Arts program was the product which was used as a vehicle through which instruction took place.

It will be recalled from the previous section that the Alberta Multiple Activity Program was first implemented in the schools of the province beginning in the 1964-65 school year. The Department of Education had a curriculum committee to prepare an interim curriculum guide to meet the needs of the revised program. An analysis of the 1964 guide identified objectives of secondary education, specific objectives of the Industrial Arts program and specific objectives for each Area of Study. The objectives of secondary education were classified into four categories. One of the categories was Personal Development, which listed the following objective: "Industrial Arts aim is to assist in developing a broad understanding of science, its major findings and its influence on human affairs" (Department of Education, Junior High School Curriculum Guide for Industrial Arts, 1964, p. 3). This objective was established so the learning activities in Industrial Arts would include science concepts that could be reinforced through a hands-on experience. In support of this objective, objective three from the specific objective section of the Industrial Arts Program was "to provide an opportunity for students to apply their skills in mathematics, science and English to the solutions of practical problems" (Department of Education, Junior High School Curriculum Guide for Industrial Arts, 1964, p. 5). Both of these objectives were seen by curriculum designers as a means of reinforcing the academic disciplines in Industrial Arts. This concept would force the Industrial Arts teacher to be a teacher of students and not a teacher of how to make things.

The content portion of the 1964 guide had two columns, a "to do" column and a "to know" column. This was the result of what Fryklund (1942) advocated from the analysis of a trade for the instructional content, to be taught to one learning the trade being analyzed. Combined these two columns became instructional units which included things that must done and things that must be known. These elements when taught to the learner in various combinations would result in a human accomplishment.

To provide the junior high school student with a wide range of exploratory experiences, the following nine Areas of Study were listed: Power Mechanics, Metals, Electricity-Electronics, Computer, Woods 1 and 2, Graphic Arts, Graphic Communications, and Industrial Crafts (Department of Education, Junior High School Curriculum Guide for Industrial Arts, 1964, p. 8). These nine Areas of Study were subdivided into fifteen units. A detailed analysis of each of the fifteen instructional units of the 1964 guide show that three of the units identified science concepts to be taught. These sections were Electricity, Electronics and Power Mechanics. The science concepts that were to be taught in each section are shown in the following chart.

Chart 1

Science Concepts Derived From Areas of Study

Units	Science Concepts
1. Electricity	Meaning of energy and power Pressure Friction Definition of electricity (pp. 19-20)
2. Power Mechanics	Principles of science applied in carburetion Principles of science applied by pressure Lubricating systems and gauges Operation of simple machines-lever, pulley, wheel and axle, inclined plane, screw, and wedge. (pp. 40-43)
3. Electronics	Behaviour of AC and DC circuits The effect of resistance in circuits

How microphones work, crystal and carbon. (pp. 23-24)

1965 Curriculum Guide

Similar to the predecessor guide, the 1965 curriculum guide was also developed by a curriculum committee working under the auspices of Department of Education personnel. The 1965 guide provided minor changes in format from the 1964 guide except that an Appendix was added which provided the teacher with information on how to make Instructional Sheets in the form of Information Sheets and Job Sheets that could be used to supplement instruction.

The 1965 guide continued to list the nine Areas of Study with their fifteen units, with the recommendation that a minimum of three units to a maximum of five units be taught each year of junior high school. It was also recommended that most representative units of a productive industry should be chosen and taught (Department of Education, Junior High School Curriculum Guide for Industrial Arts, 1965, p. 8).

Each unit of study was outlined in a uniform manner with topics listed in a logical teaching sequence. The science concepts to be taught were integrated into each of the units as they were in the 1964 curriculum guide. The listed science concepts were identical in both curriculum guides.

1969 Curriculum Guide

The 1969 _Curriculum Guide for Industrial Arts_ from the Department of Education was prepared by the Junior High School Industrial Arts Ad Hoc Committee comprised of teachers, Department of Education personnel, supervisors, and University personnel. This committee operated under the direction of the Secondary School Industrial Arts Curriculum Committee and the Secondary School Curriculum Board (Department of Education, _Junior High School Curriculum Guide for Industrial Arts_, 1969, not paginated). This guide contained content to be taught, methods of developing the concepts presented, suggestions for using teaching aids and additional reference books for teacher and student use.

In 1968 both Industrial Arts and Vocational Education were brought under the umbrella term of Industrial Education. The courses that were offered at the senior high school level were placed into Career Fields and the course content was modularized. This change was reflected in the 1969 Junior High Curriculum Guide when the Areas of Study were renamed _Fields of Study_ (for emphasis). With this change the nine Areas of Study were compressed into six Fields of Study which included: Power, Materials, Electronics, Graphics, Industrial Crafts, and Developmental Research. The six Fields of Study were further subdivided into 13 units. Before the Developmental Research Field of Study could be taught, the teacher had to define the content of the unit as well as receive the approval of the provincial Supervisor of Industrial Arts and the school principal (Department of Education, Junior High School Curriculum Guide for Industrial Arts, 1969, p. 5).

The 1969 guide was quite different from the 1965 guide. Changes were made to: objectives; breadth of content; and format of presentation. General Objectives of Secondary Education that were stated in the 1965 guide were eliminated from the 1969 guide. Specific objectives of an Industrial Arts program were shortened from eight to seven in the 1969 guide. Although the objective that dealt with the reinforcement of academic subjects was not changed there was an indication that the reinforcement of science concepts remained an integral part of the Industrial Education curriculum for the junior high school learner. In addition to the six Fields of Study, the learning environment where the Fields of Study were to be taught included a testing area and a instructional materials centre. Sequential Pictorial Instruction booklets were introduced as a new form of instructional materials that could be used with the individualization of instruction. This form of instruction allowed the student more flexibility in the use of his/her time. Another major change found in the 1965 curriculum guide was the format of the instructional content. It was evident that the 1965 guide based its instructional content on Trade and Job Analysis. The 1969 guide had its instructional content organized as a system base of input, process, and output. A system base looked at Resources (Man, Capital, Materials, Technology) and how these resources must be used to produce goods and services. The format for the instructional content of the curriculum guide reflected this system base. It consisted of four columns: Systems, Time, Student Experiences and Activities, and Instructional Media.

An analysis of the guide for science concepts to be reinforced in an industrial setting showed that objectives in only two Fields of Study mentioned either science concepts or principles. One of the objectives from the Power Field of Study stated "to help the student understand the many basic concepts and principles of science at work in power and relate these concepts to the vast area of power technology" (Department of Education, Junior High School Curriculum Guide for Industrial Arts, 1969, p. 13). A section titled Suggested Approach stated "The power area should focus on the application of scientific concepts in technology. Parallel of the utilization of scientific concepts should be drawn between their use in power technology and other technologies wherever possible" (p. 13).

A further objective from the Electricity Fields of Study stated "to develop an understanding of the basic electrical principles of these systems and other individual sections within these systems" (p. 51).

1976 Curriculum Guide

Like its predecessors the 1976 curriculum guide was prepared by an Ad hoc Committee. The Junior High Industrial Education Ad Hoc Committee in 1976 consisted of seven inservice Junior High Industrial Education teachers, two university professors from the Department of Industrial and Vocational Education, a supervisor from a large school district, and four Department of Education personnel. When this guide was released to the teachers in September 1976, they were informed that it was a service publication only.

The content portion of the guide was divided into four Fields of Study: Power Technology, Materials Technology, Visual Communications Technology, and Synthesizing. Industrial Crafts was placed under Materials Technology and Developmental Research was renamed Synthesis. A Field of Study was defined as "The general title given to the basic technologies represented, e.g. [sic] Materials, Visual Communications" (Alberta Education, <u>Junior High Industrial Education Curriculum Guide</u>, 1976, p. 3). Each Field of Study was comprised of a number of modules. With the 1976 guide the term module was substituted for Units of Study. Each module consisted of 15 to 25 hours of work in each Field of Study and was divided into several topics which provided the teacher with flexibility to design a program for their particular geographic area and laboratory (Alberta Education, <u>Junior High Industrial Education Curriculum Guide</u>, 1976 p. 17). The following chart shows the relationship of each Field of Study and its modules.

Chart 2

Relationship of Career Field of Study to Module

Career Field	Module
Power Technology	Electricity Electronics/Computer Power Mechanics
Materials Technology	Earths Lapidary and Art Metals Metals Plastics Woods
Visual Communication Technology	Graphics Photography/Drafting
Synthesizing	Construction Industrial Simulation Consumerism Student Contracting Development Research

The guide provided three categories of general objectives for the Industrial Education program: Personal Growth, Career Exploration and Occupational Skills. In support of these general objectives, specific objectives for each Field of Study were presented. An analysis of both sets of objectives found that the teaching of science concepts could be found in the following general objective. The objective stated "To provide a technical environment which permits students to synthesize their accumulated knowledge in the solution of practical problems, and to assist the student to develop habits that will be conducive to the establishment of a safe environment" (Alberta Education, Junior High Industrial Education Curriculum Guide, 1976, p. 2). Upon reviewing the Fields of Study for their specific objectives only Power Technology referred to the teaching of science concepts. The objective that referred to the teaching of science concepts was "To help the student understand the many basic concepts and principles of science at work in power and relate these concepts to the vast area of power technology" (p. 17). The use of a process learning activity or product was also described in the guide. According to the guide a process learning activity was a central ingredient to Industrial Education but it must be viewed as a vehicle through which instruction takes place. When the product ceases to be a medium of instruction it loses its usefulness. The process learning activity could be used to reinforce either the academic disciplines or science concepts. Distributed throughout 15 modules are science concepts that are specific to a module. Included among these concepts are: The conversion of electrical energy to mechanical heat, light and chemical energy; conversion of electrical energy into sound; and combining of materials by adhesion, coating, and mechanical fasteners.

The format of the instructional content portion of the

Generalizations, Concepts/subconcepts, Learning tasks, and Resources.

The guide did not provide definitions of generalization and concept. Because of this omission some confusion may have arisen in understanding the actual intent of the instructional content. In this context generalization might be interpreted as a concept. Kameenui and Simmons (1990) define concept as "an object, event, action, or situation that is part of a class of objects, events, actions, or situations that are the same based on the same feature or set of features" (p. 75). The process of acquiring a concept comes from observing a set of examples and non-examples. The learner must select the feature that is common in all the examples in the set. The learner in effect makes up a rule about the sameness that is in all the examples presented to him. This sameness would not be present in the non-examples. Generalization is the process where the learner identifies many features about the given examples but chooses only those that are common in the given set. Kameenui and Simmons (1990) state "After a series of examples has been presented and labelled for the learner, the learner is able to make a generalization - the process of detecting the same quality in all examples of a particular concept" (p. 76). It follows that to test the learner for mastery of a concept, the learner "must be able to identify 'novel' instances (i.e., newly encountered, never before seen class of objects or events" (p. 75). The confusion that could arise from concepts and generalizations is that both could be used as areas of knowledge to be studied. Concepts and generalizations then become the means to classify blocks of knowledge rather than a process by which a learner can grasp and comprehend a phenomena in his/her environment.

1982 Curriculum Guide

The 1982 curriculum guide was released by the Curriculum Branch in September 1982. Like the 1976 guide it was developed by a curriculum committee. The committee was an Ad Hoc committee of four inservice junior high school Industrial Education teachers and five personnel from Alberta Education. The latter group included the Associate Director of Curriculum-Industrial Education as well as consultants for Industrial Education from the Department of Education. No university personnel were invited to serve on the 1982 curriculum committee.

There was little change in format or structure in the 1982 guide from the 1976 guide. Of the eleven general objectives listed under Personal Growth; Career Exploration; and Occupational Skills there is only one objective that is tangentially related to the student either reinforcing or developing science concepts in Industrial Education. This objective states "to provide a technical environment which the solution of practical problems, and to assist students to develop habits that will be conducive to the establishment of a safe environment" (Alberta Education, Junior High School Grades 7-8-9 Industrial Education Curriculum Guide, 1982, p. 2).

One of three innovations of the 1982 guide was a schematic which illustrated the relationship between the four Fields of Study and the 15 modules that made up the four Fields of Study. In the guide each of the fifteen modules are further sub-divided from two to five topics.

The format of the instructional content shows that each topic is proceeded by a statement of "Generalization". This statement is supported by the concepts/subconcepts a student will develop by being involved in a specific learning task. An analysis of the concepts/subconcepts indicates that a learner is to acquire a number of science concepts at the conclusion of instruction. For example, a student working on a process learning activity in the Materials Technology Field of Study, Plastics module, might learn science concepts such as: adhesion, cohesion, and mechanical fasteners when combining plastic material. Of the four Fields of Study, Power Technology is the only one that has as one of its objectives the teaching of science concepts. This objective states "To develop in the student an appreciation of the many basic concepts and principles of science at work in power and

(p. 18).

The structure of the curriculum for junior high school Industrial Education was designed so that modules are not dependent upon any sequence. As a consequence any module can be taught as a introductory module.

The description and function of a process learning activity or product in this guide is that it is a central ingredient to Industrial Education and must be viewed as a vehicle through which instruction takes place. When the product ceases to be a medium of instruction it loses its usefulness.

The fifteen modules listed in the curriculum guide are designed to be taught in 15 to 25 hours of instruction time. It is recommended that students study a minimum of three modules each year, which equates to 75 hours of instruction providing the school offers a three year junior high school program. In junior high schools that offer a two year program, it is recommended that four different modules be presented each year (Alberta Education, _Junior High School Grades 7-8-9 Industrial Education Curriculum Guide_, 1982, p. 3). Over the three years of junior high school, the Industrial Education program should total two hundred and twenty five hours.

Science Curriculum Guides

1962 Curriculum Guide

The 1962 science curriculum guide for the junior high school program were organized into two separate booklets. One booklet was titled Grades VII and VIII Curriculum Guide for Science and the other was titled Grade IX Curriculum Guide for Science. The organization of the content was the same for the two booklets. It consisted of the following topics:

- Primary Considerations
- Making science Teaching More Effective
- Perspective and Grade Grids
- Regarding Experiments and Demonstrations
- Enrichment
- A Reminder Regarding Collections
- Course Outline for Grade Seven
- Course Outline for Grade Eight

The content for the grade seven program listed the following topics:

1. Plants, Fall Activities
2. Earth's Crust
3. Soil and Erosion
4. Water
5. Plants, Spring Activities

The grade eight topics were:

2. Magnetism and Electricity

3. The Solar System

4. Weather

5. Domestic Animals

From the grade nine curriculum guide the content was identified as:

Unit I Measurement

Unit II Light

Unit III Combustion and Fuels

Unit IV Heat and Temperature

Unit V Machines

Unit VI Energy and Transportation

1974 Junior High School Science Curriculum Guide

The 1974 junior high school curriculum guide was developed through an ad hoc committee. This ad hoc committee worked under the guidance of the Secondary School Science Policy Committee.

The content of the curriculum guide was organized having the following topics:

A. Objectives of the Secondary School Science

B. Philosophy and Goals of the Junior High School Science Program

C. Major Objectives of Junior High Science

D. Skills to be Developed in science

Science, Grade 8 - Earth Science, Grade 9 - Physical Science

F. Suggestions for Implementing the Science Program

The content expressed as concepts for the three junior high school programs are listed below.

Grade Seven Life Science

The following concepts were listed in the curriculum to be developed:

a. All sets of objects including living things may be classified into groups having common characteristics.

b. Cells are the unit of structure and function of most living things.

c. Living things carry on certain fundamental processes in order to sustain life.

d. All living things interact with and are interdependent with each other and their environment.

Grade Eight Earth Science

a. A perspective of the position and motion of the Earth in space is gained by celestial observation and measurements.

b. Various theories attempt to explain the origin of the solar system and the universe.

c. Matter everywhere in the universe seems to be composed of the same elements that are found on the earth.

d. The sun is a typical star.

by an atmosphere of air.

f. Local conditions in the atmosphere are referred to as weather.

g. Weather conditions as recorded over a long period of time define the climate of a region.

h. Weather modification has occurred through man's activities.

i. Water is an important part of the Earth's surface.

j. The crust of the Earth is constantly being changed.

k. The crust of the Earth is formed of rocks.

l. Evidence for determining the part history of the Earth comes from a study of the crust.

Grade Nine Physical Science

a. Matter occupies space and has mass.

b. The forms and behaviour of matter can be explained by the kinetic molecular theory.

c. The many forms of energy can be transferred from place to place or converted from one form to another but in each case, the total amount of energy remains constant.

d. Matter and energy are related and interchangeable.

e. Energy is responsible for bringing about physical and or chemical changes in the forms and behaviour of matter.

f. A basic language for understanding chemistry has been developed.

topics:

Objectives of Secondary School Science for Alberta

Philosophy and Goals of the Junior High Science Program

Major Objectives of Junior High Science

Skills to be Developed in science

Concepts to be Developed for Grade Seven, Grade Eight, and Grade Nine

Print Resources

The concepts listed in this curriculum guide were very similar to the previous 1974 curriculum guide. The optional topic 'A basic language for understanding chemistry has been developed' was dropped in this guide.

1978 Curriculum Guide

The 1978 curriculum guide for science contained the following sections: Guidelines; Program for the following grades; Life Science Grade Seven, Earth Science Grade Eight, and Physical Science Grade Nine. In the section titled Guidelines, Objectives of Secondary School Science and Junior High Science are listed. The remaining three sections describe the specific objectives and the content for the programs specific to each grade level.

For grade seven, the curriculum guide described content that identified concepts that were related to living things.

that sustain and perpetuate life, and the interdependency of living things upon each other and the environment.

