AN ABSTRACT OF THE THESIS OF

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Title: AN ANALYSIS OF SELECTED PROGRAM OUTCOMES IN THE INDUSTRIAL ARTS EDUCATION PROJECT: OCCUPATIONAL VERSATILITY

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Purpose of the Study

The purpose of this study was to determine if eighth grade students taking industrial arts education for the first time would experience a significant shift in beliefs about the problem solving process and have class performance altered by participation in project Occupational Versatility. In order to accomplish this, the following procedures were considered.

Procedures

The design for this investigation was a variation of the experimental four-group design utilizing a pre-test and post-test. The treatment for this experimental study was project Occupational Versatility, which is an individualized industrial arts education program.

The Childhood Attitude Inventory for Problem Solving was used to establish and assess whether there was a shift in beliefs about the problem solving process. A five point rating scale was used to verify a significant shift in class performance in terms of self-sufficiency, productivity and adaptability. The statistical treatments used to analyze the measured results were the One Way Analysis of Variance and the Pearson Product-Moment correlation coefficient.

The following basic conclusions were drawn from the data obtained in this study.

1. There was a difference in the students' beliefs about the problem solving process and class performance between the combined treatment and the combined control group, in regard to all factors. This shift in beliefs about problem solving and class performance was attributed to the treatment group's participation in project Occupational Versatility.
2. There was a significant relationship at post-test in the students' class performance and problem solving beliefs, within the combined treatment group and within the combined control group. However, within the combined control group, these factors are not as highly related.

Recommendations

On the basis of the findings and conclusions drawn in this study, it is recommended that:

1. A realistic problem solving ability instrument be developed based upon the four technology approach of power, electricity, materials processes and graphic communications. This performance test should be basic and general to all four areas and should be developed to be utilized for assessing actual problem solving ability of junior high school students.
2. Occupational Versatility should be given consideration as an approach for accomplishing the broad educational goals of industrial arts.

An Analysis of Selected Program Outcomes in the Industrial Arts Education Project: Occupational Versatility

by

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I. INTRODUCTION

Industrial arts education instruction has the general objective of developing problem solving abilities of students related to materials, processes and products of industry. The Handbook for Industrial Arts in Oregon Schools (1968) identifies this general objective as a major instructional function of industrial arts education.

The educational function of industrial arts programs is further amplified by the Industrial Arts Guide for the State of Washington (1961) which states as one of the purposes of industrial arts education, to assist the student in discovery and development of personal aptitudes, interests, sound judgment, creative ability, self-reliance and resourcefulness through problem solving and self expression in an industrially oriented classroom.

Industrial arts educators (Decker, 1970; Maley, 1970) are projecting a new emphasis for the role of industrial arts education instruction. The instructional program will become learner oriented rather than content or subject matter centered. The utilization of instructional technology and individualized instruction will become major thrusts to accomplish this goal. This new role for industrial

arts education is a re-emphasis of education for the individual and is exemplified by project Occupational Versatility (Occupational Versatility, 1969).

The Industrial Arts Project Occupational Versatility is an innovative effort in individualized instruction at the junior high school level to develop meaningful and relevant experiences for each student. Project Occupational Versatility identified objectives that will give students the opportunity to determine and develop their identity in a comprehensive industrial arts education classroom or laboratory environment. The goal of allowing students to determine and develop their own identity is facilitated by a problem solving centered program of student paced and oriented instruction supported by diversified media. Bushnell (1971) describes media for "today's" educators as instructional technology utilizing a maximum of various forms of hardware and software. Bushnell believes "instructional technology offers us important tools for providing a scope, depth and diversity of learning never before possible in our schools" (p. 9).

Three specific student objectives were identified by project Occupational Versatility with the primary purpose of developing observable behavior that would allow each student the opportunity to accomplish the following:

> Self-sufficient - The student will initiate and carry through to satisfaction of self and instructor, a project of his own choosing.

Productive - The student will increase his efficiency in operation within the industrial arts facility as indicated by a decreasing amount of time spent on non productive activities and a decreased number of requests for assistance.

Adaptable - The student will readily accept changes and deterents as indicated by a decreasing of waiting time between various task performance and a decrease in the number of requests for direction (Occupational Versatility, 1969).

The American Council of Industrial Arts Supervision (1963) relates the student's attainment of these objectives as guidelines for teaching industrial arts education at the junior high school level.

Statement of the Problem

The purpose of this study was to determine if eighth grade students taking industrial arts education for the first time would experience a significant shift in beliefs about the problem solving process and have class performance altered by participation in project Occupational Versatility. This necessitated the formulation of some specific questions and the development of a series of hypotheses designed to systematically investigate each question. In order to accomplish this, the following questions were considered in relationship to the statement of the problem and the experimental random four group study design which utilized a pre-test (t_1) and post-test (t_2). The hypotheses relating to the following questions are presented in Chapter IV.

1. Is there a difference between the treatment and the control group in the students' beliefs about the problem solving process, at t_1?
2. Is there a relationship within the treatment and within the control group in the students' beliefs about the problem solving process, at t_1?
3. Is there a difference in the students' beliefs about the problem solving process as a result of the t_1 procedures, within either the treatment or within the control group after t_2?
4. Is there a difference in the students' beliefs about the problem solving process within either the treatment of the control group from t_1 to t_2?
5. Is there a difference in the students' beliefs about the problem solving process between the combined treatment group and the combined control group, at t_2?
6. Is there a difference in the students' class performance between the combined treatment group and the combined control group, at t_2?
7. Is there a relationship in the students' beliefs about the problem solving process and class performance within either the combined treatment group and the combined control group, at t_2?

8. Is there a relationship within either the combined treatment group and the combined control group in the students' beliefs about the problem solving process, at t_2?
9. Is there a relationship within either the combined treatment group and the combined control group in the students' class performance, at t_2?

Importance of the Study

The major importance of this study was to investigate whether students being taught by the problem solving centered concept of Occupational Versatility, through the use of instructional technology and individualization of instruction, received at least equivalent instruction as compared with students participating in a regular industrial arts education program. If this study determines that students given instruction in the Occupational Versatility program are benefiting at the same level or higher, the conclusions in consideration of the study limitations would provide foundation evidence for more specialized investigation.

Bruner (1966, p. 53) theorizes that instruction is a provisional condition or, "state that has as its objective to make the learner or problem solver self-sufficient." This learning theory, of self-sufficiency, was identified as a desirable objective in industrial arts

education project Occupational Versatility. This study was designed, in part, to assess the accomplishment of that objective.

There is a real necessity to develop and substantiate the application of the problem solving process in industrial arts education, but there is currently a lack of research and evidence to support this approach (Sage, 1971). As Sage contends, even though problem solving ability is identified as a goal or broad objective for industrial arts education, there is little research to substantiate accomplishment. This study was an attempt toward filling that void.

Design and Methodology of the Study

The design for this investigation was a variation of the experimental four group design (Good, 1963) utilizing a pre-test (t_1) and post-test (t_2). The following experimental design and symbolism (Crawford, 1970) was utilized in this study:

			t_1		t_2
Treatment Group	R	Gp_1	0	T	0
	R	Gp_2		T	
Control Group	R	Gp_3	0		0
	R	Gp_4			0

The treatment group was randomly divided into two equal groups of 70 each, RGp_1 and RGp_2. The pre-test treatment group was RGp_1. The control group was randomly divided into three groups, RGp_3, RGp_4 and RGp_5, each with 70 students. RGp_5 was dropped from the

study to obtain balance between the treatment and control groups. RGp_3 was the control pre-test group. Both random groups within the treatment and control groups participated in the post-test. A student class performance evaluation was made during the t_2 period. The design of the study and both instruments are clarified in further detail within Chapter III. The constraints of this investigation are presented in detail within the limitations of the study. The findings of this study are presented in detail within Chapter IV. The data were tabulated by the Oregon State University Computer Center.

Definition of Terms

For the purpose of this study, to attain clarity and a degree of exactness, the following definitions are included.

Industrial Arts Education - Industrial Arts Education is an aspect of education that deals with materials, tools, machines, processes, and concepts of industry and technology with relationship to student needs in our changing society (Idaho, 1964).

Industrial Arts Educational Project Occupational Versatility - Project Occupational Versatility is an innovative program in Industrial Education stressing individualized instruction that is both student paced and student oriented. Occupational Versatility is funded under Title III of the Elementary and Secondary Educational Act to the Highline School District #401, with the Seattle Metropolitan Area Industrial

Arts Consultants serving as an advisory body (Occupational Versatility, 1969).

Individualized Instruction - Edling (1970) defines individualized instruction as being student:

1. Oriented - the instructional process is oriented toward the individual student, rather than a class or group of students.
2. Paced - the instructional process is paced to meet the needs of the individual student, rather than group or class paced.

Problem Solving Center Instruction - The learning experiences are identified as either major problems for the student to solve or minor problems within a larger, major problem. The student has a complete opportunity to identify the problem and select a plan of action that will facilitate a successful conclusion to meet his needs (Occupational Versatility, 1969).

