A COMPARISON OF SELECTED INDUSTRIAL TRADES TO DETERMINE THE RELATIONSHIP BETWEEN PSYCHOMOTOR OBJECTIVES AND THE COGNITIVE SKILLS NECESSARY FOR THEIR ACCOMPLISHMENT

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CHAPTER I

INTRODUCTION

As vocational educators look expectantly toward competency-based instruction to cope with the demands of expanding technology, more and more teachers of industrial trades in both secondary and adult training programs are recruited from jobs in industry. Many of these persons learned on the job; and because they tend to teach as they were taught, the development of a responsive training program is extremely slow, with methodology based on the uncertain whims of the individual novice teacher and his natural aptitude (or lack of aptitude) for teaching.

Teacher education programs do an excellent job in pursuit of their goal to ensure the professional development of the vocational teacher to his maximum potential. Nonetheless, the role-change for the novice from industry to teaching is rather abrupt--and, combined with an innate resistance to new ideas and concepts, normally results in a time-lag of two years or more before a satisfactory level of program effectiveness is realized.

Frequently, beginning teachers are plagued with frustrations of their own creation as they attempt to operate production-type shops with inexperienced students. They avoid the use of planning strategies and unfamiliar media and methods that are necessary for learning transfer and enhancement, simply because they do not know why or how. And the poor teaching habits they acquire are difficult to change.

All too often, the novice is led to believe (or he believes of his own accord) that his trade competency automatically makes him a teacher of that trade. And, of course, a high degree of proficiency in his trade is essential for the vocational teacher. However, competency in the trade offers no assurance whatever that he can impart his skills to others. Faced with the threat of educational technology, he compares its limitations with his own strengths, ignoring the fact that effective teaching requires the best of both. So, he complacently plods along, secure in the belief that trade competency is all that is necessary in his new role.

Development of a teaching style compatible with learners' needs is gradual. It is only after two or three years and several education courses that the novice begins to apply effective methods and media. Much time is wasted during these beginning years simply because too many educators believe that educational technology is necessary only in the refinement of the teacher--not a preservice requirement. But if teacher education programs are to keep pace with technological advancements in the vocational trades, teachers must learn to use the tools of education early in their teaching careers. In short, survival skills training must prepare the beginning teacher to establish a student-centered learning environment.

In order to ensure such an environment, methodology should be compatible with training objectives. Performance is measurable, but, to accomplish an objective, the student must learn in all three domains: cognitive, affective, and psychomotor. Since vocational trades differ widely in the types of tasks required for employability (a diversity that exists even within a trade), the establishment of the relationships between the various domains in order to categorize motor tasks would aid in the identification of performance objectives, in the selection of teaching content and, ultimately, in the choice of media and methodology.

The Problem

Many researchers and other authorities have addressed the question of identifying teacher competencies. Lists of competencies have been prepared and validated, with common competencies identified. However, available research makes no distinction to the extent that certain teaching methods might best meet learners' needs for the accomplishment of a particular type of performance objective; that other methods may be compatible with other types of tasks; nor that any motor objectives require cognition in the higher "synthesis" and "evaluation" levels. Competencies are grouped under one heading: "Vocational." Lists of teaching competencies and rank-order-importance of methods, then, are of little functional use to educators.

Diverse types of motor tasks involve thought processes that encompass various levels of cognition for their attainment. Although, educators readily admit the obvious differences between trades and between the types of operations within a given trade, the paucity of research to establish the relationships between the three domains of learning suggests a need for further study. A system for categorizing psychomotor objectives based on skills in either the cognitive or affective domains was not found by this investigator. Such a system would be extremely helpful in the development of curriculum as well as an aid in the selection of learning activities.

Purpose of Study

The major purpose of this study was to identify similarities and differences in four industrial trades: Automotive Mechanics, Welding, Machine Shop, and Refrigeration-Air Conditioning; and to establish the relationships between psychomotor and cognitive skills in the selected trades.

Results of the study provides evidence of value to curriculum writers, teachers, supervisors, and teacher educators for the planning and development of training programs in the selected trades, as well as in other trades involving similar skills.

Objectives of the Study

The following objectives were formulated in order to deal with the purpose:

1. Identify the types of tasks (operations) performed in the four selected trades.
2. Establish the percentage of time a learner should normally spend in the performance of each type of task in each trade.
3. Establish the rank-order of importance of each type of task to each of the selected trades.
4. Identify the cognitive skills the learner must attain in order to accomplish motor objectives required for each type of task.
5. Analyze data obtained in order to compare the selected trades for similarities and differences, and to establish the correlation between cognitive and motor skills.

Scope and Limitations of the Study

The study was limited to the identification of types of motor tasks and the establishment of the relationships of cognitive skills to these same types of tasks. Factors involving the affective domain were not included, since this investigator believed that such evidence should entail additional studies. The study was limited to the four trades identified previously. However, these trades offer a broad range in the types of tasks performed, and findings may be of value in the development of programs for other trades that involve similar skills.

Data for this study were obtained by the use of a questionnaire. To ensure broad diversity in previous trade and teaching experience of the respondents, the instrument was administered to a panel of experts made up of curriculum specialists and state supervisory personnel, to participants in program planning workshops, to trade teachers in Skills Centers and other Manpower Training Programs, and to trade teachers in Area Vocational-Technical Schools in Oklahoma.

The internal validity of the study was limited by how specifically the respondents ranked the required frequency and importance of the various types of tasks, and by how discriminative they were in identifying the level of cognition necessary for the accomplishment of psychomotor objectives for each task category.