For the grade eight science program the guide identified concepts that were related to earth science. The major concepts in the program were: motion of the earth gained by celestial observations, theories explaining the origin of the universe and the solar system, physical forces that hold planets of the solar system in orbit, surface of the earth and its atmosphere, weather, the crust of the earth and the study of rocks.

The grade nine science program provided experiences in the physical sciences. The major concepts in the program were: characteristics of matter, using the Kinetic Molecular Theory to explain the behaviour of matter, using molecular motion to explain heat and motion, work, and the structure of matter

From an analysis of the 1978 curriculum guide the following concepts that can be reinforced in the Industrial Education program are listed:

Grade Seven Science

Cells

Energy

Classification

Atmosphere and atmospheric pressure

Heat energy.

Grade Nine Science

Matter - states and characteristics

Diffusion

Evaporation

Heat energy and temperature

Expansion and contraction of matter

Kinetic or potential energy

Forms of energy

Physical and chemical change

Adhesion and cohesion.

1990 Program of Studies

The new science program, Science, Technology, and Society (STS) that was developed by the Curriculum Branch, Alberta Education, is presently being implemented in phases in the junior high schools in Alberta. Because the students texts were written specifically for the program it was decided by the Curriculum Branch not to produce a curriculum guide. The grade seven science program was phased in at the start of the 90-91 school year. The science program for both grades eight and nine was implemented during the 91-92 school year (Alberta

The design of the STS program is based on an integrated approach to science education. At each grade level the program includes content from biological, physical, and earth sciences.

The program at each grade level has three major areas of emphasis. The first is the nature of science. Here the emphasis is to provide the student with opportunity to learn and experience the nature of science, attitudes that are associated with science and processes that are involved in accumulating knowledge. This can be interpreted as demonstrating an understanding of natural phenomena. The second emphasis of the science program is the application of science knowledge to the solution of practical problems. Students are invited to develop the awareness that science and technology are interrelated. Emphasis of the last section is the impact that technology has on personal, societal and environmental levels. Responsible decision making implies that information must be available and understood by all who live in a democratic society (Alberta Education, 1990, Junior High Science Program of Studies p. (A1-A2).

The following units make up the grade seven STS program

1. Characteristics of Living Things
2. Structures and Design

5. Micro-organisms and Food Supplies

6. Evidence of Erosion

From an analysis of the grade seven program the following science and technological concepts can be reinforced in a junior high school Industrial Education laboratory.

Unit Structures and Design

- Humans design structures in response to needs, purposes, and aspirations
- Design processes are a function of knowledge of materials and structural principles
- Factors that must be identified that determine the selection of a design and materials.

Unit Force and Motion

- Force
- Mass

Unit Temperature and Heat Measurement

- Temperature
- Thermal expansion and contraction in materials
- Heat energy

The following is a list of the units included in the grade eight STS program:

1. Solutions and Substances

2. Energy and Machines

5. Growing Plants

6. Interactions and Environments

An analysis of these units show the following concepts that may be reinforced in an Industrial Education program.

Unit Solutions and Substances

- Solutions, solvents, rate of solubility.

Unit Energy and Machines

- Mechanical devices can be understood as systems and are made up of subsystems and components
- Mechanical systems are designed to perform one or more functions
- Transmission of power
- Conversion of energy from one form to another in a mechanical system
- Efficiency of mechanical devices.

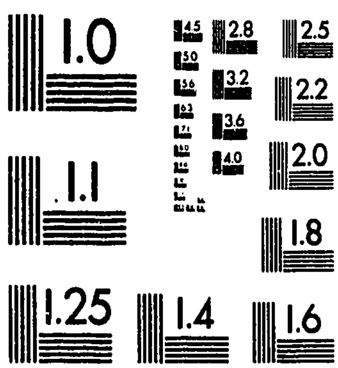
The following units are listed for the grade nine STS program

1. Diversity of Living Things
2. Fluids and Pressure
3. Heat Energy: Transfer and Conservation
4. Electromagnetic Systems
5. Chemical Properties and Changes
6. Environmental Quality

An analysis of the grade nine STS program shows the

2

PM-1 3½"x4" PHOTOGRAPHIC MICROCOPY TARGET
NBS 1010a ANSI/ISO #2 EQUIVALENT



following concepts can be reinforced in a junior high school Industrial Education program.

Unit Fluids and Pressure

- Compressibility of liquids and gases
- Effects of temperature changes on viscosity of liquids applications where viscosity of fluids is a significant factor
- Drag and aerodynamic design.

Unit Heat Energy: Transfer and Conservation

- Heat energy
- Conduction, convection and radiation
- Heat transfer.

Unit Electromagnetic Systems

- Production of current electricity using chemical principles
- Conversion of mechanical energy to electrical energy using electromagnetic means
- Series and parallel circuits
- Electrical resistance
- Various applications of switches.

Unit Chemical Properties and Changes

- Observable and measurable properties of matter
- Oxidation and corrosion reactions.

RELATED RESEARCH

The review of the related research section concentrated on research that was specially related to this study. A manual search was made of The Canadian Education Index, The Educational Index, The Alberta Education Index, Resources in Vocational Education, Technical Education Abstracts, Dissertation Abstracts International, and Education Thesis collection shelved in the H. T. Coutts Library. From this search two Masters theses were identified that had relevancy to the current study. Both Masters theses were completed at the University of Alberta. One was completed by D. Manuel (1968) and the other was completed by L. Robinson (1984).

Manuel (1968)

This researcher conducted this study to fulfil the requirements for a Masters degree at the University of Alberta. The specific problem of this research was concerned with the external segment of structure; specifically, with the effect, if any, that an experimental Industrial Arts curriculum [The Alberta Multiple Activity Program] had upon a learner's achievement in grade nine science (p. 2). In conducting his research Manuel used a treatment and a non-treatment group. The treatment group included 21 grade nine girls who participated in the University of Alberta Industrial Arts program. The non-treatment group included 19 girls enrolled in an Home Economics program. Achievement in science was measured in terms of scores the girls made on the grade nine science departmental examination of the Department of

Education, Government of Alberta.

The results of this study showed that the treatment group achievement results were significantly higher than the non-treatment group in responding to items representative of the three highest levels of the Cognitive Domain of Bloom's Taxonomy. Although Manuel looked at the external structure of the relationship between the objectives of the University of Alberta Industrial Arts program and the objectives of the grade nine science program, it did not provide data on the science concepts involved with a process or in making a process learning activity (project).

The study by Manuel had a relationship to the current study. In his thesis, Manuel describes a number of contemporary In ustrial Arts programs that were popular at the time the research was completed. One of the programs described in his study was the University of Alberta program later called the Alberta Plan. For a more detailed description of this program than described by Manuel in this thesis please see section 'An Overview of Development of Industrial Arts in Alberta' page 33 of Chapter Two.

Robinson (1984)

Robinson also completed the requirements for a Master's degree at the University of Alberta. The major purpose of Robinson's study was to determine if students who were enrolled in Industrial Arts simultaneously with mathematics and science, achieved better in these academic subjects (p. v). In fulfilling that purpose the study tested one of the Industrial Arts objectives given in the _Junior High School Curriculum Guide for Industrial Arts_ (1969). That objective was "to provide a synthesizing environment for students to apply their academic knowledge in the solution of practical problems" (p. 3). Robinson also used a treatment and control group. The treatment group represented the students who were enrolled in Industrial Arts, mathematics and science during the 1981-82 school year. The control group were enrolled in mathematics and science courses but not in Industrial Arts. Both these groups did the same mathematics and science courses prescribed by the Department of Education for their grade level. In total there were 176 students in the treatment group and 328 students in the control group. The achievement in mathematics and science for students in grade seven and eight was measured by using the junior high school internal departmental examinations for grades seven and eight; but for grade nine achievement in mathematics and science was measured by using the departmental examinations set by the Calgary Board of Education (p. vi). The results of this study indicated that the six hypotheses established by the researcher were rejected.

The contemporary Industrial Arts program that the Department of Education in a publication released through its curriculum branch was described by Robinson in the literature and related research section of his study. An analysis of that section provided this researcher with information that was used to report the contemporary program for Industrial Education found in earlier pages of this chapter.

SUMMARY

This chapter consisted of these two major sections; the review of related literature and review of related research. There were three parts to the review of related literature; overview of the evolution of Industrial Arts in Alberta from 1900 to the time of the study, a description of Trade and Job Analysis procedure which was used to identify instructional content of an occupation to be taught, and a review of Industrial Education and science curriculum guides. The second section reviewed two theses that were related to the current study.

Manual Training 1905 - 1914

This foundational program for what became known as Industrial Arts demonstrated for the first time that skills relating to the practical environment could be developed in a formal education setting rather than taught through a master craftsman - apprentice process. This was an important advancement in the evolution of practical education as principles used to teach academic subjects could also be applied to the teaching of skills in practical education.

Manual Arts 1913 - 1934

Because of the restrictions in the Manual Training program which developed manual related skills through the use of exercises, Manual Arts developed the concept of the project which emphasized aesthetics and creativity as well as skill development.

Technical Education 1913 - 1936

With the rapid growth in technology, Technical Education was pseudo-vocation education which included Woodwork, Metals, Electricity, Motor Mechanics, and Business Education. Technical Education grew into a distinct and separate identity. In the two major population centres schools were built for both technical and academic education. Closely related to Technical Education were the Technical Electives which were taught by specially prepared teachers. These teachers taught Metalwork I, Woodwork I, Electricity, Printing, and Arts and Crafts I in a unit shop setting.

General Shop 1939 - 1945

A shift from vocational occupational skill development to more generalized awareness in technology and industry began to merge. This approach was thought to better meet the needs of more students than courses that focused vocational skill development.

Industrial Arts 1945 - 1968

Industrial Arts was a program that witnessed a shift in emphasis from the tools, machine's materials, and processes of industry to exposure of a broad spectrum of technologies found in a productive society.

Alberta Plan 1962 - 1968

Alberta Plan was a program developed in Alberta that provided the learner with an exposure to a broad spectrum of basic technologies; used the multiple activity laboratory as the learning environment; and developed an articulated program from grade one through graduate school.

Industrial Education 1969 - 1983

Because of a lack of money and growth of educational accountability in the province, Industrial Arts and Vocational Education were reorganized to become Industrial Education. The goals of Industrial Education realigned more closely with the goals of general education.

Practical Arts 1977 - 1983

Personnel of Alberta Education grouped together Industrial Education, Home Economics, and Business Education were under the title of Practical Arts. When this occurred greater coordination among these groups began taking place.

Industrial Arts 1945 - 1968

Industrial Arts was a program that witnessed a shift in emphasis from the tools, machine's materials, and processes of industry to exposure of a broad spectrum of technologies found in a productive society.

Alberta Plan 1962 - 1968

Alberta Plan was a program developed in Alberta that provided the learner with an exposure to a broad spectrum of basic technologies; used the multiple activity laboratory as the learning environment; and developed an articulated program from grade one through graduate school.

Industrial Education 1969 - 1983

Because of a lack of money and growth of educational accountability in the province, Industrial Arts and Vocational Education were reorganized to become Industrial Education. The goals of Industrial Education realigned more closely with the goals of general education.

Practical Arts 1977 - 1983

Personnel of Alberta Education grouped together Industrial Education, Home Economics, and Business Education were under the title of Practical Arts. When this occurred greater coordination among these groups began taking place.

six when they added conditioning and finishing to the list.

Review of the Junior High School Industrial Education and Science Curriculum Guides

The 1964, 1965, 1969, 1976, and 1982 curriculum guides for Industrial Education were analyzed for the objectives that expressed a reinforcement of science concepts. The guides were also reviewed for their instructional content.

The 1962, 1974, 1977, and 1978 junior high school science curriculum guides were reviewed for the content that could be reinforced in the junior high school Industrial Education program. The 1990 Program of Studies for junior high school science were reviewed for the content for grades seven, eight, and nine. The results of this analysis were used to design the research instrument.

Review of the Research

Two theses, one by Manuel (1968) and the other by Robinson (1984) were related to the current study and were reported. Manuel conducted a study to determine the effects of the Industrial Arts curriculum upon a learner's achievement in grade nine science.

Robinson's study was to determine if students who were enrolled in Industrial Arts, mathematics, and science achieved higher scores in the latter two subjects than those students enrolled only in mathematics and science.

Chapter III

ANALYSIS AND PRESENTATION OF DATA

INTRODUCTION

The content of the previous chapter presented an overview of the evolution of the Industrial Education program in Alberta, and a review of the Junior High School Industrial Education Curriculum Guides since the introduction of the Alberta Multiple Activity Program in 1963. Also reviewed were the Junior High School Science Curriculum Guides from 1963 to the time of the study to identify science concepts. In addition, a review of the literature related to the development of a process learning activity, and a review of the research related to the current study was reported.

The purpose of this chapter is to analyze the research data that were collected from the 37 junior high school Industrial Education teachers in both public and separate school boards in Calgary and Edmonton, who returned a completed questionnaire. The items in each instrument were reviewed by the researcher before these data were entered into an Emacs data file at the Academic Computer Services, University of Calgary, for electronic analysis.

THE RESEARCH INSTRUMENT

The questionnaire designed for this study was formatted into two parts. Part I consisting of seven statements, which was designed to collect demographic information from the participating junior high school Industrial Education teachers. Part II was comprised of six process learning activities from the Materials Technology Field of Study. Two process learning activities were taken from each of the Metals, Plastics, and Woods modules. A seven column chart was designed for each activity. The purpose of this section was to give the participants a list of science concepts that were associated with a particular element involved in making that specific product. Each process learning activity was analyzed for its operations and elements. Operations were placed in column one and the supporting elements for each operation were placed in column two. Science concepts that were identified from the elements were listed and placed in column three. Columns four, five, and six allowed the participants in the study to respond to the verification of science concepts by selecting from the 'agree', 'disagree', and 'don't know' columns of science concepts listed for each element. The seventh column was labelled 'taught' and was designed to collect the data on the science concepts that the Industrial Education teacher taught as content to be learned when the student was engaged in the process learning activity. Appendix A, page 179 contains a copy of the research instrument. No data were collected by the researcher that could assess the science concepts mastered by the learner in completing a process learning activity.

The data from the questionnaires were analyzed using a statistical program selected from the Statistical Package for the Social Sciences (SPSS) Release 4 which is a library of programs, from that library a SPSS frequencies program was selected for data analysis. This program was chosen because it would produce a table of frequencies and percentages for each of the 222 science concepts that were part of the research instrument. Because many science concepts in each operation were repeated, the repetitions for the different operations were filtered out. As a result of this process, 142 science concepts were identified. These concepts listed in tables 11 through 16 inclusive were used for data analysis.

For the ease of reporting the collected data, this chapter is divided into the following sections: Demographics, Verification of Science Concepts, and Science Concepts taught by the Industrial Education teacher. The collected data is presented in the form of tables so the reader may review the information.

DEMOGRAPHICS

The demographics section, Part I, of the instrument collected information on the teaching background and the professional preparation of the individuals who participated in the study. This section of the research instrument consisted of seven questions that dealt with items such as teaching experience, possession of a education degree, the institution which granted the degree, identification of the minor for that degree, the materials technology courses taught, and the percent of time the teacher spent teaching Industrial Education.

Question I asked:

> How many years of experience do you have teaching junior high school Industrial Arts?
>
> 1. 1-5   2. 6-10   3. 11-1   4. 16-20   5.21-+

The purpose of this question was to determine the number of years each individual had teaching junior high school Industrial Education. The data collected with this question appear in Table 1. The analysis of these data show that 12/37 or 32.4% of the participants had 21 or more years of experience teaching Industrial Education and that 8/37 or 21.6% of teachers had between 16 and 20 years of teaching experience in this subject area. A further analysis show that 21.6% of the participants had between 1 and 5 years of experience and that 16.2% had between 11 and 15 years of teaching experience in this subject area. The smallest group of 8.1% of the participants had between six and ten years experience teaching junior high school Industrial Education. These data could be interpreted to mean the majority of junior high school teachers teaching Industrial Education for the public and separate school boards from the two largest urban centers in the province that participated in the research, was relatively a mature group of teachers.

Table 1

Junior High Industrial Education Teaching Experience

(N=37)

Years of Experience	Participants No.	Participants %
1 - 5	8	21.6
6 - 10	3	8.1
11 -15	6	16.2
16 -20	8	21.6
21 +	12	32.4
Total	37	99.9[1]

[1]Percent is less than 100 because of rounding.

Question 2

The second question was a two part question. The first part needed only a simple 'yes' or 'no' response. This question asked:

> Do you possess a Bachelor of Education degree or equivalent from a University other than the University of Alberta?
>
> 1. Yes 2. No
>
> The second part of this question read:
>
> If Yes, please circle the number of the institution which granted the degree:

1. University of British Columbia
2. University of Saskatchewan
3. University of Manitoba
4. University of Toronto
5. McGill University
6. Memorial University
7. Nova Scotia Teachers College
8. University of New Brunswick
9. Other______________________

If the response was 'yes', the participant was asked to identify the institution which granted the degree by circling the appropriate number before one of the Canadian universities listed. These universities have an undergraduate program of study that prepares Industrial Education teachers. Participants who did not graduate from a Canadian university could enter that information in option 9, the 'Other' category.

Data collected with the question were used to organize tables 2 and 3.

Data in table 2 show that 26 of the 37 teachers who participated in the study received a Bachelor of Education degree from the University of Alberta where the Alberta Plan is taught. This represented 70.2% of the research cohort.