Problem Solving Process - From a study of the problem solving process, Bingham (1959) has suggested the following definition of the process:

1. Identify the problem
2. Diagnose the problem situation
3. Consider alternative actions
4. Try out plan of action
5. Adapt the plan

Limitations of the Study

The investigation reported in this study was subject to the following limitations and any generalizations made from this study should take these factors into consideration.

1. This study was limited to the utilization of three different junior high schools with adjacent boundaries in the Highline Public School District, Seattle, Washington.
   a. Control schools:
      Olympic Junior High School
      Pacific Junior High School
   b. Treatment school:
      Chinook Junior High School
2. This study was limited to the utilization of different teachers for the treatment school and the control schools.
3. This study was limited to students with similar family socio-economic characteristics for the chief income recipient within each family. Spiegelman (1968) identifies three major areas used by the Bureau of the Census to establish similar socio-economic characteristics for various families based upon the primary income recipient of each. These areas were utilized in this study to report the status of the participant's family situation (Appendix D).

a. Salaried workers - 82.5% of the total population

b. Educational attainment - 12.3 years average

c. Annual income - $9,800 average

4. This study was limited to students with nearly identical standardized achievement test scores for arithmetic comprehension and problem solving on the Lorge Thorndike Standardized Scholastic Aptitude test at the seventh grade level. This item is further clarified within Chapter III of the study.

5. This study was limited to the total population of eighth grade boys taking industrial arts education in the treatment school and the control schools (static group).

6. This study was limited to the utilization of local industrial arts education supervisors in the assessment of class performance.

7. Class performance was assessed in a situation where the treatment school could obviously be identified.

8. This study was limited to the 1970-71 school year for the Highline Public Schools, Seattle, Washington.

9. Student class performance in both the treatment and the control group was assessed at t_2 only. Both the control group and the treatment group consisted of eighth grade boys with no previous experience in industrial arts education.

The assumption was made that both groups entered the program with similar class performance ability.

Approval for Research

This research study was conducted during the implementation phase of industrial arts education project Occupational Versatility. The project was sponsored on behalf of the Highline School District, Seattle, Washington, in conjunction with an organization of supervisory personnel in industrial arts education from the Tacoma and Seattle Metropolitan area, known as the Metropolitan Area Industrial Arts Consultants. Approval to conduct this study was obtained from both groups.

II. REVIEW OF RELATED LITERATURE

This chapter is devoted to the review of related literature in relationship to the following categories: (1) problem solving in industrial arts education, (2) literature related to beliefs about the problem solving process with specific emphasis on beliefs toward the nature of the problem solving process and self-confidence in undertaking problem solving activities, (3) literature related to investigations conducted within the field of industrial arts education utilizing problem solving procedure as either a method or technique of instruction.

Materials for this investigation were obtained by reviewing pertinent literature. Books, doctoral dissertations, and periodicals were key sources of information. The information collected from this literature review was analyzed, synthesized and organized into narrative form to provide an orderly overview of literature related to the study. This review was made from selected literature and was not an exhaustive survey of all literature. This literature review indicates to date little has been written concerning the relative effect of two specifically different industrial arts education curricula on students' class performance and problem solving beliefs. No research has been conducted which compares the traditional industrial arts program to Occupational Versatility.

Problem Solving in Industrial Arts Education

Industrial arts educators (Swanson, 1956; Miller, 1971) have for some time expressed the importance and need for developing within each student the ability to utilize and apply the problem solving technique. However, most authors stop at the telling stage. Very little research has actually been conducted to substantiate the concept. Sage (1971), as many current authors, discusses problem solving as a major method, but with very little implication for the total education spectrum (kindergarten through adult). Anderson (1963) also described the use of problem solving as a major method of instruction within the specific area of industrial arts education. He points out that many industrial arts educators find the topic particularly interesting because of its direct relationship to handling of tools and materials in the laboratory situation. The project method and the problem solving process associated with the teaching of industrial arts education lends itself readily to the student's exercise of imagination in designing of useful, interesting, and attractive articles. Anderson observed that problems always occur during the construction of a shop project regardless of instruction and information available.

Sommers' (1961) review of literature found various articles which suggest that industrial arts education teachers can contribute a great deal to the development of a positive attitude toward problem

solving. These articles pointed out a number of suggestions for the regular classroom teachers, such as encouraging students to value their own ideas, helping them overcome their awe of masterpieces, and providing periods of non-evaluation to permit uninhibited experimentation to develop good self-confidence. A number of articles emphasizing the importance of teaching industrial arts education students how to solve problems are typified by Swanson's (1956) belief that

> The most promising approach to developing problem solving ability, and there is a need for much experimentation at this point, seems to be to teach for understanding and to provide as many problem situations as possible, allowing the student to structure his own attack on them (p. 244).

The terms "creative problem solving" as used by Balin (1960) and "problem solving" have appeared in a wide variety of lay and professional magazine articles, books and pamphlets. Maltzman (1960) defines the relationship between creative problem solving and problem solving as being close and common to one another.

> . . . there is no fundamental difference in the behavioral principles determining originality and problem solving behavior generally. Both involve the evocation of relatively uncommon responses, otherwise the situation would not be called a problem or the behavior original (p. 232).

Seitz (1965) reviewed problem solving in industrial arts education by analyzing articles appearing in six major periodicals, with literature related specifically to the industrial arts education teacher. This investigation dealt with literature covering a span of 25 years

(1940-1965). The main purpose of Seitz's study was to obtain a tabulation of articles according to content expressed in each one, with direct reference to problem solving. Three specific classifications were used, these being instructional, information and proposal type articles.

The instructional articles were classified as initiative, adaptive or inventive in relationship to the action necessitated by the student. The informational articles contained explanations of existing courses of study, educational programs, or the results of research in terms of whether or not problem solving was considered by the author. The proposal type articles contained proposed instructional methods, objectives, or new course content with specific reference to problem solving. Seitz found five times as many articles written about instructional information as compared to proposal type and twice the amount containing informational material. The findings of Seitz support the need for a more specific clarification of problem solving activities in industrial arts education laboratories if a comprehensive utilization of the major periodicals is to be used as resource and reference material to establish direction and possible innovative needs.

In brief summary, the literature related to problem solving importance within the curriculum area of industrial arts education is massive. However, literature and research related directly to

identifying and establishing the importance of problem solving belief and self-confidence in working with a problem solving situation, specifically on the part of students in a student centered program, is extremely limited. Schumm (1972) emphasizes that no specific single pedagogical approach for implementation of the problem solving technique has been accepted even though theorists within the field have identified the process as a goal.

The writings of recent researchers (Sommers, 1961; Anderson, 1963) in industrial arts education suggest that it will not be an easy matter to adapt problem solving to the teaching-learning process. There are many different modes of problem solving. All of them have their place in the learning process at one time or another. The teacher should be aware of problem solving techniques which are well researched and which have been carefully adapted to classroom use.

Literature Related to Beliefs and Self-confidence in the Problem Solving Process

Bloom (1950) conducted an exploratory investigation dealing with college students' mental processes toward problem solving situations. There were specific differences in student achievement which could be accounted for by difference in methods of attacking problem solving situations. In discussing student differences, two groups were identified by Bloom as successful and unsuccessful problem solvers.

It was his judgment that the differences in student success in problem solving situations were as marked as the differences in their academic achievement. It should be pointed out that Bloom evidently used his judgment as sole authority and jury for analysis and synthesis of the data.

Attitude toward the solution of problems was identified as one major difference between the groups. By "attitude" Bloom referred to such characteristics as emotions, values, beliefs, feelings and prejudices of the student as they are involved in solving various problems. It was possible for Bloom to identify at least three distinct kinds of attitudes: (1) attitude toward the problem solving process (reasoning), (2) self-confidence in ability to solve problems, and (3) introduction of personal considerations into the solution of problems.

Bloom's work was followed by Covington (1966) who developed an instrument, entitled the Childhood Attitude Inventory for Problem Solving (CAPS), to assess student beliefs about the problem solving process. Covington developed the Childhood Attitude Inventory for Problem Solving for creative problem solving research at the University of California. He used the inventory as one element of a large task-performance study to devise instruments to assess problem solving beliefs among upper elementary school children.

The present inventory development covered a period of three years. The initial form consisted of 40 true-false items in Scale I

designed to assess the child's beliefs about the nature of the problem solving process and 35 true-false items in Scale II designed to assess the child's feelings about his own ability to succeed (self-confidence) in problem solving situations. To obtain information about any difficulties in administration or comprehension of the directions and to provide data for item analysis to establish validity, this initial form was tried out on a total of 123 fifth grade and sixth grade students from the Berkeley public schools and vicinity. Using the median score on Scale I as a cutting point, the students were divided into high and low scores. The same computation was done for Scale II. Point bi-serial correlations were then computed for each item between the total score on a given scale and the relative proportions in the high and low groups' answering consistent with the scoring key. Items not differing significantly from zero were either dropped entirely from the scale or substantially modified. The magnitude of the reliability coefficients for the preliminary form were encouraging, being .93 for Scale I and .86 for Scale II, using the K-R formula 20, and .71 and .69, respectively, for a Pearson product-moment test-retest reliability over a four week interval.

The original instrument contained 60 true-false items, equally divided between two scales. The responses were constructed on the yes-no criteria and the possible credit for each item was one point.

The 60-item form of CAPS was administered on two separate occasions to 325 fifth and sixth grade students. A five-week period intervened between the two administrations. The test-retest reliability was .69 for Scale I and .65 for Scale II. The Pearson product-moment correlation test-retest reliability coefficient was .65 over a five-week interval. The product-moment correlation between the two scales for the total sample of 325 students was .35.

Covington (1966) developed a 34-item group administered paper-pencil attitude inventory comprised of two scales, one assessing the child's beliefs about the nature of the problem solving process (odd numbers) and the other assessing the child's self-confidence in undertaking problem solving activities (even numbers). This inventory was compiled by taking the most significantly differing items from the 60-item Childhood Attitude Inventory for Problem Solving and items that were substantially modified in an attempt to balance the response factor to some degree and establish a high degree of validity and reliability.

Carey (1958) developed a problem solving attitude scale similar to that of Covington (1966). However, the Carey scale was specifically designed for college level subjects. A five-point rating scale was used by Carey for 18 items to assess positive attitude toward problem solving situations and demands. A number of the specific individual items on both forms A and B have a likeness to those used by Covington on the Childhood Attitude Inventory for Problem Solving.

Shaw and Wright (1967), in summarizing attitude measurement scales relative to social institutions, note that there are very few scales which have been developed for this purpose in spite of the importance of these institutions in such a highly organized society as ours. One factor perpetuating this is validity or agreement upon what is valid.

They also note that there are many scales for measurement of attitudes toward childrearing, toward ethnic groups, toward war, toward nationalistic attitudes, toward liberalism, conservatism, and toward tariffs. However, they say that there seems to be very few designed to measure attitude toward abstract concepts such as life, freedom, education and time.

Attitudes discussed by Shaw and Wright (1967) represent the end products of the socialization process, man's attitude will significantly influence his responses made to various specific factors and broad situations. Formal definitions of attitude were offered by many authors. Shaw and Wright cite a number of traditional definitions that are illustrative for common usage:

1. An enduring learned predisposition to behave in a consistent way toward a given class of objects (English and English, 1958, p. 50).

2. An enduring system of positive or negative evaluations, emotional feelings, and pro or con action tendencies with respect to a social object (Krech, Critchfield and Ballachey, 1962, p. 177).

3. A mental and neutral state of readiness, organized through experience, exerting a directive or dynamic influence upon the individual's response to all objects and situations with which it is related (Allport, 1954, p. 45).

4. An individual's social attitude is a syndrome of response consistency with regard to social objects (Campbell, 1950, p. 31).

Shaw and Wright point out in their research that Osgood, Suci and Tannenbaum (1957) and Anderson and Fishbein (1965) further suggest that attitude toward an object is a sum of the strength of beliefs about the subject and the evaluative aspect of these beliefs. Shaw and Wright believe when considering the importance of attitude and its influence upon learning, the attitudes which have occupied a central place in social psychology and education during the last half of the century is not surprising. Shaw and Wright in studying "Scales for the Measurement of Attitudes" defined attitude themselves as

> A relatively enduring system of affective evaluative reactions based upon and reflecting the evaluative concepts or beliefs which have been learned about the characteristics of a social object or class of social objects. As an affective reaction, it is a covert or implicit response (p. 10).

Purvis (1968) used Covington's Childhood Attitude Inventory for Problem Solving in a study dealing with differential feedback and its effect upon the students' beliefs about the problem solving process. He used the 60-item CAPS instrument developed by Covington, assessing the beliefs structure of the individual student in terms of beliefs

about the nature of the problem solving process and self-confidence in undertaking problem solving activities.

The population for Purvis' study represented students from three fifth grade classes in a middle class, suburban school in central New York State. They were randomly assigned to four experimental groups and a control group. Positive and negative teacher comments were collected and used to provide differential feedback to students within the experimental group at the conclusion of a problem solving task.

Purvis' findings supported the hypothesis that the differential feedback did affect some aspects of the beliefs about the problem solving processes. The results of Purvis' experiment indicate that when students work on a problem solving task, their behavior can be influenced by feedback. The degree and direction to which they are influenced may depend upon certain individual differences.

> Sensitivity to external inputs in a manner that may cause a dissident condition to exist until an internal adjustment is made in their belief system. As a student is increasingly presented individualized instructional and problem solving situations through the application of technology, the instructional designer will need theoretical guidance for effectively utilizing tasks performance feedback (p. 110).

The prime purpose of Purvis' study was to see whether specific types of task-performance feedback would have a differential effect on the problem solving belief system of the subjects. The results, although not as conclusive as Purvis would have liked, did, however,

indicate that differential feedback had a significant effect. The following recommendation was offered by Purvis in regard to the instrument used to assist further research in this area of problem solving beliefs and self-confidence.

> The instrument used to measure the independent variable should be appropriate for assessment of the type of changes anticipated in the learners over the experimental period. It may be that the CAPS instrument, used in this study, is appropriate for the measurement of long term effects, whereas another instrument might be more appropriate for the measurement of transient or short term influence (p. 115).

In an effort to develop meaningful education experiences to support the development of problem solving ability and attitude, Crutchfield (1965), in collaboration with Covington, explored the concept of training students for creative problem solving ability.

Problem solving, as defined by Crutchfield, is a process requiring many skills. The problem solver must be able to sense and to identify a problem and formulate it into workable terms. He must be able to grasp the essential elements of the problem, to separate the relevant from the irrelevant, to detect gaps, and to determine what further information may be needed. He must be able to call upon what he possesses in the way of concrete knowledge, principles and conceptual models (Crutchfield, 1965). Crutchfield believed that common to all problem solving situations was what he called "a master thinking skill."

> I believe, however, that the master thinking skill requires direct training in and of itself. Thus, I would stress the value of practicing the specific skills not singly and separately, but as combined within the global context of shole and relatively complex problems (p. 40).

Crutchfield observed that by taking elementary children through a series of meaningful problem solving situations the children developed a strong sense of self-confidence in working with the problem solving process irregardless of the problem solving outcome. He observed that the individual's self-confidence in his own creative powers was reinforced.

In summary, the related literature dealing with attitude toward the solution of problems in terms of beliefs about and self confidence in utilizing the problem solving process is much more limited than the general literature on problem solving. Some work in regard to developing a positive attitude toward problem solving activity has been done in industrial education as suggested by Sommers (1961). However, the greatest contribution has come from educational research efforts in general, especially those approaches requiring extra motivation or effort on the part of an individual instructor and from researchers attempting to establish some foundation for research in the effective domain. Attitudinal scales for assessing problem solving factors within the effective domain are extremely scarce for a wide range of research situations. Agreement upon validity as it concerns various groups seems to be the major obstacle (Shaw and Wright, 1967).

When considering the literature reported here in regard to beliefs and self-confidence in problem solving, Bloom's work was conducted at the college level and attempts at data classification correlated with various student performance in problem solving situations is extremely limited beyond clarifying that certain beliefs are common to most successful problem solvers. Covington developed his inventory based upon the relationship between its content and the beliefs he felt were associated with successful problem solving. The concern for validity must be clarified when using Covington's inventory, that is, it must be used for assessing program objectives dealing with problem solving beliefs and self-confidence.

Related Industrial Education Studies in Problem Solving

Johnson (1958) conducted a study with prospective elementary teachers currently enrolled in beginning woodworking. The basic purpose was to delineate whether beginning students in this area would accept the responsibility of designing their own project by using a problem solving approach and secondly, whether this could be accomplished at the beginning of the course when background is limited.

Students were given basic introductory information in the use of tools and materials during construction of a simple class project.

This initial project was used as an illustration of problem solving processes. Concurrently, information was given by means of instructor lectures and written assignment sheets on the process of creative problem solving involving recognition, analysis, hypothesizing, synthesis, incubation and application. Qualities of good design were discussed and explained by using cartooned instruction sheets.

The finished projects were analyzed with respect to certain aspects of successful problem solving in conjunction with both instructors' and students' reactions to all phases of the study. Students' reactions were generally favorable and it was found the cartooned problem solving instruction sheets allow beginning students to be successful in designing and planning their own projects along with receiving instruction in the problem solving process.

Sommers (1961) investigated the feasibility of improving creative problem solving within the framework of existing subject matter courses at the college level. The specific subject matter was Freehand Drawing--one of eight shop-laboratory type courses required of all industrial arts freshmen. The subjects used in the experiment were randomly selected from pre-registered freshmen. The experiment was conducted during the first and second quarters.

Treatment of the control group consisted of assigning a standard sequence of learning activities for the subject matter course. The experimental group was handled in a different manner, problem

solving activities being substituted for some of the standard learning activities.