Analysis of these data show that the remaining 11 teachers (29.8 %) received a bachelor degree from a university other than the University of Alberta. By comparing data in table 3 with the data in table 2, it was found that participants who did not graduate from the University of Alberta graduated from one of the following Canadian universities: University of Calgary, 5 (13.5 %); University of

Saskatchewan, 2 (5.4 %); University of Manitoba 1 (2.7 %). Eight point one percent of the research participants indicated they graduated from the following American universities: Brigham Young University, 2 (5.4 %); and Montana State University, 1 (2.7 %); It is evident from these data that more than two thirds, 26 of the 37 junior high school Industrial Education teachers who were involved in the research were graduates of the Industrial Arts program offered at the University of Alberta. Canadian universities, west of Ontario in total, prepared 34 of the 37 teachers with the remaining three prepared by American universities.

The five teachers who graduated from the University of Calgary had to receive their expertise to teach Industrial Education through teacher in-service programs offered by either the employing school district or the Industrial Education Specialists Council of the Alberta Teachers' Association. The University of Calgary does not offer a Industrial Education teacher preparation program. This is the mandate of the University of Alberta.

In this chapter the reader will find white space on a number of pages. This is by design of the researcher to have the tables and analyses in proximity to each other.

Table 2

Graduate University of Alberta: Bachelor of Education

(N=37)

University of Alberta Graduate	Participants	
	No.	%
Yes	26	70.2
No	11	29.8
Total	37	100

Table 3

Other Universities Which Granted Degree to Participants

(N=11)

Institution	Participants	
	No.	%
University of British Columbia	0	0
University of Saskatchewan	2	5.4
University of Manitoba	1	2.7
University of Toronto	0	0
McGill University	0	0
Memorial University	0	0
Nova Scotia Teachers College	0	0
University of New Brunswick	0	0
Other: University of Calgary	5	13.5
Brigham Young University	2	5.4
Montana State University	1	2.7
Total	11	29.7

Question 3.

Question three was designed to determine the subject area in which participants specialized for their minor field of study while attending university. It was anticipated that this question might help to determine the extent that Industrial Education teachers were academically prepared to identify science concepts presented in the analysis of the six process learning activities found in Part II of the instrument. Data in Table 4 indicate that 54% of the participants elected as a minor "either mathematics (2) or "other" (18). 'Other area' were identified by participants as Physical Education, Agriculture, History, Multi-Cultural Education, French, Psychology, Sociology, Geography, Administration, and Religious Studies. The remaining participants (6) did not identify their minors. This indicated that over half of the participants except for a required full course in science had little or no study in science or applied science while attending university. This lack of preparation might also suggest there had been very little academic preparation in science as teachers for them to identify and apply science concepts as an objective when teaching Industrial Education courses at the junior high school level. Ten of the 37 participants or 27% acquired a minor in general science; 1, 2.7%, in biological science; 4 or 10.8% in physical science; and 2 or 5.4% in chemistry.

Table 4

University Minor Completed for Degree Requirements by Participants

(No=37)

Minor	Participants No.	Participants %
General Science	10	27.
Biological Science	1	?.7
Physical Science	4	10.8
Physics	--	--
Chemistry	2	5.4
Mathematics	2	5.4
Other Area	12	32.
No Response	6	16.
Total	37	99.3[1]

[1]Percent is less than 100 because of rounding.

Question 4.

Question four asked:

Have you completed any university courses in Chemistry?

1. YES 2. NO

If "yes" number of courses ________

This determined the number of university chemistry courses completed by participants. This question helped to focus on a specific discipline that the participants might have taken either for interest or in meeting the requirements for a degree. Chemistry was chosen by the researcher as a discipline for inclusion in the questionnaire because many of the principles learned in a university level chemistry course could be directly applied to the process learning activities that are used in the junior high school Industrial Education program. Table 5 show data that 16 of the 37 participants (43.2%) had completed one or more courses in chemistry as an undergraduate student. These data also show that the remaining 21 participants did not take a single chemistry class at the undergraduate level.

Table 5

Participants: Chemistry Courses

(N=37)

Chemistry Courses	Participants	
	No.	%
Yes	16	43.2
No	21	56.7
Total	37	99.9[1]

[1]Percent is less than 100 because of rounding.

An analysis of the data in Table 6 show that 16 of the 37 participants provided the required data. Of these 16 teachers one completed 8 chemistry courses while attending university to meet the requirements for the first degree. At the opposite end of the continuum there were 7 members of the research group who completed only one course in chemistry.

Table 6

University Chemistry Courses Completed:Participants

(N = 37)

No. Chemistry courses completed	Participants	
	No.	%
0	21	56.8
1	7	18.9
2	3	8.1
4	2	5.4
6	3	8.1
8	1	2.7
Total	37	100

Question 5.

Question five asked:

> Have you completed any university courses in Physics?

1. YES 2. NO

If "YES" number of courses_________

This two part question determined the number of university physics courses completed by participants. The first part of the question helped to focus on a specific discipline that the participants might have taken either for interest or in meeting the requirements for a degree. The second part of the question determined the number of university level physics courses that were completed. Physics was another discipline chosen because many of the principles learned could be directly applied to the process learning activities used in the junior high school Industrial Education program. In Table 7 are data which show that 21 of the 37 participants (56.7%) indicated that they had taken courses in physics at the undergraduate level. Cross referencing these data with data in Table 8 it is evident that 12 of 37 participants who answered 'yes' had taken only 1 physics course. There were 4 participants who completed 3 courses in physics.

Table 7

Participants: Physics Courses

(N=37)

Physics Courses	Participants No.	Participants %
Yes	21	56.7
No	16	43.2
Total	37	99.9[1]

[1]Rounding makes this percent less than 100.

Table 8

University Physics Courses Completed: Participants

(N=37)

No. Physics courses completed	Participants No.	Participants %
0	16	43.3
1	12	32.4
2	5	13.5
3	4	10.8
Total	37	100

Question 6

The sixth question on the research instrument had two parts. The question asked:

> Please circle which of the following modules from the Materials Technology field of study you are currently teaching;
>
> 1. Woods 2. Earths 3. Plastics
> 4. Metals 5. Leathers and Textiles.
>
> or
>
> those modules that you have previously taught?
>
> 6. Woods 7. Earths 8. Plastics
> 9. Metals 10. Leathers and Textiles

The first part asked participants to identify, from a list, those Material Technology modules that they were teaching when the research was conducted. The second part of the question asked the participants to identify those Material Technologies that they had previously taught.

The data collected with this question were used to assemble Table 9, which show that of the five modules, three - Metals, Plastics, and Woods were being used to a greater extent by participants in their program: 36 of the 37 (97.3%) taught the Woods module, 35 of 37 (94.6%) taught Metals, and 33 of 37 (89.2%) taught the Plastics module. Only 18 or 48.6% of those involved in the research taught Earths and 13 (35.1%) taught Leathers/Textiles. From the second part of the question, the data indicate that with the exception of the Leather/Textiles module the distribution was nearly even for the remaining four modules. These data in the lower portion of Table 9 show that in the past, 30 (81.1%) of the participants taught Earths and 24 (64.9%) taught Leathers/Textiles. It is evident from these data when compared to the taught section of this table that a number of participants elected to remove the Leather/Textile module from the instructional content they taught.

Table 9

Materials Technology Modules Taught or Previously Taught

(N=37)

Materials Technology Module	Participants No.	Participants %
Presently Taught		
Woods	36	97.3
Metals	35	94.6
Plastics	33	89.2
Earths	18	48.6
Leather/Textile	13	35.1
Previously Taught		
Woods	35	94.6
Metals	35	94.6
Plastics	34	91.9
Earths	30	81.1
Leather/Textile	24	64.9

Question 7

The last question in the demographics portion of the instrument asked participants to identify the percent of the school day they devoted to teaching Industrial Education. This question was phrased in this manner:

Please circle the percent of time that you teach Industrial Education?

1. 20% 2. 40% 3. 60% 4. 80% 5. 100%

The data in Table 10 show that 23 participants (62.2%) taught Industrial Education 100% of the time, 10 (27%) taught this subject 80%, 3 (8.1%) taught 60%, and 1 (2.7%) participant taught Industrial Education 40% of the school day.

Table 10

Percent of Time Teaching Industrial Education: Participants

(N=37)

Percent of teaching time	Participants	
	No.	%
20	--	--
40	1	2.7
60	3	8.1
80	10	27.
100	23	62.2
Total	37	100

ANALYSIS OF SCIENCE CONCEPTS IN SIX PROCESS LEARNING ACTIVITIES

The science concept analysis for the six process learning activities comprised the second part of the questionnaire. This part consisted of three sub-sections with the following process learning activities for each sub-section: Metals- learning activities (a) Sandcasting (b) Fabrication-Garden Shovel; Plastics- learning activities (a) Rotation Molding (b) Acrylic Ring, and Woods- learning activities (a) Pot Holder (b) Turned Bowl. The collected data will be presented as tables and supplemented with a written commentary for the benefit of the reader.

Woods, Metals, Plastics, Earths, Textiles and Leathers have been identified in the junior high curriculum guide as the five materials that are included in the Materials Technology Field of Study. The use of these materials become a vehicle to achieve whatever instructional objectives the teacher has established for the learner. Most, if not all, student process learning activities using these materials would involve most if not all of the these operations; Depicting, Separating, Forming, Conditioning, Combining, and Finishing.

A depicting operation has to do with sketching, laying out, or drafting something. Separating is an operation that involves process of using chip or non chip method of dividing material. A forming operation refers to the changing of material by heating, welding, molding, or bending. A shaping operation has to do with changing the shape of materials with edge tools or by grinding. Combining is an operation which involves the assembling of parts, while finishing as an operation is the application of materials to protect, beautify, decorate and sanitize the surface of materials. Each of these operations involves a number of science concepts that the Industrial Education teacher can have the learner identify when performing these operations in constructing a process learning activity. The linking of science concepts with a learning activity would provide the learner a better understanding of how scientific concepts can be applied in Industrial Education using the activity as a vehicle. Thus the learner would reinforce those concepts that were learned previously in science courses.

To validate the science concepts that were verified in the study, the researcher arbitrarily established a pre-set value of 60%, as the cut off point for the frequency whether to accept or reject the concept. Those concepts that were below the 60% criterion were rejected and were eliminated from the study.

The factors that were considered in determining the arbitrary number as the cut-off point in the frequency distribution for the validation of the science concepts in the 'agree' column were; 1) The amount of science preparation that participants had acquired. It had been determined from the data in the instrument that 54% of the participants did not have a minor in science. This knowledge helped the researcher to establish the cut-off point of 60%. The second was the relatively high frequency distribution in the 'don't know' column. This factor indirectly lowered the frequency in the 'agree' column whereby many valid science concepts would have to be omitted if a higher cut off point were chosen. Because of these factors the researcher established 60% as the cut-off point.

This cut-off point does not apply to the frequencies found in the 'Taught' column. The 'Taught' column is a function of the science concepts that were verified by the participants. This column was designed to determine the percent of participating teachers who taught the verified science concepts of that particular process learning activity to the learner. This would establish that science concepts were being taught to the learner and the extent they were being taught with a specific process learning activity.

Many of the science concepts to be verified were repeated in an operation. The design of the instrument did not accommodate for this repeating characteristic. Thus the 'taught' scores on the succeeding science concepts in reality may have been higher than indicated in the analyzed data. If a participant checked a science concept to establish that it was taught to the learner, the participant would not likely check the same science concept that was again listed in the operation to confirm having taught that concept. If the instructions had been written 'check if taught and/or reinforced', the participant might have checked the succeeding same concepts raising the frequency of those concepts. It is suggested that because of the inadequate instructions the percent established by the frequency for the concepts in the 'taught' column would indicate a lower number than actually took place.

There were 23 science concepts listed for the Sand Casting process learning activity in the research instrument. Data in Table 11 show that of the 23 science concepts listed for the three operations: Separation, Form, and Finish, participants agreed that 7 science concepts could be related to the Sand Casting project. These science concepts were: friction, hardness, change of state, property of liquid, evaporation, adhesion, and states of matter. The number of participants who taught these concepts were: change of state 12/37 or (32.4%), friction 11/37 or (29.7%), states of matter 11/37 (29.7%), hardness 9/37 or (24.3%), property of liquid 9/37 or (24.3%), evaporation 9/37 or (24.3%), adhesion 7/37 or (18.9%). From the operation of Separation: friction and hardness were verified as science concepts. Eighteen point nine percent of the participants did not consider heat energy a science concept in the operation of Separation. It was evident that participants did not consider the inclined plane as a science concept because it was rated the highest frequency (20/37) of 'don't know'

For operation - Form: change of state, and states of matter, and property of liquid were verified as science concepts. Mechanical energy was the science concept that had the highest percent of 'disagree' (35.1%) and impenetrability had the highest percent (62.2%) for 'don't know'.

For the operation - Finish: evaporation and adhesion were verified as science concepts. Cohesion was the science concept that had the highest frequency (6/37) of 'disagree' and hardness and surface tension were two concepts that had the highest frequency of 'don't know' (9/37) which meant participants did not know whether or not these science concepts could be applied in a finishing operation.

Table 11

Verification of Science Concepts: Sand Casting

(N=37)

Science Concepts	Participants							
	A	%	D	%	K	%	T	%
Operation-Separation								
Inclined plane	10	27.0	7	18.9	20	54.1	3	8.1
Friction	25	67.6	1	2.7	11	29.7	11	29.7
Mechanical energy	16	43.2	7	18.9	14	37.8	4	10.8
Mechanical advantage	13	35.1	7	18.9	17	45.9	3	8.1
Hardness	27	73.0	--	--	10	27.0	9	24.3
Heat energy	12	32.4	7	18.9	18	48.6	4	10.8

Table 11 Con'd
Verification of Science Concepts

Operation-Form								
Change of state	28	75.7	1	2.7	8	21.6	12	32.4
Heat energy	22	59.5	1	2.7	14	37.8	9	24.3
Liquefaction	20	54.1	1	2.7	16	43.2	4	10.8
Cohesion	17	45.9	5	13.5	15	40.5	4	10.8
Adhesion	17	45.9	8	21.6	12	32.4	5	13.5
Compression	20	54.1	2	5.4	15	40.5	4	10.8
Impenetrability	10	27.0	4	10.8	23	62.2	3	8.1
Hardness	12	32.4	7	18.9	18	48.6	2	5.4
Mechanical energy	6	16.2	13	35.1	18	48.6	2	5.4
States of matter	26	70.3	--	--	11	29.7	11	29.7
Property of liquid	24	64.9	--	--	13	35.1	9	24.3
Crystallization	15	40.5	4	10.8	18	48.6	5	13.5
Operation-Finish								
Evaporation	23	62.2	3	8.1	11	29.7	9	24.3
Hardness	13	35.1	5	13.5	19	51.4	3	8.1
Adhesion	23	62.2	2	5.4	12	32.4	7	18.9
Surface tension	15	40.5	3	8.1	19	51.4	3	8.1
Cohesion	14	37.8	6	16.2	17	45.9	3	8.1

Legend

A= number agreed to the concept
D= number disagreed to the concept
K= number that don't know
T= number that taught the concept

The data in Table 12 identifies the science concepts verified by research participants for the process learning activity: Garden Shovel. Data in Table 12 show that of the 25 science concepts listed 10 were verified by the participants to be science concepts that the student could acquire in the fabrication of the Garden Shovel. The science concepts verified by those involved in the research were: friction, heat energy, mechanical advantage, malleability, force, lever, momentum, solvent, evaporation, and adhesion. The percentage of the participants that taught these science concepts were: friction (45.9%), evaporation (45.9%), adhesion (40.5%), mechanical advantage (40.5%), solvent (37.8%), malleability (27%), lever (27%), heat energy (24.3%), momentum (18.9%), and force (18.9%).

For the operation - Separation: friction, heat energy, and mechanical advantage were verified as science concepts by the research participants. Energy conversion was the science concept that 16.1% of the participants felt was not a concept. Thirty five point one percent of the 37 teachers 'didn't know' if the inclined plane was a science concept in a Separation operation.

For the operation - Form: mechanical advantage, malleability, lever, and force were verified as concepts. Four of the 37 participants disagreed that the wheel and axle was a science concept that could be applied to this operation. Fifteen teachers from the cohort of 37 did not know if mechanical energy was a science concept in an operation to form a material.

For the operation - Combine: malleability, force, and momentum was verified as science concepts. There was disagreement among 24.3% of the participants that heat energy was a concept in the operation - Combine and 37.8% of the research sample who indicated they did not know if the lever was a science concept in an operation to combine metal materials.

The operation - Finish had solvent, evaporation, and adhesion verified by research participants as science concepts. Hardness was the concept that had both the highest frequency of 'disagree' (9/37) and 'don't know' (15/37) among those involved in the study.