Sommers used an experimental design with the control group receiving the traditional instruction, a pre-test was given to both groups. The measurements tools consisted of a locally prepared examination on subject matter that had been accepted by the Drafting Department as a valid measurement tool and Torrance "Test of Imagination"; both instruments had evidence of validity and reliability. The experimental group was then given new instruction procedures in freehand drawing, involving problem solving principles. Sommers found by an analysis of variance use of specific problem solving methods designed to increase creative thinking, certain abilities associated with an industrial arts laboratory course could also be improved. He also concluded these special methods would not negatively affect subject matter learning. In fact, the use of the methods actually increased subject matter learning.

Anderson (1963) designed a study to evaluate two procedures formulated to develop creative problem solving abilities in a general education college industrial arts course. The population cut across a number of academic subject areas and the full range of undergraduate classifications. A general education course was used to provide students not currently in the industrial arts teacher education program. A laboratory sequence was added to this course and students

voluntarily enrolled in various sections. The lecture session met at the same time and the experimental treatments took place at different times in the laboratory sequence. Three laboratory sections were established by random assignment.

Three treatments, two experimental and one control, were used. The treatment consisted of (1) nine brochures containing creative problem solving material and short ideation exercises, and (2) the nine brochures plus oral, group problem solving exercises. The third group of students, the control group, did not receive the treatments designed to develop creative problem solving abilities.

An analysis of variance indicated significant differences on mean scores using the Minnesota Test of Creative Thinking. In all three replications, the adjusted scores favored the experimental group in which a combination of brochures and problem solving exercises were used.

Moss (1966) investigated the relationship between creative problem solving abilities and actual problem solving performance using eighth grade industrial arts education students. The primary goal was to assess the concurrent validity for the paper and pencil Minnesota Tests of Creative Thinking Abbreviated Form VII, identifying the creative problem solving abilities of eighth grade students in industrial arts education. A second objective was to investigate the relationship between creative problem solving abilities and intelligence, and

school achievement of eighth grade boys taking industrial arts education.

A set of guidelines for the measurement of creative problem solving abilities were developed by Moss. These guidelines were then scrutinized by a group of educational psychologists and industrial arts teacher educators to determine their acceptability.

Moss selected three pairs of industrial arts education instructors and trained them in the measurement procedure. Observations were then made on three pairs of eighth grade classes throughout the semester in order to obtain the criterion measures. The classes consisted of 95 students. Eight creative problem solving criterion measures were established. Moss made the assumption that instructors being trained would respond similarly to identical situations.

Moss administered the Minnesota Test of Creative Thinking Abbreviated Form VII at mid-semester and secured an ex-post-facto teacher ratings of student creative problem solving ability and peer ratings of creative problem solving abilities were secured to assess the construct validity of the criterion measures. Moss summarized that the identification of creative problem solving abilities of industrial arts education students appears to meet the stipulated criteria based on the limitation within the study. The teacher ratings of observed student behavior as it occurs in a typical industrial arts education environment proved to be only partially successful. The teacher

ratings of the student products had sufficient reliability, but in Moss' judgment there were not enough ratings made to assume adequate reliability of their criterion measures for individual students. The measures yielded by the Minnesota Tests of Creative Thinking Abbreviated Form VII were not sufficiently high to serve as indices of actual creative problem solving output in the eighth grade industrial arts students used in the study

Harney (1967) compared the effects of problem solving and non-problem solving design experiences in woodworking, metalworking and crafts at the college level as measured by the Minnesota Test of Creative Thinking Form VII and a jury competent in evaluating design and determining the students' reaction to the teaching method, course content and laboratory facilities as measured by a course evaluation questionnaire. The problem essentially dealt with providing information to note the result of a problem solving teaching strategy on creative problem solving research and design judgment in industrial arts design. Harney found indication that teaching strategy would have an effect on creative problem solving course work if a method conducive to its encouragement were used.

The control group followed the regular course outlines for wood technology, metal technology and crafts. The basic course outline was also used in the experimental treatment with material by widely

known authors and material developed by Harney used in an effort to encourage creative problem solving judgment.

The population consisted of 147 industrial arts education students taking course work in one of the three areas identified, either fall or spring semester. The study used existing classes and no randomization was used. The control group was made up of two wood technology classes, one metal technology and one crafts class. The experimental group treatment was initiated at the beginning of the spring semester while the control group treatment took place during the fall semester. The control treatment consisted of a traditional structured teaching strategy.

The pre-test and post-test scores for both groups on the Minnesota Tests of Creative Thinking Form VII were used to estimate the effects of the treatment. Based on the analysis of variance findings of Harney's study and recognizing the limitations stated in the study, the following conclusions resulted from an analysis of the study.

1. The data noted significant differences in general creative problem solving confidence between the control treatments and the experimental treatments in wood technology and metal technology favoring the experimental groups. This indicates, Harney concluded, that it is better to encourage general creative problem solving in existing laboratory

classes by a problem solving teaching strategy than the more restricted traditional technique.

2. Analysis indicates no significant difference in the results of products developed and the design factor. The problem solving teacher strategy is as effective as the traditional highly structured approach.
3. The data indicated a significant difference in the wood technology area. The problem solving teaching strategy was somewhat more effective than the traditional structured approach. There was no difference in the achievement in the metal technology and crafts subject matter test scores.

Miller (1971) conducted a study with the major problem being to compare cognitive achievement and affective behavior of students enrolled in the Industrial Arts Curriculum Project (I. A. C. P.) and students enrolled in conventional junior high school industrial arts programs. His study used a Static-Group Comparison, with some degree of modification, as the research design. Miller worked with a relatively small population and limited randomization. An analysis of covariance was used to analyze scores obtained on an I. A. C. P. project developed achievement test. This test was not available, however. Data reported by Miller indicated a high validity and reliability. Students enrolled in the I. A. C. P. achieved significantly higher than those in the traditional programs.

The General Scale of Attitudes of junior high school industrial arts was used to assess student attitude. This scale contained 60 items with five option answers. This scale, when scored, provides a total score and six sub-scores relating directly to attitude toward various factors of industrial arts education. Miller developed this scale and it was not available in his work. Miller selected and developed the items on the scale and reported a reliability estimate using the Kuder-Richardson formula 8 as .083. Only one sub-scale indicated a significant difference between the two programs, that of social position and its relationship to success.

Summarizing the investigations in problem solving conducted within the field of industrial arts education, it is obvious that most are at the college level. The use of currently available, relatively crude instruments for assessing the hypothesized independent variables is likely to reveal only the grossest components of problem solving performance. The task of refining the explanation and prediction of problem solving performance will also require more discriminating and discrete measure of the dependent variable. The techniques and conditions under which different kinds of output are measured will greatly influence the results; conditions which tend to motivate or inhibit, free or freeze potential should be taken into account (Moss, 1966).

The statistical analysis employed in most investigations is the analysis of covariance which is particularly useful when it has not been possible to compare randomly selected samples. However, this is a common situation in classroom experiments using available samples (Best, 1970).

III. DESIGN AND METHODOLOGY OF THE STUDY

Experimental research requires that the design be specified in such a way as to indicate the experimenter's method of controlling the dependent and independent variables. In this study, the dependent variables were the subject's scores judgmentally assigned to denote beliefs about the problem solving process and evaluator assigned score denoting assessed class performance. The independent variable was the treatment from industrial arts education project Occupational Versatility, which emphasized individualized, student paced and oriented instruction. The limitations of this specific research should be considered when any generalizations are made pertaining to the study.

Design

The design for this investigation was a variation of the experimental four group design (Good, 1963) utilizing randomization with a pre-test and post-test, for both control and experimental groups.

The randomized four group pre-test/post-test design was selected because, according to Campbell and Standley (1963), it controls for internal validity. Crawford (1970) supports this concept by advising the researcher to provide for one or more control groups to discover whether or not rival events exert an influence.

The treatment group was a static group which consisted of all the eighth grade boys taking industrial arts education at the treatment school. This approach was taken in order to obtain a maximum number of participants within the treatment group.

The following symbolization and experimental design model (Crawford, 1970, p. 63) were utilized in this study.

T	R	Gp_1	t_1	O. V.	t_2
	R	Gp_2		O. V.	t_2
C	R	Gp_3	t_1		t_2
	R	Gp_4			t_2
	R	Gp_5		dropped	

T = Treatment group
C = Control group
R = Randomize
Gp = Specific group
t_1 = Pre-test
O. V. = Occupational Versatility
t_2 = Post-test

Population

The population for this study consisted of 280 eighth grade boys with no previous industrial arts education experience. The subjects were identified by the Highline Public Schools as having similar socio-economic backgrounds and similar aptitude and achievement test scores. The latter was confirmed by a separate analysis at t_1, to test whether there were any significant differences between the groups in regard to Lorge Thorndike test scores that were given during the seventh grade. A t-test statistic was used to determine if a significant difference existed within the area of arithmetic, specifically arithmetic comprehension (CA) and problem solving (PA). Both raw scores (RS) and percentiles (PCT) were computed. All the information pertaining to this analysis is contained in Table I. Each item received t scores of no significant difference.

The treatment group consisted of 140 eighth grade boys who were participating in project Occupational Versatility. The control group consisted of 209 eighth grade boys who were taking a traditional industrial arts education course. The control group schools were selected by the Director of Research, Highline Public Schools, Seattle, Washington. The control group schools had adjacent boundaries with the treatment group school. The experimental group was randomly divided by computer printout and simply counting off

Table 1. Summary of No Significant Difference in the Lorge-Thorndike Arithmetic Test Scores between Treatment and Control Groups at t_1.

Group	Category	Mean	Standard Deviation	t
Treatment	RS - CA	40.69	6.39	0.409 ns
Control	RS - CA	40.35	6.22	
Treatment	PCT - CA	33.76	22.85	0.071 ns
Control	PCT - CA	33.54	23.86	
Treatment	RS - PA	44.72	6.96	0.531 ns
Control	RS - PA	44.25	6.75	
Treatment	PCT - PA	50.21	23.13	0.655 ns
Control	PCT - PA	48.19	24.05	

ns - not significant ($p < .05$)

1, 2, 3, etc. into two equal groups of 70 each, RGp_1 and RGp_2. The pre-test experimental group was RGp_1. The control group was randomly divided by the same process as the treatment group into three groups, RGp_3 and RGp_4, each with 70 and RGp_5 with 69 students. RGp_3 was the control pre-test group and RGp_5 was dropped from the study to obtain a balance between the control and experimental groups of 140 students each. Both random groups with the experimental and control groups participated in the post-test. It should be pointed out at this time that three of the treatment students and four of the control students transferred schools during the year.

Treatment

The treatment for this experimental study was project Occupational Versatility, which is an individualized industrial arts education program. Occupational Versatility was organized as a student paced program and as a student oriented program rather than the traditional industrial arts program of instructor paced and oriented.

The treatment was given to the total experimental group over a period of seven months. Because of facility remodeling, project Occupational Versatility was implemented two months after school began. The treatment consisted of letting the students take responsibility for selecting specific objectives or goals he would like to accomplish and the method or process used for attainment.

Occupational Versatility was organized to allow each student the responsibility of:

1. Keeping individual attendance records
2. Individual clean up
3. Individual materials accountability
4. Self instruction

The above opportunities were available in a comprehensive laboratory utilizing a multi-area concept rather than a single one or two. The following areas were available for student exploration in conjunction with a power tool and general resource area:

1. Guidance and counseling
2. Wood
3. Plastics and fiberglas
4. Building trades
5. Electricity
6. Machine tools
7. Sheet metal
8. Welding
9. Forging
10. Hot metals
11. Drafting and planning
12. Printing
13. Signs and labels

14. Material finishing

15. Small gas engines

16. Records section

The instructor's responsibility was to function as a resource person. The instructor placed himself as manager within a learning situation.

Instruments Used

The Childhood Attitude Inventory for Problem Solving was used to establish and assess whether the exposure to industrial arts education project Occupational Versatility shifted the students' beliefs about the nature of the problem solving process (Appendix A). The following statement clarifies a 34-item, five-point rating scale administered paper-pencil-paper attitude inventory used in this study. The instrument was comprised of two scales, one assessing the child's belief about the nature of the problem solving process (odd numbers) and the other assessing the child's self-confidence in undertaking problem activities (even numbers). This inventory was compiled by taking the most significantly differing items from the 60-item Childhood Attitude Inventory for Problem Solving and items that were substantially modified in an attempt to balance the response factor to some degree (Covington, 1966). The 34-item instrument was further modified by the investigator's doctoral committee to balance the

negative and positive responses, which is desirable in an attitudinal scale (Best, 1970).

The pre-test consisted of the Childhood Attitude Inventory for Problem Solving to establish a reference point in the students' beliefs toward the problem solving process. The Inventory was also used for the post-test in conjunction with a class performance evaluation.

The student class performance assessment was made during the post-test period by a team of three members from the Metropolitan Area Industrial Arts Consultants Association who, at the conclusion of several laboratory observations, evaluated each student on a five-point rating scale, in terms of self-sufficiency, productivity and adaptability as defined by project Occupational Versatility (Appendix B). Best (1970) recommends the rating scale method for opinion assessment because of its simplicity and flexibility. He suggests keeping the number of items to be rated at a minimum to evade the tendency of a halo effect. The halo effect is likely to appear in a rating scale situation when the evaluator is asked to rate a number of factors of which he has no specific evidence for judgment. A single tabulation was made from the team evaluations to represent a composite measurement of class performance in terms of self-sufficiency, productivity and adaptability for each student at t_2. There was no class performance evaluation of t_1 because all students were eighth grade boys with no previous industrial arts education experience.

Collection of Data

The Childhood Attitude Inventory for Problem Solving was administered as the pre-test to RGp_1 and RGp_3 prior to treatment. The administration to both groups was arranged on a morning/afternoon basis, with make-up provision for the following day. Local instructors and administrators assisted in supervision. The same procedure was utilized during the post-test phase for all groups, RGp_1, RGp_2, RGp_3 and RGp_4. The subjects were assembled en masse and given the instrument with the following verbal directions:

> May I have your attention please. Before we begin, I would like to thank you and your teachers and principal for agreeing to assist us in our work.
>
> When the booklet is passed out, would you please open it to the first page. Print your name, school and date. Read the directions carefully and answer all the questions. When you are through, you are free to leave. This will take from 10 to 15 minutes. Thank you.

The evaluation team, consisting of three supervisory personnel from the Metropolitan Area Industrial Arts Consultants Association, conducted observations to each school situation throughout the school year. Each class participating in the study was observed in its entirety at least three times. The evaluators visited each school at random and independent of one another. They became familiar with the instructional methodology used in each specific school situation and the students' application of learning through various project activity. The team held a practice evaluation session at a neutral

school, evaluating five students in terms of self-sufficiency, adaptability and productivity after two extensive visitations.

The treatment and control group student class performance was assessed in the same manner. The instructor and evaluator mutually assessed each student, with the evaluator asking questions about each specific student within the constraints identified by the definition for each term (Appendix B). All evaluators were present in each specific situation and had final responsibility for actually rating each student. The three assessments were then compiled by the researcher to obtain one composite score.

Analysis of Data

The data analysis in this study is presented in direct relationship to the study limitations and any generalizations made should take into consideration these factors. The Hawthorne effect is of prime importance because no attempts beyond selecting students with no previous industrial arts experience, randomly grouping and pre-testing both treatment and control groups were made to limit the possible Hawthorne effects. These efforts would, at best, only check to some degree one aspect of the Hawthorne effect. Rosenthal (1968) identifies two major Hawthorne effects within the expectancy concept. First, those whose behavior is being assessed "know" that the experiment or treatment will have some effect upon them. This effect is

checked to some degree in this study. Secondly, the expectation of those who initiated the experiment or treatment for another person's behavior on that other person's behavior. It is this second interpersonal type that must be considered when generalizations are made in reference to this study.

Both Best (1970) and Rosenthal (1968) express concern that, although it is believed that the Hawthorne effect is a specific threat to experimental validity, it would seem imperative that further study of the nature of this phenomenon is needed.

Once the data for use in this study were collected, the following steps were undertaken for analysis of the results.

1. Upon completion of the pre-test, the Childhood Attitude Inventory for Problem Solving Instrument was scaled and coded for key punching on IBM cards for electronic analysis.
2. The same procedure was followed for the Childhood Attitude Inventory for Problem Solving post-test.
3. Class performance ratings were obtained from the evaluators and ratings were tabulated and coded for key punching and analysis.

The following parametric statistics were selected because the data were expressed as equidistant interval. The Student t test statistic was selected for testing significant differences between group means on standardized test scores, to establish similarity of groups

at t_1 (Smith, 1967). The one-way analysis of variance was used to determine possible significant differences between individual mean scores, both within and between groups (Li, 1964). The Pearson Product-Moment Correlation Coefficient was used to test for significant differences of various factors of the independent variables (Courtney, 1970).

The level of significance in this study was at the 5 percent level (.05). Best (1970) recommends this level for educational research. The 5 percent level of significance suggests a 95 percent likelihood or probability that the results or difference assessed was due to the treatment variable rather than to sampling error.

IV. PRESENTATION AND ANALYSIS OF DATA

This chapter presents the findings of nine stated null hypotheses. The results of this study were assembled according to the questions listed within the statement of the problem section of Chapter I.

Theorists such as Glasser (1969) suggest that our schools today are very typical to one another and are "designed for failure" or toward solely teacher prescribed goals. He proposes a relevance for instruction and learning based upon real problem solving situations and more peer group control of behavior with no "right" answers and greater opportunity for students to be directly involved in a decision making process. Bruner (1966) contends that "children learn by success." He feels the school environment should provide success orientated learning situations with the student as the central factor of concern.

The hypotheses stated here are derived from the question outlined in the statement of the problem and the theory that participation in a student oriented program as compared to a traditional or teacher oriented program will have greater effect upon the students' beliefs and class performance. The statistical treatments to test the hypotheses are presented in the previous chapter.