Table 12

Verification of Science Concepts: Garden Shovel

(N=37)

Science Concepts	Participants							
	A	%	D	%	K	%	T	%
Operation-Separation								
Friction	30	81.1	--	--	7	18.9	17	45.9
Heat energy	24	64.9	3	8.1	10	27.0	9	24.3
Energy conversion	20	54.1	6	16.1	11	29.1	5	13.5

Table 12 Con't
Verification of Science Concepts

Operation-Separation								
Mechanical advantage	26	70.3	4	10.8	7	18.9	12	32.4
Mechanical energy	22	59.5	5	13.5	10	27.0	8	21.6
Inclined plane	19	51.4	5	13.5	13	35.1	8	21.6
Operation-Form								
Mechanical advantage	30	81.1	1	2.7	6	16.2	15	40.5
Malleability	28	75.7	3	8.1	6	16.2	13	35.1
Force	28	75.7	3	8.1	6	16.2	7	18.9
Lever	24	64.9	5	13.5	8	21.6	10	27.0
Wheel and axle	19	51.4	4	10.8	14	37.8	6	16.2
Mechanical energy	19	51.4	3	8.1	15	40.5	8	21.6
Operation-Combine								
Malleability	28	75.7	4	10.8	5	13.5	10	27.0
Force	24	64.9	2	5.4	11	29.7	7	18.9
Mechanical advantage	21	56.8	5	13.5	11	29.7	6	16.2
Momentum	23	62.2	5	13.5	9	24.3	7	18.9
Lever	15	40.5	8	21.6	14	37.8	3	8.1
Potential energy	19	51.4	6	16.2	12	32.4	5	13.5
Kinetic energy	19	51.4	7	18.9	11	29.7	7	18.9
Heat energy	16	43.2	9	24.3	12	32.4	4	10.8

Table 12 Con't
Verification of Science Concepts

	A	%	D	%	K	%	T	%
Operation - Finish								
Solvent	25	67.6	3	8.1	9	24.3	14	37.8
Evaporation	28	75.7	2	5.4	7	18.9	17	45.9
Hardness	13	35.1	9	24.3	15	40.5	5	13.5
Adhesion	28	75.7	--	--	9	24.3	15	40.5
Surface tension	19	51.4	4	10.8	14	37.8	7	18.9

Legend

A= number agreed to the concept
D= number disagreed to the concept
K= number that don't know
T= number that taught the concept

Data presented in Table 13 show there were 25 science concepts listed on the questionnaire that were associated in the production of plastic casting using Rotation Molding as a process. Of these 25 concepts, 8 were verified by the participants as being concepts to be developed in the production of a plastic casting product. These concepts were: force, adhesion, heat energy, wheel and axle, gear ratio, contraction, state of matter, and the screw. The percent of participants that taught these concepts were; contraction (32.4%), heat energy (29.7%), force (27%), adhesion (24.3%), state of matter (24.3%), wheel and axle (16.2%), gear ratio (16.2%), and the screw (13.5%).

In the operation - Depict: none of the concepts listed were verified as such. Synthetic material was the science concept that had highest frequency of 'don't know' (17/37).

One of the four science concepts listed for the operation - Separation were verified. That concept was force. Friction and inclined plane both had the highest frequencies (15/37) in the 'disagree' column thus were discounted as science concepts. Mechanical advantage was the concept that had the highest frequency (12/37) in the 'don't know' category.

Of the fourteen concepts listed for the operation - Form: adhesion, heat energy, wheel and axle, gear ratio, contraction and state of matter were verified to be science concepts. Force and mechanical advantage were items that had the highest frequency (10/37) of 'disagree' and latent heat had the highest frequency (19/37) for 'don't know'.

Of the six science concepts listed under the operation - Combine: the screw was verified as a concept. The concept wheel and axle had the highest percent of disagreement among those involved in the study (37.8%) and mechanical energy and friction and mechanical energy were concepts that had the highest percent of 'don't know' (40.5%).

Table 13

Verification of Science Concepts: Rotation Molding

(N=37)

Science Concepts	Participants							
	A	%	D	%	K	%	T	%
Operation-Depict								
Synthetic material	20	54.1	--	--	17	45.9	12	32.4
Operation-Separation								
Inclined plane	21	56.8	7	18.9	9	24.3	7	18.9
Friction	13	35.1	15	40.5	9	24.3	6	16.2
Force	23	62.2	7	18.9	7	18.9	10	27.0
Mechanical advantage	13	35.1	12	32.4	12	32.4	4	10.8
Operation-Form								
Surface tension	19	51.4	5	13.5	13	35.1	7	18.9
Adhesion	24	64.9	4	10.8	9	24.3	9	24.3
Cohesion	19	51.4	5	13.5	13	35.1	8	21.6
State of matter	22	59.5	7	18.9	8	21.6	12	32.4
Heat energy	23	62.2	7	18.9	7	18.9	11	29.7
Force	15	40.5	10	27.0	12	32.4	5	13.5
Mechanical advantage	19	51.4	10	27.0	8	21.6	4	10.8
Wheel and axle	23	62.2	5	13.5	9	24.3	6	16.2
Gear ratio	23	62.2	4	10.8	10	27.0	6	16.2

Table 13 Con't
Verification of Science Concept

Operation-Form								
Mechanical energy	18	48.6	9	24.3	10	27.0	6	16.2
Contraction	26	70.3	2	5.4	9	24.3	12	32.4
Specific heat	13	35.1	6	16.2	18	48.6	5	13.5
Latent heat	15	40.5	3	8.1	19	51.4	6	16.2
State of matter	23	62.2	4	10.8	10	27.0	9	24.3
Operation - Combine								
Mechanical advantage	18	48.6	9	24.3	10	27.0	6	16.2
Screw	24	64.9	4	10.8	9	24.3	5	13.5
Force	21	56.8	7	18.9	9	24.3	10	27.0
Mechanical energy	12	32.4	10	27.0	15	40.5	6	16.3
Friction	10	27.0	12	32.4	15	40.5	4	10.8
Wheel and axle	11	29.7	14	37.8	12	32.4	2	5.4

Legend

A= number agreed to the concept
D= number disagreed to the concept
K= number that don't know
T= number that taught the concept

Table 14 lists 24 science concepts that research participants were to verify in the production of a plastic laminated product: Acrylic Ring. Twelve of these 24 concepts were verified as science concepts. The concepts that were verified included: measurement, scale, ratio, force, mechanical advantage, friction, solvent, dissolve, bonding, heat energy, evaporation, and the screw. The percent of participants who taught these concepts in making this product were: evaporation (56.8%), measurement (54.1%), dissolve (48.6%), solvent (48.6%), bonding (45.9%), scale (43.2%), ratio (37.8%), friction (35.1%), heat energy (32.4%), force (29.7%), mechanical advantage (27%), and the screw (16.2%).

For the operation - Depict: measurement, ratio and scale, were verified as science concepts. Four of the 37 participants disagreed that ratio was a science concept and it was also the concept that had the highest frequency of 'don't know' (10/37).

For the 10 science concepts listed in the operation - Separation: the concepts, force, the screw, mechanical advantage, friction, and heat energy were verified as concepts. The concept that had the highest frequency (11/37) for not being considered a concept was the inclined plane. Resolution as a concept had the highest frequency (20/37) of 'don't know'.

For the operation - Combine, there were 11 science concepts listed, 7 of these were verified as concepts: solvent, dissolve, bonding, evaporation, the screw, mechanical advantage, and force. Fifteen of the 37 participants disagreed that friction was a concept that could be linked to the product. Friction was also the concept that had the highest frequency (11/37) for the 'don't know' category.

Table 14

Verification of Science Concepts: Acrylic Ring

(N=37)

Science Concepts	Participants							
	A	%	D	%	K	%	T	%
Operation-Depict								
Measurement	31	83.8	1	2.7	5	13.5	20	54.1
Scale	25	67.6	2	5.4	10	27.0	16	43.2
Ratio	23	62.2	4	10.4	10	27.0	14	37.8
Operation-Separation								
Wheel and axle	21	56.8	6	16.2	10	27.0	4	10.8
Inclined plane	16	43.2	11	29.7	10	27.0	4	10.8
Force	24	64.9	4	10.8	9	24.3	11	29.7
Screw	23	62.2	5	13.5	9	24.3	7	18.9
Mechanical advantage	27	73.0	4	10.8	6	16.2	10	27.0
Friction	25	67.6	5	13.5	7	18.9	13	35.1
Hardness	21	56.8	5	13.5	11	29.7	11	29.7
Mechanical energy	22	59.5	7	18.9	8	21.6	6	16.2
Heat energy	23	62.2	5	13.5	9	24.3	12	32.4
Resolution	10	27.0	7	18.9	20	54.1	5	13.5
Operation - Combine								
Solvent	28	75.7	2	5.4	7	18.9	18	48.6
Dissolve	29	78.4	3	8.1	5	13.5	18	48.6

Table 14 Cont'd
Verification of Science Concept

Operation-Combine								
Cohesion	20	54.1	6	16.2	11	29.7	15	40.5
Bonding	30	81.1	2	5.4	5	13.5	17	45.9
Evaporation	29	78.4	1	2.7	7	18.9	21	56.8
Screw	25	67.6	5	13.5	7	18.9	6	16.2
Wheel and axle	18	48.6	11	29.7	8	21.6	4	10.8
Mechanical advantage	24	64.9	6	16.2	7	18.9	10	27.0
Force	23	62.2	7	18.9	7	18.9	9	24.3
Mechanical energy	19	51.4	8	21.6	10	27.0	5	13.5
Friction	11	29.7	15	40.5	11	29.7	7	18.9

Legend

A= number agreed to the concept
D= number disagreed to the concept
K= number that don't know
T= number that taught the concept

For the four operations found in Table 15 there were 21 science concepts that participants were to verify in the production of the ceramic tile inlaid into a wooden Pot Holder. From these 21 concepts, seven were verified as science concepts. They were: measurement, hardness, friction, bonding, mechanical energy, adhesion, and evaporation. The percent of participants who taught these seven concepts were: adhesion (51.4%), bonding (45.9%), measurement (45.9%), friction (43.2%), hardness (43.2%), mechanical energy (27%), and evaporation (24.3%). In the operation - Depict: measurement, was considered to be a concept.

Of the five concepts presented in the operation - Separation, three were verified as science concepts: hardness, friction, and mechanical energy. Inclined plane was not considered to be a science concept by 11 of the 37 participants for the operation of Separation. This concept had the highest frequency (10/37) of 'don't know'.

Of the three science concepts listed for the operation, Combine, adhesion and bonding were verified to be concepts. Six of the 37 participants disagreed that evaporation was a science concept for the operation, Combine. This concept had the highest frequency (9/37) for the 'don't know' category.

For the operation - Finish participants verified that adhesion, hardness, bonding, friction and evaporation were science concepts. Inclined plane was the concept that had the highest frequency (17/37) of disagreement. Resolution was the concept that had the highest frequency (21/37) of 'don't know'.

Table 15

Verification of Science Concepts: Pot Holder

(N=37)

Science Concepts	Participants							
	A	%	D	%	K	%	T	%
Operation-Depict								
Measurement	26	70.3	3	8.1	8	21.6	17	45.9
Operation-Separation								
Inclined plane	13	35.1	12	32.4	12	32.4	4	10.8
Hardness	27	73.0	2	5.4	8	21.4	16	43.2
Friction	28	75.7	3	8.1	6	16.2	16	43.2
Heat energy	18	48.6	10	27.0	9	24.3	11	29.2
Mechanical energy	23	62.3	7	18.9	7	18.9	10	27.0
Operation - Combine								
Adhesion	31	83.8	--	--	6	16.2	19	51.4
Evaporation	22	59.5	6	16.2	9	24.3	9	24.3
Bonding	29	78.4	1	2.7	7	18.9	17	45.9
Operation - Finish								
Adhesion	27	73.0	1	2.7	9	24.3	11	29.7
Evaporation	26	70.3	3	8.1	8	21.6	9	24.3
Resolution	8	21.6	8	21.6	21	56.8	4	10.8
Bonding	28	75.7	3	8.1	6	16.2	10	27.0
Surface tension	21	56.8	6	16.2	10	27.0	8	21.6

Table 15 Con't
Verification of Science Concept

Operation - Finish								
Cohesion	18	48.6	8	21.6	11	29.7	8	21.6
Inclined plane	6	16.2	17	45.9	14	37.8	5	13.5
Hardness	23	62.2	5	13.5	9	24.3	11	29.7
Friction	28	75.7	3	8.1	6	16.2	13	35.1
Heat energy	15	40.5	11	29.7	11	29.7	8	21.6
Mechanical energy	15	40.5	10	27.0	12	32.4	5	13.5
Evaporation	27	73.0	2	5.4	8	21.6	13	35.1

Legend

A= number agreed to the concept
D= number disagreed to the concept
K= number that don't know
T= number that taught the concept

The data in Table 16 lists 25 science concepts for the five operations in making a wood turned product: Bowl. Of these 25 concepts, the participants verified that 8 were concepts that could be associated in making a wood turned product. These concepts were: measurement, scale, force, hardness, friction, adhesion, mechanical advantage, and absorption. The percent of participants who taught the identified concepts were as follow: measurement (70.3%), scale (56.8%), absorption (56.8%), adhesion (51.8%), hardness (37.8%), friction (37.8%), force (35.8%), and mechanical advantage (18.9%).

The operation - Depict had three science concepts listed, two of these, measurement and scale were verified as science concepts. Ratio was a concept that had the highest frequency of 'disagree' (8/37). It was also the concept that had the highest frequency of 'don't know' (8/37).

Force, hardness, and friction were verified as science concepts in the operation - Separation. Of the 37 Industrial Education teachers, 10 felt that heat energy was not a concept in the operation - Separation. Heat energy was also the concept that had the highest frequency (8/37) of 'don't know'.

For the operation - Combine, three of the ten science concepts, adhesion, force, and mechanical advantage were verified by those involved in the research to be concepts. Mechanical energy was the concept with the highest frequency (12/37) of disagreement and absorption had the highest frequency (13/37) for 'don't know'.

For the operation - Finish: absorption and adhesion were verified as concepts. Cohesion was the concept that had both the highest frequency of disagreement (9/37) and 'don't know' (13/37).

Table 16

Verification of Science Concepts: Wood Turned Product

(N=37)

Science Concepts	Participants							
	A	%	D	%	K	%	T	%
Operation-Depict								
Measurement	31	83.8	2	5.4	4	10.8	26	70.3
Scale	27	73.0	3	8.1	7	18.9	21	56.8
Ratio	22	59.5	8	21.6	7	18.9	17	45.9
Operation-Separation								
Inclined plane	22	59.5	7	18.9	8	21.6	13	35.1
Mechanical energy	21	56.8	9	24.3	7	18.9	10	27.0
Force	28	75.7	5	13.5	4	10.8	13	35.1
Mechanical advantage	21	56.8	10	27.0	6	16.2	8	21.6
Hardness	27	73.0	3	8.1	7	18.9	14	37.8
Friction	27	73.0	3	8.1	7	18.9	14	37.8
Heat energy	19	51.4	10	27.0	8	21.6	10	27.0
Operation - Combine								
Absorption	19	51.4	5	13.5	13	35.1	8	21.6
Evaporation	21	56.8	6	16.2	10	27.0	9	24.3
Adhesion	31	83.8	2	5.4	4	10.8	19	51.8
Cohesion	15	40.5	11	29.7	11	29.7	7	18.9

Table 16 Con't
Verification of Science Concept

Operation-Combine								
Friction	21	56.8	8	21.8	8	21.6	6	16.2
Inclined plane	20	54.1	8	21.6	9	24.3	10	27.0
Force	23	62.2	4	10.8	10	27.0	5	13.5
Mechanical advantage	25	67.6	5	13.5	7	18.9	7	18.9
Wood cells	22	59.5	5	13.5	10	27.0	7	18.9
Mechanical energy	16	43.2	12	32.4	9	24.3	4	10.8
Operation - Finish								
Absorption	31	83.8	3	8.1	3	8.1	21	56.8
Evaporation	22	59.5	6	16.5	9	24.3	11	29.7
Adhesion	23	62.2	6	16.2	8	21.6	9	24.3
Surface tension	18	48.6	5	13.5	14	37.8	5	13.5
Cohesion	15	40.5	9	24.3	13	35.1	5	13.5

Legend

A= number agreed to the concept
D= number disagreed to the concept
K= number that don't know
T= number that taught the concept

Chapter IV

INTERPRETATION OF DATA

INTRODUCTION

The previous chapter of this report presented an analysis of data that were collected with the research questionnaire. These data were presented in tabular form using frequencies and percentages to structure each table. An analysis of data from each table was made for the benefit of the reader.

COMPOSITE PROFILE OF THE TYPICAL PARTICIPANT

The following composite profile of the typical junior high school Industrial Education teacher who participated in the study was developed using demographic data that were collected with Part I of the research instrument. Support for this profile can be found in tables 1 through 10 inclusive in Chapter Three.

The typical junior high school Industrial Education teacher who was involved with this research was a graduate of the University of Alberta. While at university this individual was enrolled in the Industrial Arts Program of Study, which utilized the Alberta Plan as its philosophical foundation. The learning environment for the Plan was organized as a multiple activity laboratory where either Materials or Technologies were taught. As an undergraduate student this teacher took a minimum number of physics and/or chemistry courses and selected as a second teachable minor, a subject area other than the sciences.

This teacher had 16 or more years of teaching experience as an Industrial Education teacher at the junior high school level. In the school where this teacher was employed, he/she was assigned to teach Industrial Education 100% of the time. The learning environment where this teacher taught was organized as a multiple activity laboratory. In that laboratory the teacher used the prescribed curriculum guide to select instructional content from three of the five modules from the Materials Technology Field of Study. These three modules were: Metals, Plastics, and Woods. However prior to the research this teacher taught from Materials Technology: Earths, Textiles and Leathers. To present instructional content to the learner this teacher used the product as the means for the student to develop a use level of skill on the hierarchy of skills.