Findings Related to the Pre-test Hypotheses

The pre-test/post-test experimental research design utilized

in this study attempted to show by the assessment of the control group in comparison to the treatment group at pre-test that: 1) the groups were not significantly different, and 2) any differences which occurred in the treatment group, taking into consideration the study limitations, could be attributed to participation in Occupational Versatility.

Three sub-hypotheses were developed and tested in relation to the first question. A one-way analysis of variance was used to test the null sub-hypotheses and three separate analyses were run.

Hypothesis 1. There is no significant difference at t_1 in the students':

a. composite beliefs about the problem solving process between RGp_1 and RGp_3.

b. belief about the nature of the problem solving process between RGp_1 and RGp_3

c. self-confidence in undertaking problem solving activities between RGp_1 and RGp_3.

The results of these analyses are shown in Table 2. The implications drawn indicate no significant difference. Therefore, the three null sub-hypotheses were accepted.

Six sub-hypotheses were developed and tested in relationship to the second question. A Pearson Product-Moment correlation coefficient statistical analysis was used and six analyses were run.

Table 2. One-way Analysis of Variance for Beliefs about the Problem Solving Process between the Treatment Group (RGp_1) and the Control Group (RGp_3) at Pre-test (t_1).

Source of Variation	d. f.	MS	F
Between groups	136		
Composite beliefs	1	159.61	1.71 ns
Error variance	135	93.41	
Belief	1	57.41	2.32 ns
Error variance	135	24.70	
Self-confidence	1	25.57	0.47 ns
Error variance	135	54.38	

ns = not significant ($p < .05$)

Hypothesis 2. There is no significant relationship at t_1 in the students':

a. composite beliefs about the problem solving process and their belief about the nature of the problem solving process within RGp_1.

b. composite beliefs about the problem solving process and their belief about the nature of the problem solving process within RGp_3.

c. composite beliefs about the problem solving process and their self-confidence in undertaking problem solving activities within RGp_1.

d. composite beliefs about the problem solving

process and their self-confidence in undertaking problem solving activities within RGp_3.

e. belief about the nature of the problem solving process and their self-confidence in undertaking problem solving activities within RGp_1.

f. belief about the nature of the problem solving process and their self-confidence in undertaking problem solving activities within RGp_3.

The results of these analyses are shown in Table 3. The implications drawn indicate a significant relationship in all sub-hypotheses except (e), belief about the nature of the problem solving process and self-confidence in undertaking problem solving activities within RGp_1. Therefore, null hypothesis 2 was rejected.

Findings Related to the Post-test Hypotheses

Two sub-hypotheses were developed and tested in relation to the third question. A one-way analysis of variance was used to test the two sub-hypotheses and two analyses were run.

Hypothesis 3. There is no significant difference at t_2 in the students' composite beliefs about the problem solving process between:

a. RGp_1 and RGp_2 within the treatment group.

b. RGp_3 and RGp_4 within the control group.

Table 3. Pearson Product-Moment Correlation Coefficient to Assess Relationship of Beliefs about the Problem Solving Process within the Treatment Group (RGp_1) and the Control Group (RGp_3) at Pre-test (t_1).

Group	Category	Mean	Standard Deviation	r	t
RGp_1	Composite beliefs	103.80	8.69	0.660**	7.196
	Belief	51.04	4.80		
	Composite beliefs	103.80	8.69	0.837**	12.542
	Self-confidence	52.75	6.60		
	Belief	51.04	4.80	0.142 ns	1.178
	Self-confidence	52.75	6.60		
RGp_3	Composite beliefs	105.96	10.56	0.688**	7.297
	Belief	52.34	5.14		
	Composite beliefs	105.96	10.56	0.881**	15.155
	Self-confidence	53.62	8.09		
	Belief	52.34	5.14	0.237*	1.986
	Self-confidence	53.62	8.09		

*Significant ($p < .05$)

**Significant ($p < .01$)

ns - not significant ($p < .05$)

The results of the statistical tests for hypothesis 3 are shown in Table 4. The implications drawn indicate no significant difference. Therefore, the two null sub-hypotheses were accepted.

Table 4. One-way Analysis of Variance for Composite Beliefs about the Problem Solving Process between Treatment Groups RGp_1 and RGp_2 and Control Groups RGp_3 and RGp_4 at t_2.

Source of Variation	d. f.	MS	F
RGp_1 and RGp_2			
Between groups	137		
Composite beliefs	1	0.46	0.01 ns
Error variance	136	58.93	
RGp_3 and RGp_4			
Between groups	136		
Composite beliefs	1	24.10	0.36 ns
Error variance	135	66.24	

ns - not significant ($p < .05$)

Six sub-hypotheses were developed and tested in relationship to the fourth question. A one-way analysis of variance was used and results of six analyses were reported.

Hypothesis 4. There is no significant difference from t_1 to t_2 in the students':

a. composite beliefs about the problem solving process within RGp_1.

b. composite beliefs about the problem solving process within RGp_3.

c. belief about the nature of the problem solving process within RGp_1.

d. belief about the nature of the problem solving process within RGp_3.

e. self-confidence in undertaking problem solving activities within RGp_1.

f. self-confidence in undertaking problem solving activities within RGp_3.

The findings of the analyses are shown in Table 5. The implications drawn indicate no significant difference within RGp_3. The three null sub-hypotheses pertaining to RGp_3 were accepted. However, those pertaining to RGp_1 were rejected. This last factor indicates a need to check mean scores for RGp_1 at t_1 and compare to t_2 scores for direction of shift.

Three sub-hypotheses were developed and tested in relationship to the fifth question. The results of a one-way analysis of variance are reported for these analyses.

Hypothesis 5. There is no significant difference at t_2 between the combined treatment and the combined control group in the students':

Table 5. One-way Analysis of Variance for Beliefs about the Problem Solving Process within RGp_1 and RGp_3 from t_1 to t_2.

Group	Source of Variation	d. f.	MS	F
RGp_1	Within	69		
	Composite beliefs	1	2136.59	34.07*
	Error variance	68	62.72	
RGp_3	Within	68		
	Composite beliefs	1	126.18	1.47 ns
	Error variance	67	85.57	
RGp_1	Within	69		
	Belief	1	605.22	23.94*
	Error variance	68	25.28	
RGp_3	Within	68		
	Belief	1	6.18	0.28 ns
	Error variance	67	22.36	
RGp_1	Within	69		
	Self confidence	1	467.51	14.65*
	Error variance	68	31.92	
RGp_3	Within	68		
	Self confidence	1	76.50	1.45 ns
	Error variance	67	52.83	

*$p < .05$

ns - not significant ($p < .05$)

a. composite beliefs about the problem solving process.

b. belief about the nature of the problem solving process.

c. self-confidence in undertaking problem solving activities.

The results of the statistical tests for hypothesis 5 are shown in Table 6. The implications drawn indicate a significant difference. The fifth null hypothesis was, therefore, rejected.

Table 6. One-way Analysis of Variance for Composite Beliefs, Belief about and Self-confidence between Combined Treatment and Control Groups at t_2.

Source of Variation	d. f.	MS	F
Treatment and Control			
Between groups	274		
Composite beliefs	1	1250.43	20.10***
Error of variance	273	62.20	
Treatment and Control			
Between groups	274		
Belief	1	393.51	18.06***
Error of variance	273	21.79	
Treatment and Control			
Between groups			
Self-confidence		241.00	5.71*
Error variance		42.17	

*$p < .05$

***$p < .001$

Three sub-hypotheses were developed and tested in relationship to the sixth question. A one-way analysis of variance is reported for each of the three sub-hypotheses.

Hypothesis 6. There is no significant difference at t_2 between the combined treatment and the combined control group in the students':

a. self-sufficiency

b. productivity

c. adaptability

The findings of the analyses are illustrated in Table 7. All three factors are significant. Therefore, null hypothesis 6 was rejected.

Table 7. One-way Analysis of Variance for Class Performance between Combined Treatment Group and the Combined Control Group at t_2.

Source of Variation	d. f.	MS	F
Treatment and Control			
Between groups	274		
Self-sufficiency	1	283.16	45.76***
Error variance	273	6.19	
Treatment and Control			
Between groups	274		
Productivity	1	106.55	25.98***
Error variance	273	4.10	
Treatment and Control			
Between groups	274		
Adaptability	1	73.25	20.38***
Error variance	273	3.59	

*** $p < .001$

Two sub-hypotheses were developed and tested in relationship to the seventh question. A Pearson Product-Moment Correlation Coefficient statistic is reported for two separate analyses.

Hypothesis 7. There is no significant relationship at t_2 in the students' composite beliefs about the problem solving process and class performance within the combined:

a. treatment group.

b. control group.

The results of these analyses are shown in Table 8. Null hypothesis 7 was rejected because a significant relationship existed for factors.

Six sub-hypotheses were developed and tested in relationship to the eighth question. A Pearson Product-Moment correlation coefficient statistical analysis is reported for each sub-hypothesis.