VERIFICATION OF THE SCIENCE CONCEPTS FOUND IN SELECTED PROCESS LEARNING ACTIVITIES

The author analyzed the selected process learning activities for their science concepts using a task analysis approach as prescribed by Fryklund (1970). The identified science concepts were listed in Part II of the instrument which was sent to the participants for verification. The author acknowledges that not all science concepts associated with the selected learning activities were identified and those listed may not be associated with the learning activities. This procedure met the requirements of the problem statement which was:

> The purpose of the study was to analyze selected process learning activities from the Woods, Plastics, and Metals modules found in the Materials Technology Field of Study for their scientific concepts. These process learning activities were those that were thought to be used by junior high school industrial education teachers in the province of Alberta to present instructional content to the learner.

The second section of the research instrument listed 222 science concepts that were associated with the elements for the operations of the six process learning activities. The modules from which the process learning activities were taken were: Metals, Plastics, and Woods. Many of the science concepts that were applied to the elements of the operations in the selected process learning activities were collected by analyzing the junior high school science curriculum guides and program of studies. By using this procedure to design Part II of the questionnaire, the researcher insured that the requirements for two and three of the supporting objectives of the problem statement were met. These supporting objectives were stated:

> to review science curriculum guides in grade seven and eight for their science concepts that may be reinforced through the use of process learning activities in a junior high school industrial education laboratory.
>
> to review the grade nine science curriculum guide for the science concepts that were related to selected process learning activities that may be

> used with grade nine students so that these principles may be reinforced as the student constructs a product.

Participant teachers were asked to verify whether they 'agreed', 'disagreed', or 'didn't know' whether the science concept was associated with the specific process learning activity. Because some of the science concepts were repeated in the operations of the six process learning activities, they were compressed to 142 concepts which were listed in the tables 11 to 16 inclusive in Chapter Three. A science concept was considered to be verified if its frequency met the 60% criterion. Data that were analyzed show that the participants as a group, verified 53 of the 142 science concepts. More specifically, those involved in the study verified seven science concepts for Sand Casting. These were: friction, hardness, change of state, property of liquid, evaporation, adhesion, and states of matter. Ten concepts were confirmed in the fabrication of the Garden Shovel. They were: friction, heat energy, mechanical advantage, malleability, force, lever, momentum, solvent, evaporation, and adhesion. Eight concepts in the Rotation Molding process were verified. These were: force, adhesion, heat energy, wheel and axle, gear ratio, contraction, state of matter, and the screw. For the production of the Acrylic Ring, thirteen concepts were verified. They were: measurement, scale, ratio, force, mechanical advantage, friction, solvent, solubility, bonding, heat energy, evaporation, and the screw. The seven confirmed concepts in the production of a Hot Pot Holder were: measurement, hardness, friction, adhesion, bonding, mechanical energy, and evaporation. Finally the eight concepts for the Turned Bowl of wood were: measurement, scale, force, hardness, friction, adhesion, mechanical advantage, and absorption.

These 53 science concepts that were verified in the study could further be compressed to 40, because 13 of these concepts were repeated in some of the five operations that were used to analyze the six process learning activities. These 13 repeatable concepts were adhesion (4); force (3); friction (3); evaporation, bonding, hardness, heat energy, measurement, and mechanical advantage (2); and scale, solvent, state of matter, and the screw (1). The number in the parenthesis indicates the frequency that the science concept was repeated.

To get another perspective of the total picture for the verification and reinforcement of science concepts from the selected process learning activities an average of the frequencies for each column for tables 11 through 16 was calculated. The information below was the result of averaging procedure.

Of the 23 science concepts for Sand Casting process presented in Table 11 it is evident that 47.9% of the participants agreed with these concepts. Conversely, there were 41% who by their 'don't know' rating could not verify the concept in the process learning activity. This could be a reflection of the second teachable subject participants selected in their undergraduate preparation which handicapped them when it came to applying scientific knowledge.

Table 12 lists 29 science concepts that were an integral part of making a Garden Shovel. From the averaging procedure there were 61% of those who provided data who agreed with the list of concepts. There were 30% of the participants who 'didn't know' if the concept applied to the activity.

A similar interpretation could be made from data found in Table 13 where an average of 50% of the research sample agreed with the 25 science concepts that were listed and 30% 'didn't know'.

It is evident from the data in Table 14 that when an average was computed for each of the three columns that 61.6% of the research cohort agreed with the 24 science concepts. The average for the 'don't know' column had a percentage of 23.5%

The same interpretation could be made from the averaging procedure for Table 15 and Table 16 which show an average of 59% and 61.3% respectively for the 'agree' column for these tables.

It becomes evident when interpreting data in the six tables for the process learning activities that the 'disagreed' average rating was the lowest of the three ratings.

Data from tables 11 through 16 inclusive show that those involved in the study verified 52 of the 142 science concepts that were presented for the six process learning activities. Consequently, this satisfied one of the three supporting objecting established for the research. That objective read:

> to verify science concepts that were inherent in selected process learning activities commonly performed by students in the Metals, Plastics, and Woods areas found in a junior high school industrial education multiple activity laboratory.

PERCENT OF VERIFIED SCIENCE CONCEPTS TAUGHT

Column 7 in the tables 11 through 16 inclusive show the frequency that the verified concepts were 'taught' by the participants. The average for column seven, the taught column for the tables of the six process learning activities show that these data range from 10.6% to 30.1% as verified concepts. An interpretation of data from these tables could mean that reinforcement of science concepts in a multiple activity laboratory where Materials Technology was taught was not a high priority as an instructional objective in the design of lessons of the participants.

An analysis of the data from tables generated from data of Part II of the questionnaire indicate that a well articulated linkage between the Industrial Education program and the core subject of science has not been established . The range of percent for the 'don't know' column of the six selected process learning activities was from 41% to 21.9%. This interpretation suggests the verification of science concepts associated with the process learning activities were not well interpreted by those involved in the research. Some of the teaching force responsible for teaching junior high school Industrial Education may have made a concerted effort to develop/reinforce science concepts as a goal in their teaching, while others were doing this incidentally. Cross-curricular integration is still a goal of the future that really needs to be worked on by teachers from related subject areas whether core or complementary.

REINFORCEMENT OF SCIENCE CONCEPTS

The grade seven program that is described in the 1990 Program of Studies for Junior High School Science is comprised of the following six units: Characteristics of Living Things, Structure and Design, Force and Motion, Temperature and Heat Measurement, Micro-organisms and Food Supplies, and Evidence of Erosion. Of these six units, that make up the content for the science program, the researcher felt the units of: Structure and Design, Force and Motion, Temperature and Heat Measurement could be correlated with the Industrial Education program. The table below lists the science concepts for the selected process learning activities that were verified from the research and links them with the appropriate unit for the grade seven science program.

Table 17

Reinforcement of Science Concepts: Grade Seven

Process Learning Activity	Verified Science Concept	Science: Topic of Study
Sand Casting		
	evaporation	Temperature and Heat Measurement
Garden Shovel		
	force, momentum	Force and Motion
	heat energy	Temperature and Heat Measurement
Rotation Molding		
	force	Force and Motion
	heat energy	Temperature and Heat Measurement
Acrylic Ring		
	measurement, scale, ratio,	Structure and Design
	force	Force and Motion
	heat energy	Temperature and Heat Measurement
Pot Holder		
	measurement	Structure and Design

Wood Turned Bowl	measurement, scale,	Structure and Design
	force	Force and Motion

The 1990 Program of Studies for grade eight junior high school science consists of these six units: Solutions and Substances, Energy and Machines, Consumer Product Testing, The Earth's Crust, Growing Plants, and Interactions and Environments. It is the opinion of the investigator that of the six units two: Solutions and Substances, and Energy and Machines could be integrated with process learning activities of the Industrial Education program for junior high school students. Information in Table 18 shows the relationship between the fifteen verified science concepts for the selected process learning activities from the research and the selected units from the grade eight science program, 1990.

Table 18

Reinforcement of Science Concepts: Grade Eight

Process Learning Activity	Verified Science Concept	Science: Topic of Study
Sand Casting	friction,	Energy and Machines
	property of a liquid	Solutions and Substances

Table 18 cont'd

Garden Shovel	friction, heat energy, mechanical advantage, force, lever,	Energy and Machines
	solvent	Solutions and Substances
Rotation Molding	force, heat energy, wheel and axle, gear ratio, the screw	Energy and Machines
Acrylic Ring	force, mechanical advantage, friction, heat energy, the screw	Energy and Machines
	solvent, dissolve, bonding	Solutions and Substances
Pot Holder	friction, mechanical energy,	Energy and Machines
	bonding, adhesion	Solutions and Substances
Wood Turned Bowl	force, friction, mechanical advantage	Energy and Machines
	absorption	Solutions and Substances

Similarly, the grade nine program as identified in the 1990 Program of Studies for junior high science is also comprised of six units. These six units are: Diversity of Living Things, Fluids and Pressure, Heat Energy: Transfer and

Conservation, Electromagnetic Systems, Chemical Properties and Changes, and Environmental Quality. Of these units, the ones that could be linked with the 14 verified science concepts from the research found in the selected six process learning activities are: Fluids and Pressure, Heat Energy: Transfer and Conservation, and Chemical Properties and Changes. The table below shows the cross-curricular linkage of Industrial Education and science for these six products or processes.

Table 19

Reinforcement of Science Concepts: Grade Nine

Process Learning Activity	Verified Science Concept	Science: Topic of Study
Sand Casting	friction, change of state, evaporation	Heat Energy: Transfer and Conservation
	property of liquid, evaporation	Fluids and Pressure
Garden Shovel	friction, heat energy, malleability	Heat Energy: Transfer and Conservation
	force	Fluids and Pressure
	solvent	Chemical Properties

Rotation Molding	heat energy, contraction, state of matter	Heat Energy: Transfer and Conservation
Acrylic Ring	heat energy, evaporation,	Heat Energy: Transfer and Conservation
	solvent, dissolve	Chemical Properties
Pot Holder	friction, mechanical energy, evaporation	Heat Energy: Transfer and Conservation
	evaporation	Fluids and Pressure
	adhesion	Chemical Properties
Wood Turned Bowl	friction,	Heat Energy: Transfer and Conservation
	adhesion, absorption	Chemical Properties

Although there may be other science concepts in process learning activities that could be reinforced, the concepts that were listed were only the ones that participants verified during the research.

Interpreting data from Part II of the instrument indicates that a cross-curricular link between the Industrial Education program and the science program has not been established. The range of percentages for the 'don't know' column of the six tables for the selected process learning activities were from 41% to 21.9% supports the interpretation that the identification of science concepts associated with products used as a teaching vehicle in Industrial Education by the participants is not well articulated.

An objective stated in past curriculum guides for Industrial Education and implied in the 1982 guide was to provide students with an environment in which they can apply their academic knowledge to generate solutions for practical problems, particularly in science. The results of this study helped to generate a greater understanding of that objective and helped to determine the extent that learning activities in the present Industrial Education program reinforce science concepts.

An implied need for the study was to provide additional information that would aid in the implementation of the philosophical framework for Career and Technology Studies (CTS) that is to be released in the mid-1990's by the Curriculum Design Branch of the Department of Education. The philosophical framework for CTS indicates that the Practical Arts subjects will be integrated under a single title and that a closer relationship will evolve between the core and complementary subjects. If the concept of integration is to be applied in the junior high school Industrial Education programs, one must first survey the contemporary situation to determine if teachers of this subject area are presently designing lessons that integrate their subject material with subject matter of other disciplines.

If the new CTS curriculum does not provide a structure where cross-curricular linkages are well articulated, teachers could interpret the structure to mean that the current practices of the Industrial Education program can be left to naturally evolve to incorporate the stated goal of the new CTS philosophy. Other questions can be raised about the present program and its transition to the new CTS program. For example: Will the 'process learning activity' remain as the primary learning vehicle in a junior high school Industrial Education laboratory and remain as the focal point of the program? Will the 'process learning activity' continue to be used as a vehicle to develop use level of skills in the three learning domains - affective, cognitive, and psychomotor? Will there be a theoretical model in the CTS curriculum guide or elsewhere that explains how 'the product' can be used with the three learning domains? Many Industrial Education teachers have assumed that these skills can be acquired by the student working on the process learning activity. Although the study does not give direct attention to these questions, it makes the assumption that the 'product' is a vehicle or a means to an end and not an end in itself.

CHAPTER V

SUMMARY, CONCLUSIONS, RECOMMENDATIONS, AND OBSERVATIONS

INTRODUCTION

The content of the third chapter presented an analysis of the data that were collected with the research instrument. These data were organized in tables and analyzed.

The fourth chapter gave an interpretation of the analysis of the data and provided support to the problem statement and the three supporting objectives.

This final chapter consists of four related sections. The first section is a summary of the research problem and the major components of the research design including the methodology which was used to bring the research to a conclusion. The second section presents a summary of the research findings that had their foundation in the data that were collected. From these findings, conclusions of the study were formulated and are an integral part of this section of the report. The third section presents recommendations resulting from the research findings and are directed to the following groups: personnel of Alberta Education, other researchers, academic staff of the University of Alberta, Department of Secondary Education and practising Industrial Education teachers. The fourth and final section of this chapter presents the observations of the researcher that were made while conducting the research.

SUMMARY

This section summarizes the problem statement, the research population, the instrumentation, and the methodology used to conduct the investigation.

The Problem

The major purpose of this study was to analyze two selected process learning activities from the Woods, Plastics, and Metals modules found in the Materials Technology Field of Study, for their scientific concepts. These process learning activities were those that were thought to be used by junior high school Industrial Education teachers with their learners in a multiple activity laboratory in the province of Alberta. The following three objectives were formulated to give support to the major purpose of the study:

1. to verify science concepts that were inherent in selected process learning activities commonly performed by students in the Metals, Plastics, and Woods areas found in a junior high school Industrial Education multiple activity laboratory.

2. to review science curriculum guides for grades seven and eight for their science concepts that may be reinforced through the use of process learning activities in a junior high school Industrial Education laboratory.

3. to review the grade nine science curriculum guide for science concepts that were related to selected process

learning activities that may be used with grade nine students so that these concepts may be reinforced as the student completes the learning activity.

To fulfill both the purpose of the study and its supporting objectives, a two part questionnaire was developed. Prior to being used in the research, the questionnaire reviewed by a specialist in instrument design, Department of Educational Psychology, Faculty of Education, University of Alberta. The questionnaire was then pilot tested with five junior high school Industrial Education teachers employed by the Calgary Catholic School Board. The teachers who participated in the pilot study were not involved in the research. From the pilot study the questionnaire was redesigned and then sent to the participants. By checking the appropriate columns on the questionnaire, research participants verified science concepts that could be applied to the selected process learning activities. From a pool of 142 science concepts, those involved in the research determined that 53 could be applied to each of the two process learning activities for Metals, Plastics, and Woods - three of the six materials modules that comprise the Materials Technology Field of Study for junior high school Industrial Education.

The Population

The population for this study consisted of 152 junior high Industrial Education teachers whose names were received from the public and separate school boards of Calgary and Edmonton, the two largest urban areas in the province. From the 152 names, a random sample of 50 names was generated. The procedure used to select the random sample was that recommended by Ary, Jacobs, and Razayieh (1985) in Introduction to Research in Education. The sample consisted of 25 junior high school Industrial Education teachers from Calgary and from Edmonton for a total of 50.

Instrumentation

The revised instrument was pilot tested to help establish an accurate time frame needed by an individual to complete the instrument and to identify inconsistencies within the research instrument. From the results of the pilot study, changes were made to the questionnaire before it was used to collect data. The teachers involved in the pilot study taught in the Alberta Multiple Activity Program at the junior high school level and were not involved in the main research. These teachers were used because they were readily available to the researcher.

The questionnaire used in the study consisted of two parts: Part I gathered demographic information from research participants. Part II of the research instrument listed 142 science concepts that were associated with the elements for the operations of the six process learning activities for three modules from the Materials Technology Field of Study.

Participating teachers were asked to verify whether they 'agreed', 'disagreed', or 'didn't know' whether the science concept was associated with a specific process learning activity. They were also asked to check if the science concept was 'taught' when that particular process learning activity was used.

Methodology

In preparation for establishing the problem statement, the investigator reviewed the ERIC data base using these descriptors: industrial arts, secondary schools, science concepts, science, integration, shop curriculum, and school shops, as well as reviewing book based libraries. From the ERIC data base 50 articles were selected and reviewed for their relationship to the current study. The review of these articles provided the researcher with information on science and the integration of science with technology, the shift from the aims of Industrial Arts to the goals for Technology Education and arguments for programs in applied science. These articles were written by leaders in Industrial Education and/or Technology Education from Canada and the United States. After reading these articles it was decided that a task analysis procedure would be used with each process learning activity and the science concepts related to these products would be integrated into the research instrument.

An instrument in the form of a questionnaire was designed and revised after being pilot tested.

Copies of the research design, the research instrument and an application were submitted to the Department of Adult, Career and Technology Education, Ethics Review Committee to ensure that the research design was conducted in accordance with the ethical guidelines for research established by the university. Following approval from the Ethics Review Committee, a letter was prepared and mailed to the public school superintendent in Calgary requesting permission to allow junior high school Industrial Education teachers in the district to become involved in the research. The researcher collaborated with the supervisor of Industrial Education for Calgary Catholic School District #1 to secure permission to allow junior high Industrial Education teachers in that district to participate in the study. In Edmonton, a slightly different procedure was used. An application was made through Field Services, Faculty of Education, University of Alberta, to involve the superintendents of the Public and Separate School Systems in Edmonton. Personnel of Field Services contacted each superintendent to gain permission to involve the junior high school Industrial Education teachers of their school districts in the study. Following the approval, a research package which included a covering letter, a questionnaire, and a self addressed envelope was assembled and mailed to each of the 50 Industrial Education teachers in the four school districts. By the established deadline date, 54%

(27/50) of the research participants returned completed questionnaires. To increase the rate of return, a follow up procedure in the form of a telephone call was initiated. This procedure yielded an additional 14 questionnaires which increased the rate of return to 82% (41/50). Four of the returned questionnaires had to be eliminated from the study for these reasons: three of the instruments contained incomplete data and one participant indicated that he was not involved with the six process learning activities therefore he was not able to complete the questionnaire. This reduced the useable number of questionnaires to 37 for a rate of return of (37/50) 74%.