Hypothesis 8. There is no significant relationship at t_2 in the students':

a. composite beliefs about the problem solving process and their belief about the nature of the problem solving process within the combined treatment group.

b. composite beliefs about the problem solving process and their belief about the nature of the

Table 8. Pearson Product-Moment Correlation Coefficients to Assess the Relationship for the Students' Composite Beliefs about the Problem Solving Process and Class Performance within Both the Combined Treatment and Control Groups at t_2.

Group	Category	Mean	Standard Deviation	r	t
Treatment	Composite beliefs	111.72	7.65	0.361**	4.511
	Self-sufficiency	10.96	1.97		
	Composite beliefs	111.72	7.65	0.399**	5.069
	Productivity	10.44	1.92		
	Composite beliefs	111.72	7.65	0.397**	5.041
	Adaptability	10.59	1.86		
Control	Composite beliefs	107.46	8.12	0.464**	6.081
	Self-sufficiency	8.93	2.92		
	Composite beliefs	107.46	8.12	0.580**	8.273
	Productivity	9.20	2.12		
	Composite beliefs	107.46	8.12	0.545**	7.560
	Adaptability	9.55	1.94		

** $p < .01$

problem solving process within the combined control group.

c. composite beliefs about the problem solving process and their self-confidence in undertaking problem solving activities within the combined treatment group.

d. composite beliefs about the problem solving process and their self-confidence in undertaking problem solving activities within the combined control group.

e. belief about the nature of the problem solving process and self-confidence in undertaking problem solving activities within the combined treatment group.

f. belief about the nature of the problem solving process and self-confidence in undertaking problem solving activities within the combined control group.

The results of these analyses are shown in Table 9. The implications drawn indicate a significant relationship in all sub-hypotheses except (e) and (f). Therefore, the null hypothesis was rejected.

Six sub-hypotheses were developed and tested in relationship to the ninth question. A Pearson Product-Moment correlation coefficient

Table 9. Pearson Product-Moment Correlation Coefficient to Assess Relationship of Beliefs about the Problem Solving Process within the Combined Treatment and Control Groups at t_2.

Group	Category	Mean	Standard Deviation	r	t
Treatment	Composite beliefs	111.72	7.64	0.694**	11.250
	Belief	55.23	4.78		
	Composite beliefs	111.72	7.65	0.783**	14.686
	Self-confidence	56.49	5.53		
	Belief	55.23	4.78	0.096 ns	1.127
	Self-confidence	56.49	5.53		
Control	Composite beliefs	107.46	8.12	0.444**	5.755
	Belief	52.84	4.55		
	Composite beliefs	107.46	8.12	0.831**	17.363
	Self-confidence	54.84	7.34		
	Belief	52.84	4.55	-0.129 ns	-1.517
	Self-confidence	54.62	7.34		

** $p < .01$

statistical analysis is reported for each of the six sub-hypotheses.

Hypothesis 9. There is no significant relationship at t_2 in the students':

a. self-sufficiency and productivity within the combined treatment group.

b. self-sufficiency and productivity within the combined control group.

c. self-sufficiency and adaptability within the combined treatment group.

d. self-sufficiency and adaptability within the combined control group.

e. adaptability and productivity within the combined treatment group.

f. adaptability and productivity within the combined control group.

The results of these analyses are shown in Table 10. The implications drawn indicate a significant relationship in all sub-hypotheses. Therefore, null hypothesis 9 is rejected.

Data Summary

The following summary was drawn from the data obtained in this study.

Table 10. Pearson Product-Moment Correlation Coefficient to Assess Relationship of Class Performance within the Combined Treatment Group and the Combined Control Group at t_2.

Group	Category	Mean	Standard Deviation	r	t
Treatment	Self-sufficiency	10.96	1.97	0.684**	10.937
	Productivity	10.44	1.92		
	Self-sufficiency	10.96	1.97	0.774**	14.256
	Adaptability	10.59	1.86		
	Productivity	10.44	1.92	0.821**	16.794
	Adaptability	10.59	1.86		
Control	Self-sufficiency	8.93	2.92	0.618**	9.138
	Productivity	9.20	2.12		
	Self-sufficiency	8.93	2.92	0.602**	8.752
	Adaptability	9.55	1.94		
	Productivity	9.20	2.12	0.717**	11.949
	Adaptability	9.55	1.94		

** $p < .01$

1. There was no difference between the treatment and the control group in the students' beliefs about the problem solving process at t_1.
2. There was a relationship within the treatment and within the control group in the students' composite beliefs about the problem solving process to the individual factors making up this belief structure at t_1. However, within the treatment group there was no relationship between belief and self-sufficiency.
3. There was no difference in the students' composite beliefs about the problem solving process at t_2 as a result of the t_1 procedures within either the treatment or the control group.
4. There was a difference in students' beliefs about the problem solving process within the treatment group from t_1 to t_2. However, within the control group there was no difference in students' beliefs about the problem solving process from t_1 to t_2.
5. There was a difference in the students' beliefs about the problem solving process between the combined treatment and the combined control group in regard to all factors at t_2.
6. There was a difference in the students' class performance between the combined treatment group and the combined control group in regard to all factors at t_2.

7. There was a significant relationship in the students' beliefs about the problem solving process and class performance within the combined treatment group and within the combined control group in regard to composite beliefs about the problem solving process and each factor of class performance at t_2.
8. There was a significant relationship within the combined treatment group and the combined control group in regard to students' composite beliefs about the problem solving process and the factor of belief about the nature of problem solving and the factor of self-confidence in undertaking problem solving activities. However, the two factors themselves are not significantly related within the treatment group or the combined control group at t_2.
9. There was a significant relationship at t_2 in the students' class performance within the combined treatment group and within the combined control group.

V. SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

This study was designed to determine whether beliefs about the problem solving process and class performance for junior high school industrial arts education students were altered by participation in the project Occupational Versatility. The following section offers a critical evaluation of this study. However, before any generalization can be made, consideration must be given to the study limitations and the rather narrow approach this study has taken.

Hypothesis 1 stated there was no difference between the treatment and control groups prior to the experiment; this hypothesis was accepted. This substantiated the experimental design procedures which identified similarities of socio-economic background and verified statistically that no significant difference existed on a portion of the Lorge Thorndike Aptitude Test in Arithmetic given at the seventh grade level. With known data to substantiate similarities of group, acceptance of this hypothesis supports the reliability of the problem solving instrument.

The second hypothesis stated that no relationship would exist between the problem solving factors within either group at t_1. This hypothesis was rejected because correlation did exist. A high correlation was obtained between composite beliefs and self-confidence

within both t_1 groups. However, a moderate correlation existed between composite beliefs and beliefs within both groups and a low correlation was obtained within RGp_3 for belief and self-confidence, RGp_1 had a nonsignificant correlation on these same factors. Mean scores should be noted at this time for establishment of shift in direction.

The third hypothesis stated that no significant difference would exist within the treatment group or the control group at t_2. This hypothesis was used to establish that t_1 procedures had no influence upon the t_1 groups. This hypothesis was accepted because there was no significant difference within the groups.

Hypothesis 4 stated that no significant difference would exist within either the t_1 treatment or t_1 control group from t_1 to t_2 in regard to problem solving beliefs. The hypothesis was rejected because a significant difference did exist within the treatment group. However, there was no significant difference within the t_1 control group. This is the major hypothesis of the study, as this substantiates within the study limitations that participation in Occupational Versatility caused the students to change. The direction of change needs to be determined. The t_1 mean score was 103.80 for composite beliefs, 51.04 for belief and 52.75 for self-confidence; whereas, the t_2 scores were composite 111.67, belief 55.23 and self-confidence 56.43. Therefore, the significance is in the direction of change, positive to t_2.

The investigator attempted to apply as many variables as possible including selecting adjoining schools, all eighth grade boys with no previous industrial arts experience, curricula, standard test scores of no significant difference and similar socio-economic characteristics. One variable, however, which could not be readily equated for the two groups was the teacher variable. Therefore, the possibility that an error entered into the study due to the teacher variable was perhaps possible.

Hypothesis 5 stated no significant difference would exist between the combined treatment and control groups at t_2 in regard to problem solving beliefs. This hypothesis was rejected because significance was obtained. The total experimental population was used in this hypothesis. Hypotheses 4 and 5 are extremely important to the study. Four establishes a significant difference for the groups that received everything and 5 clarifies significant difference for the total population. Again this difference is in favor of the treatment group which participated in Occupational Versatility.

Hypothesis 6 stated no significant difference would exist at t_2 in regard to class performance between combined treatment and control group. The hypothesis was rejected because a substantial significance existed. This factor was established by evaluators who obviously knew they were in the treatment school; however, there were three different evaluators establishing class performance. Although this may have

compounded the factor of experimental bias, class performance was assessed on a rather specific scale that called for a specific rating.

Hypotheses 7, 8 and 9 dealt with relationships of all factors of problem solving and class performance within the combined treatment and control groups, stating that no significant difference would exist in any combination of relationships. All three hypotheses were, therefore, rejected because a significant relationship did exist to some degree in all situations. Within each group, beliefs were moderately correlated with class performance. One observation that should be made is that mean scores within the treatment group were higher in both cases of beliefs and class performance than those scored in both cases for the control group. This factor could lead to correlations within both groups that would be predictors of possible relationships. Perhaps the traditional program offers some success in beliefs when related to specific class performance. Beliefs within both the treatment and control group had high correlation with self-confidence. However, beliefs and belief were moderately related; whereas, belief and self-confidence were not related in either situation. The implication indicates a high self-confidence but low belief in undertaking problem solving activities.

Class performance factors had a high relationship within the treatment group and a moderate relationship within the control group. Adaptability and productivity were highly related in both situations,

indicating that the traditional as well as the innovative program might have strength in developing adaptable as well as productive students. One takes the chance of overpredicting possible success in this type of situation.

Conclusions

The following conclusions were drawn from the data obtained in this study.

1. There was a difference in students' beliefs about the problem solving process within the treatment group, from t_1 to t_2, as a result of participation in Occupational Versatility.
2. There was a difference in the students' beliefs about the problem solving process between the combined treatment and the combined control group in all factors. This shift in beliefs about problem solving was attributed to the treatment group's participation in project Occupational Versatility.
3. There was a difference in the students' class performance between the combined treatment group and the combined control group at t_2. Each factor within class performance had a significant difference, that is, self-sufficiency, productivity and adaptability.
4. There was a significant relationship in the students' beliefs about the problem solving process and class performance

within the combined treatment group in regard to composite beliefs about the problem solving process and each factor of class performance. However, within the combined control group there was less relationship in regard to composite beliefs about the problem solving process and each factor within class performance at t_2.

5. There was a significant relationship within the combined treatment group in regard to students' composite beliefs about the problem solving process and the factor of belief about the nature of problem solving and the factor of self-confidence in undertaking problem solving activities. However, the two factors themselves are not significantly related within the treatment group nor the combined control group. There is a significant relationship within the combined control group in regard to composite beliefs about problem solving and belief about the nature of the problem solving process and self-confidence in undertaking problem solving activities at t_2.

6. There was a significant relationship at t_2 in the students' class performance within the combined treatment group and within the combined control group. The factors of self-sufficiency, productivity and adaptability are related extensively within the combined treatment group. However,

within the combined control group, these factors are not as highly related.

Recommendations

On the basis of the findings and conclusions drawn in this study, it is recommended that a realistic problem solving ability instrument be developed based upon the four technology approach of power, electricity, materials processes and graphic communications. This performance test should be basic and general to all four areas and should be developed to be utilized in the assessment of problem solving ability of junior high school students.

A follow-up study should be made of those students who participated in both the treatment and control groups in relationship to grades attained in a senior high school industrial arts education program. The findings of this study could be utilized by the various districts that might be involved in the implementation of Occupational Versatility to direct and facilitate implementation.

A replication of this study should be conducted using a larger population with similar socio-economic, aptitude and achievement test scores. They should be located basically in the same geographical area or within proximity of the Puget Sound area in the state of Washington.

Additional research is recommended to ascertain the actual relative effectiveness of assessing the composite beliefs about the problem solving process and actual problem solving activity or ability as determined by a valid and reliable instrument specific to industrial arts education. It is also recommended that additional research be conducted to ascertain the correlation between the students' composite beliefs about the problem solving process and 1) teacher grades and 2) achievement test score ratings.

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APPENDICES

APPENDIX A

The attached Childhood Attitude Inventory for Problem Solving is keyed and scaled according to the degree of self-confidence and beliefs about the nature of the problem solving process, as indicated.

KEY

Beliefs						Self-concept					
1.	1	2	3	4	5	2.	1	2	3	4	5
3.	5	4	3	2	1	4.	1	2	3	4	5
5.	1	2	3	4	5	6.	5	4	3	2	1
7.	5	4	3	2	1	8.	5	4	3	2	1
9.	1	2	3	4	5	10.	5	4	3	2	1
11.	5	4	3	2	1	12.	1	2	3	4	5
13.	5	4	3	2	1	14.	1	2	3	4	5
15.	1	2	3	4	5	16.	1	2	3	4	5
17.	5	4	3	2	1	18.	1	2	3	4	5
19.	5	4	3	2	1	20.	5	4	3	2	1
21.	5	4	3	2	1	22.	5	4	3	2	1
23.	1	2	3	4	5	24.	1	2	3	4	5
25.	1	2	3	4	5	26.	1	2	3	4	5
27.	5	4	3	2	1	28.	5	4	3	2	1
29.	1	2	3	4	5	30.	1	2	3	4	5
31.	1	2	3	4	5	32.	5	4	3	2	1
33.	5	4	3	2	1	34.	5	4	3	2	1

Listed below are various statements that students sometimes make about school, about thinking, and about themselves. You may find that you agree with a statement or even strongly agree with it. Or you may disagree or strongly disagree. Or sometimes you may be undecided whether you agree or disagree.

Read each statement carefully and then draw a cross (X) through one of the symbols in front of it. This is what the symbols mean:

SA means you strongly agree

A means you agree

? means you are undecided

D means you disagree

SD means you strongly disagree

SA	A	?	D	SD	1. Most problems have only one good way to be solved.
SA	A	?	D	SD	2. I often make up my mind too quickly about the answer to a problem.
SA	A	?	D	SD	3. There is not enough work in school that makes you think up ideas of your own.
SA	A	?	D	SD	4. When I don't understand something in class, I avoid asking questions about it.
SA	A	?	D	SD	5. Ideas that don't solve the problem can't help to put you on the right track.
SA	A	?	D	SD	6. I like science and mathematics.
SA	A	?	D	SD	7. Students like the kinds of problems that nobody, presently in class, knows the answer to.
SA	A	?	D	SD	8. My ideas for solving problems are about as good as those given by others in the class.
SA	A	?	D	SD	9. History is mostly just learning facts; you don't have to think things through for yourself when you study history.
SA	A	?	D	SD	10. When I'm trying to solve a problem, I often know how to get started on it.
SA	A	?	D	SD	11. Some students are just naturally poorer thinkers than others.
SA	A	?	D	SD	12. Most of the students in my class are better at solving problems than I am.
SA	A	?	D	SD	13. Students are eager to learn.
SA	A	?	D	SD	14. When I am working on a problem, I usually like to get my ideas from other students.
SA	A	?	D	SD	15. If you don't have any good ideas after working a while on a problem, you are not likely to get any that will work.

SA A ? D SD 16. When I work on problems, I often find I haven't paid attention to some important fact.

SA A ? D SD 17. Students often make the same kind of mistakes over and over again in solving problems.

SA A ? D SD 18. I would usually rather work on problems I know I can solve than on ones that may be too hard for me.

SA A ? D SD 19. Students like to work on problems like mysteries and puzzles that make them think.

SA A ? D SD 20. I usually don't get rattled and confused when I am trying to think.

SA A ? D SD 21. Problems are fair if they make you keep looking for new ideas in order to solve them.

SA A ? D SD 22. I am less interested in getting the right answer than in knowing how to get it.

SA A ? D SD 23. When you are working on a problem it is best to keep away from poor ideas because they may throw you off the right track.

SA A ? D SD 24. I often keep my ideas to myself because I think others may laugh at them.

SA A ? D SD 25. It is best to make very sure that an idea is a good one before suggesting it to the class.

SA A ? D SD 26. I often have an idea for an answer which I don't tell because I am afraid it may be wrong.

SA A ? D SD 27. Students like problems where they aren't told just exactly what the problem is.

SA A ? D SD 28. I am able to get unusual ideas--ideas that the other students don't often think of.

SA A ? D SD 29. Ideas just seem to "come to you"; there isn't any way of learning how to get more ideas.

SA A ? D SD 30. My ideas and suggestions are often not taken seriously by anyone in class.

SA A ? D SD 31. Students usually find it hard to decide whether an idea is a good one or not.

SA A ? D SD 32. I am very curious about unexplained things around me and want to try to understand them.

SA A ? D SD 33. Students like the kinds of problems that have more than one right answer.

SA A ? D SD 34. I think I have the makings of a really creative thinker.

APPENDIX B

STUDENT PERFORMANCE OBSERVATION SHEET

Student _____

Instructor _____

School _____

Evaluator _____

The above named student is judged by mutual teacher and evaluator agreement in regard to student performance for the following three abilities.

Please place a cross (X) under the appropriate scale.

	1 Poor	2 Fair	3 Average	4 Good	5 Excellent
Self-sufficient - The student has initiated and carried through to satisfaction of of self and instructor, a project of his own choosing.					
Productive - The student has increased his efficiency in operation in the industrial arts facility as indicated by a decreasing amount of time spent on non productive activities and a decreased number of requests for assistance.					
Adaptable - The student more readily accepts changes and deterents as indicated by a decreasing of waiting time between various task performance and a decrease in the number of requests for direction.					