The collected data from the questionnaires were placed into a data file at the Academic Computer Services, University of Calgary. These data were analyzed using the SPSS Release 4 frequency program which yielded frequency and percent values for the 454 variables which made up the body of the research instrument.

From the computer printout, (See Appendix B, page 205 for a page of the readout) these data were placed in tabular form for ease of interpretation and presentation. Chapter three contains the data analysis and the presentation of these data.

Related Literature and Research

The second chapter of this study provides the reader with an overview of the development of Industrial Arts in Alberta, a short description of the Alberta Multiple Activity Program, a review of the Industrial Education concept, and a description of the reviews of both Secondary Education and Practical Arts that were conducted by Alberta Education. The reviews of the latter led to the development of Career and Technology Studies. A contemporary account of the proposed Career and Technology Studies Curriculum is presented. This curriculum is scheduled to be implemented by Alberta Education in the Secondary Schools of the province in the mid-90's. The content of this chapter also gives a review of the literature written on task analysis. Curriculum guides in both science and Industrial Education were both reviewed and reported.

The overview begins with the development of Industrial Arts and charts Industrial Education from 1900 to 1963 when it was synthesized into the Alberta Multiple Activity Program. Also described were the name changes this subject area underwent with the corresponding changes to the major learning activities. This description continues with the development of the Industrial Education concept that evolved in the amalgamation of both the Industrial Arts and the Vocational Education subject areas in the late 1960's.

The Industrial Arts curriculum guides, beginning from 1964 when the Multiple Activity Program was implemented in Alberta were reviewed. The program objectives for Industrial Arts and later Industrial Education were analyzed from the 1964, 1965, 1969, 1976, and 1982 curriculum guides. Also studied in these guides were changes in content that took place as each new guide was developed. The changes in instructional content in each curriculum guides reflected societal needs of that time when the guide was released.

A review was made of the content for the 1962, 1974, 1977, and 1978 junior high school science curriculum guides. In 1990, a program of studies for the junior high school science program, "Science, Technology and Society" (STS) was released by Alberta Education instead of a curriculum guide per se. As a result, student texts were custom made for this program. This program of studies was reviewed for concepts as well as content.

A review of the research revealed that there were a very limited number of master's theses or doctoral dissertations that had been completed in Canada or the United States that researched the relationship of science concepts to a process learning activity, as a vehicle to reinforce concepts. The master's theses completed by Manuel and Robinson had a direct bearing on this study.

Manuel (1968)

The purpose of the study conducted by Manuel was to determine the effect of the experimental Industrial Arts curriculum on grade nine science achievement scores. The population for his research were grade nine girls from a junior high school in the Edmonton Public School System. The results of the study showed that the treatment group had significantly higher scores on the science achievement tests than the group of grade nine girls not involved with the experimental Industrial Arts program. Manuel's study is relevant to this study because it demonstrated that science concepts were used and applied during student learning activities in the Industrial Arts laboratory.

Robinson (1984)

The purpose of Robinson's study was to determine if students in grades seven, eight and nine enrolled in Industrial Arts achieved higher scores in mathematics and science than those who did not participate in the program. The results of the research showed no significant difference between the scores of those students enrolled in Industrial Arts and the scores of those enrolled only in mathematics and science courses. The results of Robinson's study is relevant to this study because of the information generated on one of the objectives in the curriculum guides "to provide a synthesizing environment for students to apply their academic knowledge in the solution of practical problems".

FINDINGS OF THE RESEARCH

The following research findings resulted from an analysis of the data collected in the study.

By analyzing the demographics, it was found that the largest group 12/37 or 32.4% of the research participants had 21 or more years of experience teaching junior high school Industrial Education: eight teachers (21.6%) had 1-5 years of teaching experience; 3/37 (8.1%) had 6-10 years experience; 6/37 (16.2%) had 11-15 years of experience; and 8/37 (21.6%) had 16-20 years of experience teaching this subject at the junior high school level. Supporting data for these findings may be found in Table 1, page 95.

The majority of the participants, 26/37 (70.2%) graduated from the University of Alberta with a Bachelor of Education degree. The remaining 11 respondents graduated from either another Canadian or an American university with a bachelor degree. Table 2, page 98 shows this information.

Twenty of the 37 Industrial Education teachers had a minor in a subject area other than science. Ten or 27% had a minor in general science; 1 or 2.7% in biological science, 4 or 10.8% in physical science, and 2 or 5.4% in chemistry.

At the time of the study, the following rank order of percentages show the number of participants who were currently teaching the five modules from the Materials Technology Field of Study: Woods 97.3%, Metals 94.6%, Plastics 89.2%, Earths 48.6%, and Leathers/Textiles 35.1%. These teachers in previous years taught the following modules from this Field of Study: Woods 94.6%, Metals 94.6%, Plastics 91.9%, Earths 81.1%, and Leathers and Textiles 64.9%. These data can be found in Table 9, page 108.

Twenty three of the 37 participants taught Industrial Education 100% of the time. Of the remaining participants, 10 or 27% taught Industrial Education 80% of the school day; 3 or 8.1% taught 60%, and 1 or 2.7% taught 40% of the school day. Data to support this finding can be found in Table 10 page 109

The research population, as a group, verified 52 of the 142 science concepts from the questionnaire. More specifically, participants verified seven science concepts for the Sand Casting process; ten concepts for the fabrication of the Garden Shovel; eight concepts for the Rotation Molding process; thirteen concepts for the production of the Acrylic Ring; seven concepts for the production of a Pot Holder; and eight concepts for the Wood Turned Bowl. The science concepts that were verified included:

Process/Product	Science Concept
Sand Casting:	friction, hardness, change of state, property of liquid, evaporation, adhesion, and states of matter.
Garden Shovel:	friction, heat energy, mechanical advantage, malleability, force, lever, momentum, solvent, evaporation, and adhesion.
Rotation Molding:	force, adhesion, heat energy, wheel

and axle, gear ratio, contraction, state of matter, and the screw.

Acrylic Ring: measurement, scale, ratio, force, mechanical advantage, friction, solvent, solubility, bonding, heat energy, evaporation, and the screw.

Pot Holder: measurement, hardness, friction, adhesion, bonding, mechanical energy, and evaporation

Turned Bowl: measurement, scale, force, hardness, friction, adhesion, mechanical advantage, and absorption.

CONCLUSIONS

The following conclusions are based on the findings from the research.

The focus of this study was to have junior high school Industrial Education teachers verify the science concepts found in selected process learning activities from three modules of the Materials Technology Field of Study. These science concepts could be used to reinforce the concepts that were introduced in the junior high school science program. Of the concepts listed in the instrument, research data show that there was a significant difference for the frequency distribution for the concepts in each of the three columns 'agree', 'disagree', and 'don't know'. These frequencies were tabulated from the responses made to statements on the questionnaire. In comparing the participant responses for the 'agree' and 'disagree' columns, a number of participants verified nearly every listed concept as a science concept while others placed the majority of their checks in the 'disagree' column. This wide range of responses is of interest for data analysis and interpretation as only one column for each concept was considered to be correct. This could be a result that many of the participants failed to read the directions or they did not thoroughly understand what they were to do which was to read the science concept and verify it by placing a checkmark in the appropriate column to indicate whether or not the concept was related to the specific element in the process learning activity. Furthermore, respondents may have had only an elementary grasp of the science concepts that were listed and thus may not have been able to relate the concept to the element in the process learning activity.

The frequency distribution of the science concepts in the 'don't know' column for each of the six process learning activities is significant. Possible explanations for this high incidence of 'don't know' could be the teacher and the number of science courses completed at the undergraduate level. This high frequency may be due to the following: an inadequate knowledge of the itemized science concepts; an unfamiliarity with the particular process learning activity; an inability to apply or transfer science concepts to practical situations; a lack of formal training to apply science concepts to different aspects of technological devices and processes, or a lack of familiarity with the 'task analysis' procedure in analyzing a project for its elements and tasks.

From the data that were analyzed, it became evident that many of the science concepts listed on the research instrument were being taught by junior high school Industrial Education teachers either by design or incidently. Due to the analytical procedure used by the researcher to design the research instrument, science concepts associated with the elements for the various operations were often repeated for each of the six process learning activities. Consequently, participants were repeatedly asked to check an identical concept for verification and then to confirm if the concept was taught. This may have confused some of the participants. If the concept was taught once, it would not be continually be retaught. The researcher made a poor choice in the selection of the term 'taught' when the research instrument was designed. The term for column seven should have should have been 'reinforced' instead of 'taught'. The latter term caused confusion among those involved in the study because of different interpretations that can be given to the word 'taught'. This could be considered as a weakness in the design of the instrument.

Another weakness of the study was that the researcher did not provide the participants a short description of the following process learning activities: Garden Shovel, Acrylic Ring, and Pot Holder in the questionnaire. This description would have enabled the participants to develop a better visual image of the product.

In order to provide a better perspective of the verified science concepts, the following columns are a summary of those concepts that were associated with the selected process activities in each of the three Materials Technology modules studied.

Science Concepts Associated with the Operations in Metals

Operation	**Science Concept**
Depicting	------------------
Separating	friction, hardness, mechanical advantage, heat energy
Forming	malleability, lever, force, change of state, property of liquid, mechanical advantage
Shaping	------------------
Combining	malleability, force, momentum

Finishing	solvent, evaporation, adhesion.

Science Concepts Associated with the Operations in Plastics

Operation	**Science Concepts**
Depicting	measurement, scaling, ratio
Separating	mechanical advantage, the screw, force, heat energy, friction,
Forming	contraction, adhesion, heat energy, wheel and axle, gear ratio, state of matter
Shaping	----------------
Combining	solvent, dissolve, bonding, evaporation, the screw, force, mechanical advantage
Finishing	-----------------

Science Concepts Associated with the Operations in Woods

Operation	**Science Concepts**
Depicting	measurement, scaling
Separating	hardness, friction, mechanical energy, force

Forming	----------------
Shaping	----------------
Combining	adhesion, bonding, force, mechanical advantage
Finishing	absorption, adhesion, hardness, bonding, friction, evaporation

Because the Industrial Education curriculum guide for junior high school is open ended in terms of choices of a process or a process learning activity a teacher can give to students, common factors must be identified for all these activities. The researcher listed the six operations: depicting, separating, shaping, forming, combining, and finishing commonly found in the Material Technology Field of Study and designed a linkage between them and the six units of study at each grade level in the junior high school science program. Each unit in science has been designed to identify basic scientific concepts and principles of that theme for the learner as he/she interacts through the activities. Many of the concepts identified in the science units of study can also be reinforced through the operations in an Industrial Education program. The following charts illustrate the connection between the two subject areas using the operations in Industrial Education and topic of study from the 1991 Program of Studies for science.

Grade Seven

Industrial Education Operation	**Science Topics of Study**
Depicting	Structure and Design
Separating	Force and Motion
Forming	Force and Motion
	Temperature and Heat
	Measurement
Combining	Force and Measurement
Finishing	----------------

Grade Eight

Industrial Education Operation	**Science Topics of Study**
Depicting	-----------------
Separating	Energy and Machines
Forming	Energy and Machines
Combining	Solutions and Substances
Finishing	Solutions and Substances
	Energy and Machines

Grade Nine

Industrial Education Operation	**Science Topics of Study**
Depicting	------------------
Separating	Heat Energy: Transfer and

	Conservation
Forming	Fluids and Pressure
Combining	Chemical Properties and Changes
Finishing	Chemical Properties and Changes

RECOMMENDATIONS

The recommendations that follow are based on the findings and subsequent conclusions of the research. These recommendations are not listed in any order of importance and are proposed to the group identified.

Alberta Education

It is stated in the draft philosophy of Career and Technology Studies (CTS) that the integration of theory and practice be emphasized through activities and cross-curriculum instruction when implemented will link CTS with other academic subjects specifically mathematics and science. If such linkage is to be successful, then some structure must be designed into the new Career and Technology Studies curriculum so that process learning activities, however generic, are more closely linked to both science and mathematics curricula at the junior high school level.

Serious consideration must be given by curriculum design personnel of the Curriculum Branch of Alberta Education to develop modules for the proposed strands of the junior high school CTS program that integrate concepts from other core subjects directly into the content structure of the module. For example, when developing a module for a course it is suggested that curriculum designers no longer place emphasis on 'making things' but place greater emphasis on guiding students to make connections that will help with the development of their cognitive abilities. If learners are appraised for how well the product (thing) is made, then the object of the activity may become a pre-occupation with the student developing psychomotor skills rather than developing affective and cognitive skills that will help the learner not only to learn how to think but learn how to learn.

Faculty of Education

It is recommended to personnel of the Department of Secondary Education responsible for the preparation of industrial and Vocational Education teachers, give serious consideration to changing the program so it becomes more oriented toward CTS. The researcher recommends that less emphasis be placed on skill development for preservice Industrial Education teachers and greater emphasis be placed on the practical application of science concepts and theories as they apply to process learning activities. It is also recommended that departments in the university, as well as subject area specialists, show leadership by integrating subject areas rather than having specialists in these subject areas to continually work in isolation. This sign of leadership would demonstrate to university students registered in the Faculty of Education and to practising teachers that teaching either a core subject or a complementary subject in isolation is no longer acceptable.

Other Researchers

The following recommendations are made to any researcher who may wish to conduct a similar or related study.

It is recommended that a study be designed to develop methodologies that would incorporate the most recent research in the theories of learning so that information and skills may be presented to students to learn and transfer scientific and mathematical knowledge to practical settings effectively and efficiently.

It is recommended that a study be designed to determine what science concepts are reinforced by the learner in a junior high school Industrial Education laboratory.

It is also suggested that modules for Electricity/Electronics, Power Mechanics, or Visual Communications be analyzed for their science concepts. The results of such a study could be compared with the results of this study to determine the science concepts that are either taught or reinforced by the Industrial Education teacher in a multiple activity laboratory.

It is recommended that a similar study be conducted but that the instrument be redesigned using a list of science concepts taken from the junior high science program rather than identifying these concepts with the task analysis approach for selected process learning activities. Industrial Education teachers are using a wide variety of process learning activities with their students and many are not familiar with the analysis procedure to identify instructional content. In the proposed study participants would be asked to identify the strands in the new Career and Technology Studies program in which these concepts could be either taught or reinforced.

OBSERVATIONS

The following observations were made by the researcher while conducting the study and are not necessarily supported by research evidence.

It was the observation of the researcher that the participants had difficulty recognizing a science concept. This could be partly attributed to the weak science background found in the research participants. If a router is used in activity A or B or C the science concepts associated with its use are identical and would be found in activities A, B, and C. Yet it was the observation of the researcher that the participant felt comfortable verifying science concepts for the activity he/she was most familiar with, but not with unfamiliar activities even though they included identical science concepts. Participants appeared to have had difficulty making this transference.

From follow-up telephone calls, the observation was made that many of the participants had considerable difficulty verifying the science concepts listed because of their apparent lack of science background. This was also evident in the instrument because some participants chose to disagree that abrasives (sandpaper) consisted of a layer of particles that were wedge like in shape. For scientific purposes an abrasive is considered to be an inclined plane.

It was the perception of the researcher that a major goal of an Industrial Education teacher in a multiple activity laboratory is craft skill development, and the making of things per se. This could be interpreted that the participating group of teachers were aligning their program with a particular cultural-economic value system. This cultural bias may manifest itself in the instructional content, delivery and the process learning activities the teacher designs for the students. The instructional content in this case would be largely concrete in nature and may not be viewed by either the teacher or the student as a vehicle to develop an awareness of technology and the social effects that technology has on man. Through the manipulations of these concrete materials, skills directly related to the activity are developed and reinforced. Such skills are tool identification, tool manipulation and use, and the fabrication and assembly of materials. Although these 'handyman skills' are useful and practical, they inhibit the evolutionary growth whereby the process activities can be used as vehicles to integrate concepts in science, communication, and industry/economics. Industrial Education teachers have a tendency to identify their role as a teacher in the laboratory setting through their cultural parameters. Until Industrial Education teachers shift their identity from a parochial position to a cosmopolitan one, the teacher's perception of students' needs will remain parochial and unchanged which may inhibit the student's progress.

Because of the repetition of science concepts for each operation, many participants indicated from the follow up procedure that the format of the questionnaire was difficult for them to follow, consequently, participants became distracted or confused and lost the overall perspective of the purpose of the instrument. The instrument was designed to be part of the analysis procedure that could analyze any process or process learning activity for its science principles/concepts which could be associated with a student activity. The structure of the research instrument was based on a task analysis of an activity. This analysis involved the identification of all operations used in making the object which were further sub-divided into the elements that comprise the operation. Each element was then analyzed for its science concepts. Because many individual elements were similar, the science concepts listed were repeated. The criticism of repetition could have been alleviated had the format for the instrument been modified as a chart. Across the top of the chart would be a laundry list of process learning activities commonly used by junior high school Industrial Education teachers teaching Materials Technology. Down the left-hand column would be listed the science concepts found in the products to be made. All that would be required of these participants using this chart would be for them to place a check in the appropriate cell. For those participants whose analysis skills for identifying the instructional content of a product were less sophisticated, these modifications to the instrument would have made it less confusing for them.

A problem with the selection of the Materials Technology process learning activities as the basis of the questionnaire was there were no prescribed products that every Industrial Education teacher was required to use. The nature of Materials Technology is that there are an infinite number of products that either a teacher or a student can select. Because of the unlimited number of products from which a selection could be made, the researcher elected to use process learning activities that he used with the junior high school students he taught. The six activities were representative of these three modules. During the research it became evident that participants became uncertain when completing the questionnaire because the products that were selected were not the activities these teachers and their students were currently using.

An alternative design to the present instrument would have been to choose two different process learning activities in the same Materials module with identical science concepts for verification. The participant would have the flexibility to complete either one of the two activities. It still would not have insured that the participant was currently involved with that product, but it might have increased the possibility that the participant could relate to the more familiar project.

In retrospect, the pilot study population should have been increased because the two of the five Industrial Education teachers who reviewed the instrument did not provide adequate criticism on the format that was used.

Books

Andrews, R. C.,& Ericson, E. E. (1976). Teaching industrial education principles and practices. Peoria: Chas. A. Bennett Co.,Inc.

Ary, D., Jacobs, L. C., & Razavieh, A. (1990). Introduction to research in education. New York: Holt, Rinehart and Winston.

Bennett, C. A. (1937). History of manual and industrial education 1870-1937. Peoria: The Manual Arts Press.

Chalmers, J. W. (1967). Schools of the foothills province. Toronto: University of Toronto Press.

Cochran, L. H. (1970). Innovative programs in industrial education Bloomington, Illinois: McKnight & McKnight.

Elkind, (1969). In B. B. Wolman, & G. Stricken (Eds.), Handbook of developmental psychology. New Jersey: Prentice-Hall.

Fryklund, V. C. (1942). Trade and job analysis. Milwaukee: The Bruce Publishing Company.

Fryklund, V. C. (1965). Analysis techniques for instructors. Milwaukee: The Bruce Publishing Company.

Fryklund, V. C. (1970). Occupational analysis techniques and procedures. Milwaukee: The Bruce Publishing Company.

Hurd, P. (1981). New curriculum perspectives for junior high science. California: Wadsworth Pub. Co.

Keeves, J. (1988). Educational research, methodology, and measurement: An international handbook. New York: Oxford/Pergamon Press.

Kameenui, E. J.,& Simmons, D. C. (1990). Designing instructional strategies. Columbus, Ohio: Merrill Publishng Company.

McMillan, J. H. & Schumacher, S. (1989). Research in education: A conceptual introduction. Glenview Il: Scott, Foresman.

Pautler, A. J. (1978). Teaching technical subjects in education and industry. Urbana Ill: Griffon Press.

Silvius, G. H. & Bohn, R. C. (1961). Organizing course materials for industrial education. Bloomington, Il: McKnight and McKnight.

Silvius, G. H. & Curry, E. H. (1971). Managing multiple activities in industrial education. Bloomington, Il: McKnight and McKnight.

Wiersma, W. (1986). Research methods in education: An introduction. Boston: Allyn and Bacon.

Wolf, (1988). In J. Keeves (Ed.), Educational research, methodology, and measurement: An international handbook. New York: Oxford/Pergamon Press

Wolman, B. B. and Stricken, G. (1982). Handbook of developmental psychology. New Jersey: Prentice-Hall.

Periodicals

Mathew, N. F. (1992). Career and Technology Studies: Building for the future. Exetasis.

Preitz, C. H. (1973). Developing a program to individualize instruction. Journal of Industrial Teacher Education. 10,3. 88-97.

Doctoral dissertations and master's theses

Leblanc, D. (1968). A measure of understanding of certain aspects of Alberta industry. Unpublished M. Ed. thesis, University of Alberta, Edmonton.

Harder, J.D. (1964). The development of the industrial arts program and its present status in the province of Alberta. Unpublished M. Ed. thesis, Oregon State University.

Manuel, D. W. (1968). The effects of industrial arts on science achievement. Unpublished M. Ed. thesis, University of Alberta, Edmonton.

Mathew, N.F. (1984). Industrial education in Alberta: Its evolution and development, 1968-1984. Unpublished M. Ed. thesis, University of Alberta, Edmonton.

Robinson, L. S. (1984). The effect of industrial arts on the mathematics and science achievement of students in a junior high school. Unpublished M. Ed. thesis, University of Alberta, Edmonton.

Smith, J. C. (1973). The development of industrial arts multiple-activity in Alberta. Unpublished M. Ed. thesis, University of Alberta, Edmonton.

Unpublished manuscripts and publications of limited circulation

Alberta Education. (1974). Junior high school science curriculum guide. Edmonton: Author.

Alberta Education. (1976). Junior high school industrial education curriculum guide. Edmonton: Author.

Alberta Education. (1977). Alberta Education and diploma requirements - a discussion to the curriculum policies board. Edmonton:author.

Alberta Education. (1977). Curriculum guide junior high science. Edmonton: Author.

Alberta Education. (1978). Curriculum guide for junior high school science. Edmonton: Author.

Alberta Education. (1982). Junior high school grades 7-8-9 industrial education curriculum guide. Edmonton: Author.

Alberta Education. (1983). Handbook in industrial education for guidance to teachers, counsellors and administrators. Edmonton: Author.

Alberta Education. (1985). Review of secondary programs. Alberta secondary education review: Research basis. Edmonton: Author.

Alberta Education. (1985). Review of secondary programs. Alberta's secondary education program: The public's view. Edmonton: Author.

Alberta Education. (1985). Review of secondary programs. Report of the minister's advisory committee: Foundation for the future. Edmonton: Author.

Alberta Education. (1985). Secondary education in Alberta. Edmonton: Author.

Alberta Education. (1986). Secondary education action plan. Edmonton:Author.

Alberta Education. (1986). Information bulletin. Edmonton: Author.

Alberta Education. (1987). Proposed directions for senior high school programs and graduation requirements. Edmonton: Author.

Alberta Education. (1989). Guide to senior high school handbook. Edmonton: Author.

Alberta Education. (1990). Junior high science program of studies. Edmonton: Author.

Alberta Education. (1990). A vision for Alberta's secondary practical arts program. Edmonton: Author.

Alberta Education. (1990). Framework for change: Career and Technology Studies in secondary schools in Alberta. Edmonton: Author.

Alberta Education. (1991). Career and Technology Studies: Building for the future. Edmonton: Author.

Alberta Education. (1991). Guide to education junior high school handbook 1991-92. Edmonton: Author.

Department of Education. (1938). Regulations relating to the program of studies and annual examinatons for high schools for the year ending June 30, 1939. Edmonton: Author.

Department of Education. (1962). Grades VII and VIII curriculum guide for science. Edmonton: Author.

Department of Education. (1962). Grade IX curriculum guide for science. Edmonton: Author.

Department of Education. (1964). Junior high school curriculum guide for industrial arts. Edmonton: Author.

Department of Education. (1965). Junior high school curriculum guide for industrial arts. Edmonton: Author.

Department of Education. (1969). Junior high school curriculum guide for industrial arts. Edmonton: Author.

Preitz, C. H., Deleeuw, J.,& Yanitski, N. (1983). An historical overview of industrial arts in Alberta. Edmonton, Alberta: Department of Industrial and Vocational Education.

Newspapers

The Calgary Herald. (1961). Calgary, Alta, April 8.

APPENDIX A

Included in this appendix are copies of the following documents that were used during the various phases of the study to collect data.

A copy of the research instrument which was part of the research package.

A copy of the covering letter sent to the superintendents requesting permission to involve the teachers of their district to participate in the study.

A copy of the covering letter to the participants which accompanied the research package.

A copy of the outline for the telephone follow-up that was used with participants who did not return their questionnaires by the required deadline date.

A copy of the Cooperative Activities Program Form used by Field Service, Faculty of Education with the cooperating school jurisdictions.

Information to the Participant

Please find attached a two part questionnaire that the researcher has developed to collect data for the research on science concepts found in process learning activities taught in industrial arts. You are asked as a participant to complete the attached instrument.

The following information will be helpful to you as you complete the questionnaire.

PART 1: This part of the instrument is to collect demograghic data from the participant. It includes a series of statements that are directed at the professional preparation of those involved in the study.

PART 2: This part of the instrument is comprised of two process learning activities from the Metals, Plastics, and Woods, modules. Each process learning activity has seven columns; Operation, Elements, Science Concept, Agree, Disagree, Don't Know, and Taught. The "AGREE", "DISAGREE", "DON'T KNOW" and "TAUGHT" columns need to be checked for their relationships to the "Science Concepts" column.

The major purpose of this study is:

> to analyze selected process learning activities from the Metals, Plastics, and Woods modules found in the Materials Technology field of study in the junior high school industrial education program for their scientific concepts.

For the purpose of this research the following definitions will apply:

ELEMENT: An element is a task learned and performed by the student. An element is a component of an operation or of a process used in making a process learning activity. There may be many elements in making or performing a process learning activity.

OPERATION: An operation is an unit of work used to construct a process learning activity or to perform a process which consists of a series of elements and involves depicting, separating, shaping, forming, combining, and finishing. All which are used by the learner in making or performing a process learning activity.

PROCESS LEARNING ACTIVITY: The term process learning activity is synonymous with the term project, or product. A process learning activity is an activity where a student performs a series of sequential operations and elements to manufacture an article or perform a process. The process learning activity is not performed for its own sake. It must be stressed that a process learning activity is an positive example through which a student gains experience in order for the learner to develop a science concept inherent in the activity.

SCIENCE CONCEPT: A science concept is an idea about a particular phenomena students abstract from a learning experience.

It is important that these definitions be kept in mind while the participant responds to each statement that comprises part 2 of the instrument.

PLEASE PROCEED TO PART 1

PART 1

DIRECTION TO THE PARTICIPANT

Please answer the following statements by circling the appropriate number before the response.

1. How many years of experience do you have teaching junior high industrial arts;

   1. 1-5   2. 6-10   3. 11-15   4. 16-20   5. 21-(+)

2. Do you possess a Bachelor of Education or an equivalent degree from a university other than the University of Alberta?

   1. YES   2. NO

   If YES, please circle the number of the institution which granted the degree:

   1. University of British Columbia
   2. University of Saskatchewan
   3. University of Manitoba
   4. University of Toronto
   5. McGill University
   6. Memorial University
   7. Nova Scotia Teachers College
   8. University of New Brunswick
   9. Other________________________

3. Please circle the number that corresponds with the minor you completed for the bachelor degree:

   1. General Science
   2. Biological Science
   3. Physical Science
   4. Physics
   5. Chemistry
   6. Mathematics
   7. Other________________________

4. Have you completed any university courses in Chemistry?

   1. YES   2. NO

   IF "YES" number of courses ___________________.

5. Have you completed any university courses in Physics?

1. YES 2. NO

IF "YES" number of courses ____________________.

6. Please circle which of the following modules from the Materials-Technology field of study you are currently teaching;

1. Woods	2. Earths	3. Plastics
4. Metals	5. Leathers and Textiles.	

or

those modules that you have previously taught:

6. Woods	7. Earths	8. Plastics
9. Metals	10. Leathers and Textiles	

7. Please circle the percent of time that you teach Industrial Education.

1. 20%   2. 40%   3. 60%   4. 80%   5. 100%

PLEASE PROCEED TO PART 2.

PART 2

DIRECTIONS TO THE PARTICIPANT

CAUTION: It should also be pointed out that only those element statements that have corresponding science concepts are listed in the ELEMENT column and that these statements are not written in the sequence that the student would perform them in the process learning activity.

Read each statement in the Element column and its corresponding science concept(s). [1.] Place an [X] for each concept only in ONE of the "AGREE", "DISAGREE", "DON'T KNOW" columns, that you feel most appropiate for the relation between science concept and element statement. [2.] Place a second [X] in the "TAUGHT" column IF the science concept is taught to the student performing the element of the operation in making the process learning activity.

SAMPLE

[1] Place an (X) for each line(s) in one of the `AGREE', `DISAGREE', `DON'T KNOW' columns that you conclude from reading the element of the operation statement and its corresponding concept(s) listed in the `SCIENCE CONCEPT' column.

[2] Place an (X) on the line(s) in the `TAUGHT' column ONLY if the science concept is taught by you as part of the process learning activity.

SAND CASTING

Module - Metals
Material - Aluminum

Operation	Element	Science Concept(s)	Agree	Disagree	Dont know	Taught
Form	Heat crucible until solid aluminum in crucible liquifies.	Energy conversion	X	_	_	X
		Change of state	_	X	_	_
		Heat energy	X	_	_	_
	Sprinkle parting powder on both surfaces of pattern.	Adhesion	X	_	_	_
	Make air channel in petro-bond from cavity to exterior surface of cope.	Impenetrability	_	_	X	_
		Hardness	X	_	_	_
		Mechanical energy	X	_	_	X

Please proceed to the next page

Part 2

PROCESS LEARNING ACTIVITY

Sand Casting

Module - Metals
Material: Aluminum

Operation	Elements	Science Concept(s)	Agree	Disagree	Don't Know	Taught
DEPICT - Product Planning n/a						
SEPARATION 1.chip	Use files and abrasives to remove metal flash from casting.	Inclined plane_	_	_	_	_
		Friction______	_	_	_	_
		Mechanical energy________	_	_	_	_
		Mechanical advantage______	_	_	_	_
		Hardness______	_	_	_	_
		Heat energy____	_	_	_	_
	Use hacksaw to remove sprue and riser forms from casting.	Inclined plane_	_	_	_	_
		Friction______	_	_	_	_
		Mechanical energy________	_	_	_	_
		Hardness______	_	_	_	_
		Heat energy____	_	_	_	_
2.non-chip n/a						
FORM	Heat crucible until solid aluminum in crucible liquifies.	Change of state	_	_	_	_
		Heat energy____	_	_	_	_
		Liquefaction____	_	_	_	_
	Sprinkle parting powder on both surfaces of pattern.	Cohesion______	_	_	_	_
		Adhesion______	_	_	_	_
	Ram petro-bond around pattern in cope and drag.	Adhesion______	_	_	_	_
		Compression____	_	_	_	_

FORM	Create gates in petro-bond for entry of liquid aluminum into mold cavity.	Impenetrability	_	_	_	_
		Hardness______	_	_	_	_
		Mechanical energy______	_	_	_	_
	Make air channel in petro-bond from cavity to exterior surface of cope.	Impenetrability	_	_	_	_
		Hardness______	_	_	_	_
		Mechanical energy______	_	_	_	_
	Pour liquified aluminum into cavity.	States of matter______	_	_	_	_
		Crystallization	_	_	_	_
		Property of liquid______	_	_	_	_
		Heat energy______	_	_	_	_
CONDITION n/a						
COMBINE 1.Chemical fastening n/a 2.Mechanical fastening n/a 3.Mix n/a						
FINISH	Spray a clear lacquer on casting.	Evaporation______	_	_	_	_
		Hardness______	_	_	_	_
		Adhesion______	_	_	_	_
		Surface tension	_	_	_	_
		Cohesion______	_	_	_	_

Process Learning Activity

Garden Shovel

Module - Metals
Material: Galvanized iron
Band iron

Operation	Elements	Science Concept(s)	Agree	Disagree	Don't know	Taught
DEPICT-Product Planning n/a						
SEPARATION 1.Chip	Use drill press to drill hole in handle.	Friction	_	_	_	_
		Heat energy	_	_	_	_
		Energy conversion	_	_	_	_
		Mechanical Advantage	_	_	_	_
		Mechanical energy	_	_	_	_
		Inclined plane	_	_	_	_
	Make a hole in sheet metal using a hole punch tool	Friction	_	_	_	_
		Heat energy	_	_	_	_
		Energy conversion	_	_	_	_
		Mechanical Advantage	_	_	_	_
		Mechanical energy	_	_	_	_
		Inclined plane	_	_	_	_
2.Non chip n/a						
FORM	Use forming roll to curve shovel body.	Mechanical advantage	_	_	_	_
		Malleability	_	_	_	_
		Force	_	_	_	_
		Lever	_	_	_	_
		Wheel and axle	_	_	_	_
		Mechanical energy	_	_	_	_

FORM	Use forming tool to shape band iron into a handle.	Mechanical advantage___ Malleability___ Force___ Lever___ Wheel and axle__ Mechanical energy___	_ _ _ _ _ _	_ _ _ _ _ _	_ _ _ _ _ _	_ _ _ _ _ _
CONDITION n/a						
COMBINE 1.Chemical Fastening n/a 2.Mechanical Fastening 3.Mix n/a	Use ball peen hammer to upset rivet shaft.	Malleability___ Force ___ Mechanical advantage___ Momentum___ Lever___ Potential energy Kinetic energy__ Heat energy___	_ _ _ _ _ _ _ _	_ _ _ _ _ _ _ _	_ _ _ _ _ _ _ _	_ _ _ _ _ _ _ _
FINISH	Spray a coat of paint on assembled product.	Solvent___ Evaporation___ Hardness___ Adhesion___ Surface tension_	_ _ _ _ _	_ _ _ _ _	_ _ _ _ _	_ _ _ _ _

PROCESS LEARNING ACTIVITY

Rotation-molding

Module -Plastics
Material: Polyethylene powder

Operation	Elements	Science Concept(s)	Agree	Disagree	Don't know	Taught
DEPICT-Product Planning	Choose color of polyethylene powder	Synthetic material___	_	_	_	_
SEPARATION 1. chip	Use a file/knife to remove flash from parting line.	Inclined plane___	_	_	_	_
		Friction___	_	_	_	_
		Force___	_	_	_	_
2. non-chip n/a		Mechanical advantage___	_	_	_	_
FORM	Apply wax to interior surfaces of mold halves.	Surface tension___	_	_	_	_
		Adhesion___	_	_	_	_
		Cohesion___	_	_	_	_
	Attach mold to rotation arm in preheated oven.	State of matter___	_	_	_	_
		Heat energy___	_	_	_	_
		Force___	_	_	_	_
	Allow arm to rotate for required time.	Mechanical advantage___	_	_	_	_
		Wheel and axle___	_	_	_	_
		Gear ratio___	_	_	_	_
		Mechanical energy___	_	_	_	_
	Submerge mold in cold water.	Contraction___	_	_	_	_
		Specific heat___	_	_	_	_
		Latent heat___	_	_	_	_
		State of matter___	_	_	_	_
		Heat energy___	_	_	_	_
CONDITION n/a						

COMBINE 1. Chemical Fastening n/a 2. Mechanical Fastening 3. Mix n/a	Align and bolt both halves of mold together.	Mechanical advantage____ Screw____ Force____ Mechanical energy____ Friction____ Wheel and axle____	_ _ _ _ _ _	_ _ _ _ _ _	_ _ _ _ _ _	_ _ _ _ _ _
FINISH n/a						

PROCESS LEARNING ACTIVITY

Laminated Acrylic Ring

Module - Plastics
Material: Acrylic

Operation	Elements	Science Concept(s)	Agree	Disagree	Don't know	Taught
DEPICT-Product Planning	Sketch shape of ring on paper. Transform sketch into a full size pattern or template	Measurement____	_	_	_	_
		Scale________	_	_	_	_
		Ratio________	_	_	_	_
SEPARATION 1.chip.	Use a vise to hold laminate so that it can be drilled.	Wheel and axle_	_	_	_	_
		Inclined plane________	_	_	_	_
		Force________	_	_	_	_
		Screw________	_	_	_	_
		Mechanical advantage______	_	_	_	_
	Use drill press to drill appropiate finger hole in laminate.	Mechanical Advantage_____	_	_	_	_
		Friction______	_	_	_	_
		Inclined plane________	_	_	_	_
		Hardness_______	_	_	_	_
		Mechanical energy________	_	_	_	_
		Heat energy____	_	_	_	_
	Use a stationary belt sander and/or files to shape plastic to pattern.	Inclined plane_	_	_	_	_
		Friction______	_	_	_	_
		Hardness_______	_	_	_	_
		Mechanical energy________	_	_	_	_
		Heat energy____	_	_	_	_
	Polish inside edge and outside edge using abrasives and buffer	Resolution_____	_	_	_	_
		Mechanical energy________	_	_	_	_
		Heat energy____	_	_	_	_
		Friction______	_	_	_	_
2.non-chip n/a						

FORMING n /a						
CONDITIONING n/a						
COMBINE 1.Chemical Fastening	Use methylene chloride as a solvent to fasten the two pieces of plastic together.	Solvent_______	—	—	—	—
		Dissolve_______	—	—	—	—
		Cohesion_______	—	—	—	—
		Bonding_______	—	—	—	—
		Evaporation____	—	—	—	—
	Clamp laminates until solvent flashes off.	Screw_______	—	—	—	—
		Wheel and axle_______	—	—	—	—
		Mechanical advantage______	—	—	—	—
		Force_______	—	—	—	—
		Mechanical energy_______	—	—	—	—
		Friction_______	—	—	—	—
2.Mechanical Fastening n/a 3.Mix n/a						
FINISH n/a						

PROCESS LEARNING ACTIVITY

Ceramic Inlaid Pot Holder

Module - Woods
Material: Any wood species

Operation	Element	Science Concepts	Agree	Disagree	Dont know	Taught
DEPICT- Product Planning	Choose a template and trace pattern on to stock. Choose squares of tile, center, and trace on stock	Measurement___	___	___	___	___
SEPARATION 1. chip	Use band saw to cut wood to shape.	Inclined plane___	___	___	___	___
		Hardness___	___	___	___	___
		Friction___	___	___	___	___
		Heat energy___	___	___	___	___
		Mechanical energy___	___	___	___	___
	Use an abrasive to finish edge of stock.	Inclined plane___	___	___	___	___
		Hardness___	___	___	___	___
		Friction___	___	___	___	___
		Heat energy___	___	___	___	___
		Mechanical energy___	___	___	___	___
	Use router to make cavity for ceramic tile.	Inclined plane___	___	___	___	___
		Hardness___	___	___	___	___
		Friction___	___	___	___	___
		Heat energy___	___	___	___	___
		Mechanical energy___	___	___	___	___
2. non-chip n/a						
FORM n/a						
CONDITION n/a						

COMBINE 1.Chemical Fastening	Use tile adhesive to cement tile to stock.	Adhesion____	_	_	_	_
		Evaporation____	_	_	_	_
		Bonding____	_	_	_	_
	Grout spaces between tile and edge of cavity.	Adhesion____	_	_	_	_
		Evaporation____	_	_	_	_
		Bonding____	_	_	_	_
2.Mechanical Fastening n/a 3.Mix n/a						
FINISH	Brush a primer coat of-clear urethane on stock.	Adhesion____	_	_	_	_
		Evaporation____	_	_	_	_
		Resolution____	_	_	_	_
		Bonding____	_	_	_	_
		Surface tension____	_	_	_	_
		Cohesion____	_	_	_	_
	Use a fine abrasive to sand between coats.	Inclined plane_	_	_	_	_
		Hardness____	_	_	_	_
		Friction____	_	_	_	_
		Heat energy____	_	_	_	_
		Mechanical energy____	_	_	_	_
	Brush finish coat of urethane on stock.	Adhesion____	_	_	_	_
		Evaporation____	_	_	_	_
		Resolution____	_	_	_	_
		Bonding____	_	_	_	_
		Surface tension____	_	_	_	_
		Cohesion____	_	_	_	_

PROCESS LEARNING ACTIVITY

Turned Bowl

Module - Woods
Material: Any species of wood

Operation	Elements	Science concept(s)	Agree	Disagree	Dont know	Taught
DEPICT-Product Planning	Draw a sketch and a full scaled drawing of proposed shape of bowl.	Measurement	_	_	_	_
		Scale	_	_	_	_
		Ratio	_	_	_	_
SEPARATION 1.Chip	Plane each surface of block.	Inclined plane	_	_	_	_
		Mechanical energy	_	_	_	_
		Force	_	_	_	_
		Mechanical energy	_	_	_	_
	Use band saw to cut block into a cylinder.	Inclined plane	_	_	_	_
		Mechanical advantage	_	_	_	_
		Hardness	_	_	_	_
		Friction	_	_	_	_
		Heat energy	_	_	_	_
		Force	_	_	_	_
		Mechanical energy	_	_	_	_
	Use lathe to turn edge of block.	Mechanical energy	_	_	_	_
		Inclined plane	_	_	_	_
		Mechanical advantage	_	_	_	_
		Hardness	_	_	_	_
		Friction	_	_	_	_
		Heat energy	_	_	_	_
		Force	_	_	_	_

SEPARATION 1.Chip	Use lathe to hollow face of block.	Mechanical energy___	___	___	___	___
		Inclined plane___	___	___	___	___
		Mechanical advantage___	___	___	___	___
		Hardness___	___	___	___	___
		Friction___	___	___	___	___
		Heat energy___	___	___	___	___
		Force___	___	___	___	___
	Use abrasives to sand turned shape.	Mechanical energy___	___	___	___	___
		Inclined plane___	___	___	___	___
		Mechanical advantage___	___	___	___	___
		Hardness___	___	___	___	___
		Friction___	___	___	___	___
		Heat energy___	___	___	___	___
		Force___	___	___	___	___
2.Non chip n/a						
FORM n/a						
CONDITION n/a						
COMBINE 1.Chemical Fastening	Laminate planed surfaces of two pieces of stock.	Absorption___	___	___	___	___
		Evaporation___	___	___	___	___
		Adhesion___	___	___	___	___
		Cohesion___	___	___	___	___
2.Mechanical Fastening	Attach face plate to block using wood screws.	Friction___	___	___	___	___
		Inclined Plane___	___	___	___	___
		Force___	___	___	___	___
		Mechanical advantage___	___	___	___	___
		Wood cells___	___	___	___	___
	Thread faceplate on to lathe spindle	Mechanical energy___	___	___	___	___
		Inclined plane___	___	___	___	___
		Force___	___	___	___	___
		Mechanical advantage___	___	___	___	___
3.Fix n/a						
FINISH	Apply a vegetable oil to surface of the bowl. Or apply a coat of stain and urethane.	Absorption___	___	___	___	___
		Evaporation___	___	___	___	___
		Adhesion___	___	___	___	___
		Surface tension___	___	___	___	___
		Cohesion___	___	___	___	___

University of Alberta
Edmonton
Canada T6G 2G5

Department of Secondary Education
Faculty of Education
341 Education South, Telephone (403) 492-3674
Fax: (403) 492-0236 Email: SE04@UALTAMTS

Dear (superintendent's name)

The purpose of this letter is to ask you to cooperate in my research by permitting the junior high school industrial education teachers under your leadership to participate in this study.

In addition to teaching industrial education at the junior high school level in Calgary, I am enrolled in the Faculty of Graduate Studies and Research at the University of Alberta where I am completing the requirements for a Masters degree. The topic of my research is "The Identification of Science Concepts in Junior High School Industrial Education Process Learning Activities".

The research design includes a survey of a selected group of junior high school industrial education teachers. The purpose of this study is to have these teachers verify the science concepts in a number of process learning activities. Enclosed is a copy of the research questionnaire and the target teachers who would be asked to complete this survey. The questionnaire is for your information and not for distribution to your teachers.

I have already shown my proposal and questionnaire to (supervisor's name) for his perusal. The questionnaire does not probe into any personal or school related problems. All data collected will be for the use of the researcher and will be treated as privileged information.

Enclosed is a response card for you to check and return in the self addressed stamped envelope provided. It would be appreciated if you could return the card to me no later than February 10, 1992 so that the research may proceed according to the time line I have established for its completion.

I believe the results of this study will be of benefit not only to those associated with industrial education in the province but also to those responsible for the teacher education program at the University. Your assistance in this phase of the research is indeed appreciated.

Yours truly

Richard Radomski

University of Alberta
Edmonton
Canada T6G 2G5

Department of Secondary Education
Faculty of Education
341 Education South, Telephone (403) 492-3674
Fax: (403) 492-0236 Email: SE04@UALTAMTS

Dear (teacher's name)

In addition to teaching Industrial Education at the junior high school level I am enrolled in the Faculty of Graduate Studies and Research at University of Alberta where I am completing the requirements for the Masters degree. The topic of my research is "The Identification of Science Concepts in Junior High School Industrial Education Process Learning Activities".

The purpose of this study is to verify the science concepts related to the operations used to complete a process learning activity of which there are six.

You were chosen through a random selection procedure. You are one of the 50 junior high Industrial Education teachers to be asked to participate in this study. I hope that you will take the time to assist me in identifying the required data. The success of this study depends on a high percentage of return.

The purpose for this letter is to ask you to cooperate in the study by completing the enclosed questionnaire and return it in the self addressed envelope by March 5, 1992. Any information that you provide will be treated as confidential and will be made available only to the researcher. You have the right and the privilege to withdraw from the study at any time without prejudice. When the study is completed all instruments will be destroyed.

When the study is complete, an abstract will be sent to those who wish to see the results. Thank you for your cooperation.

Yours truly

Richard Radomski

Outline for the Telephone Follow-up

Introduction

Introduce yourself

Tell the purpose of the phone call

Give a description of the study

Questionnaire

Ask if instrument packet was received

Offer to deliver another packet

Ask if the questionnaire could be completed as there is a time constraint and return the completed survey in the stamped self addressed envelope.

Thank the participant for their cooperation and taking the time to complete the questionnaire.

COOPERATIVE ACTIVITIES PROGRAM: RESEARCH APPLICATION FORM

Field Experiences
Faculty of Education
University of Alberta T6G 2G5

833 Education South
492-3661 Fax: 492-0236

---

1. Instructions

   a) This application form is to be used for research projects which constitute a major undertaking leading to a Master's thesis or a Ph.D. dissertation, and studies of similar magnitude, or lesser research projects which involve participation of human subjects.

   b) All proposed research projects involving human participants must be reviewed by the ethics committee established in each department, to ensure that ethical guidelines are followed in the conduct of the study. Once clearance is granted, a statement to this effect, signed by the chairperson of the ethics committee, must accompany this research application.

2. Organization to be Involved

   Edmonton Public School District ☑ County of Strathcona ☐ N.A.I.T. ☐
   Edmonton Catholic School District ☑ St. Albert Protestant/Separate School District ☐

3. Requester (University staff member) Date 1992 - 01 -17

   Name (include title) Clarence H. Preitz Faculty Education
   Position Professor Department Sec.Education
   Address Room 447 Telephone 492 - 4270
   Is this request being made on behalf of a graduate student ☐, undergraduate student? ☐
   If so, indicate: Richard Radomski (Name) 492 - 0724 (Phone Number)
   Rm. 253 Faculty of Education (Campus or Home Address) T6G 2G5 (Postal Code)

4. Description of Research Project - include title, objectives, procedure, evaluation techniques, ethical considerations, etc.

   Title: Analysis of Selected Industrial Education Process Learning Activities in Materials Technology for Science Concepts

   Objectives: - to identify science concepts that are inherent in selected process learning activities commonly performed by students in the Metals, Plastics, Woods areas in the junior high school industrial education program.
   - to review science curriculum guides in grade

.../2

4. Description of Activity/Research Project (continued):
seven, eight, and nine for science concepts that may be reinforced through the use process learning activities in a junior high school industrial education laboratory.

Procedure: - sample of 25 junior high industrial education teachers will be selected from both the separate and public school systems in Calgary and Edmonton.
- each participant will receive a copy of the research questionnaire to complete and return. A follow-up procedure will be initiated to increase rate of return.

Evaluation techniques - an analysis will be made of data collected with the research instrument. This data will be tabulated for reporting and analysis.
- findings, conclusions, recommendations, and observations will be made from the collected data.

Ethical Considerations: - the research design and the research questionnaire have been approved by the Research Ethics Review Committee, Department of Adult, Career, and Technology Education. Prescribed ethical guidelines will be adhered to in all phases of the research. Through correspondence participants are informed of the confidentiality of all data and the right and privilege to withdraw from the research at any time.

5. Anticipated value to the school(s) or school district(s) involved:
- reinforce science concepts taught in science classes through the process learning activities used in industrial education.
- provide junior high industrial education teachers with a list of science concepts that can be integrated into their instructional content.

6. Suggested personnel, school and times:

See attached Listing

7. Anticipated project completion date (including final report):

June 1992

For office use only:

Approved by ____________________, Field Experiences. Date ____________________

Approved by ____________________, School District. Date ____________________

Subject to the following conditions:

a) A report of the results of the findings of this project is to be forwarded to the cooperating school(s). YES ☑ NO ☐

b) A research report on this project is to be forwarded to the school system's central office.
YES ☑ NO ☐

APPENDIX B

This appendix contains a sample page of the computer readout that was used to generate the tables from the data collected with the research instrument.

agree	1	25	67.6	67.6	67.6
disagree	2	1	2.7	2.7	70.3
donot know	3	11	29.7	29.7	100.0
		-------	-------	-------	
	Total	37	100.0	100.0	

Mean	1.622	Std err	.152	Median	1.000
Mode	1.000	Std dev	.924	Variance	.853
Kurtosis	-1.306	S E Kurt	.759	Skewness	.852
S E Skew	.388	Range	2.000	Minimum	1.000
Maximum	3.000	Sum	60.000		

Valid cases 37 Missing cases 0

- -

C12 fric

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
yes	1	11	29.7	29.7	29.7
no	2	26	70.3	70.3	100.0
		-------	-------	-------	
	Total	37	100.0	100.0	

Mean	1.703	Std err	.076	Median	2.000
Mode	2.000	Std dev	.463	Variance	.215
Kurtosis	-1.213	S E Kurt	.759	Skewness	-.925
S E Skew	.388	Range	1.000	Minimum	1.000
Maximum	2.000	Sum	63.000		

Valid cases 37 Missing cases 0

- -

C13 mech energy

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
agree	1	16	43.2	43.2	43.2
disagree	2	7	18.9	18.9	62.2
donot know	3	14	37.8	37.8	100.0
		-------	-------	-------	
	Total	37	100.0	100.0	

Mean	1.946	Std err	.150	Median	2.000
Mode	1.000	Std dev	.911	Variance	.830
Kurtosis	-1.835	S E Kurt	.759	Skewness	.111
S E Skew	.388	Range	2.000	Minimum	1.000
Maximum	3.000	Sum	72.000		

Valid cases 37 Missing cases 0

CURRICULUM VITAE

Born	February 27, 1944
Education	Eastend, Saskatchewan High School
	Regina, Saskatchewan Teachers College
	Saskatoon, Saskatchewan Bachelor of Education
	Calgary, Alberta Diploma in Curriculum
	Edmonton, Alberta Master of Education
Teaching experience	Saskatchewan 4 years
	Alberta 24 years
Level	Elementary 1 year
	Junior High 25 years
	Senior High 2 years