Assumptions

It was assumed that curriculum specialists and state level supervisory personnel had the necessary training and experience to qualify them to identify the types of tasks performed in a trade, specify performance time percentages and priorities, and establish the level of cognition required for the accomplishment of motor tasks.

It was further assumed that teachers who have met the qualification requirements for employment have had adequate experience and exposure in a trade to enable them to correctly identify the information and specifics requested on the data collection instrument.

Definition of Terms

The following definitions have been adapted for this study.

Learning domains are the so-called spheres of influence in which change occurs when information and/or skills are learned. The cognitive domain deals with the knowledge area; the psychomotor domain deals with physical activity (i.e., motor or manipulative skills); and the affective domain is the sphere which involves the learner's emotions.

The taxonomy of educational objectives is a hierarchy established by Bloom (2) and others for objectives in the cognitive domain. Six cognitive levels were designated as follows: (1) Knowledge, (2) Comprehension, (3) Application, (4) Analysis, (5) Synthesis, and (6) Evaluation.

Task categories (also types of tasks) are psychomotor objectives that require similar physical movements, manual dexterity, coordination, and/or similar levels of cognition.

Trade characteristics are distinguishing traits or features of a particular trade, such as the types of motor tasks performed and the related cognitive skills required, which make the trade unique.

Competency-based vocational education (CBVE) is vocational training which ensures that the learner can perform at a given level.

Skills Centers are vocational training schools which were set up under the Manpower Development and Training Act (MDTA), and were continued under the Comprehensive Employment Training Act (CETA), primarily to prepare disadvantaged adults for entry level employment. Programs are open-entry/open-exit in design, and offer individualized instruction.

Inmate Training Centers are vocational training schools operated under the direction of the State Department of Vocational-Technical Education, located at Lexington, Hodgens, McLeod, and Granite, Oklahoma. Programs in the inmate centers are similar to those of the skills centers.

CHAPTER II

REVIEW OF LITERATURE

Introduction

Since the roles of those involved in teacher education, curriculum development, and vocational teaching are changing in the face of expanding technology, research into the characteristics of various vocational trades will aid in the identification of relevant objectives, selection of content, and the choice of methodology. This chapter deals with a review of literature and a discussion of a theoretical framework for the study.

Previous Research

In an attempt to gain information from previous studies, the researcher reviewed and analyzed research reports completed by Penner (12), Brown (4), Banks (1), DeVaughan (8), Simpson (13), and others.

Penner's (12) study dealt with teachers of adults, a population which corresponds closely with the skills center and inmate center teachers who comprised a large portion of the respondents sampled in this study. Penner apparently identified 30 effective vocational teacher characteristics in that none of 30 items submitted to three respondent groups (administrators, teachers, and students) was rejected by any group as falling below the 3.50 cut off point on a scale of 0 to 5 points. Penner found that administrators and students ranked items dealing with "teaching and/or learning aids" and "the learning environment" higher than did the teacher-respondents. Differences in these rankings may indicate that adult students are more aware of the effectiveness of learning aids than are many of their teachers; and that administrators, who normally have had several teacher education courses, place greater importance on the use of educational technology than do those teachers who have had little or no teacher training.

Brown (4) conducted a study to determine whether aptitude, academic achievement, previous education, chronological age, racial/ethnic origin, and rural/urban background were significant in predicting retention in a training program. Brown concluded that only chronological age and level of previous educational exposure are influential in predicting retention and that, in all probability, the training program design will influence success more than either aptitude or achievement levels. He strongly recommended a research study be made to investigate instructional methodology as a retention factor.

Banks (1) used Penner's (12) questionnaire with slight modifications to compare certain identified teaching success characteristics of adult vocational teachers with their attitude inventory scores determined by the Minnesota Teacher Attitude Inventory (MTAI). Although the study revealed no significant correlation between the two instruments, comments from student-respondents indicated that adult students need and want individual help and concern from the vocational teacher.

DeVaughan (8) identified 87 of the 92 competencies listed on his instrument as being rated 3.00 or higher, on a scale of 1 to 5, by three respondent groups (administrators, vocational teachers, and secondary vocational students). DeVaughan's student-respondents rated "use a multiple of audio visuals" at the 4.00 (very important) level on the 1 to 5 scale, while teacher-respondents rated the same item at 3.00 (important). Again, as in Penner's (12) study, DeVaughan indicated that students apparently are aware that their learning is enhanced by the use of a variety of media and methodology.

Simpson (13) conducted a study to design a classification system for educational objectives in the psychomotor domain. In her problem statement, she suggested that vocational-technical jobs require a high degree of ability and skill in the psychomotor domain, as well as in the cognitive and affective areas. She also suggested that a classification system for the psychomotor domain would have all of the advantages of the classification systems for the other two domains, and that it can serve as a valuable tool for curriculum writers and researchers. Following is a brief outline of the system levels in a schema Simpson developed for the classification of psychomotor objectives which she stated should be considered tentative, flexible, and incomplete.

1. Perception
2. Set
3. Guided Response
4. Mechanism
5. Complex Overt Response

Simpson (13) suggested a sixth category as a possibility, which she designated as "Adapting and Originating." Her conclusions and recommendations included the following:

> Our next major step is that of providing for trial of the schema in many situations and revising it in light of the trials. Another important step that should be taken is that of looking critically at the relationships among the three domains. It is readily apparent that they are closely related and that a single educational objective might have a particular significance in one domain and another in another domain. For example, at the mental set level in performing a motor act, knowledge is required; hence, an objective that "fits" this level would also fit into the cognitive domain and could be classified here. Much work is needed in studying the psychomotor domain and its relationships to the other two. What has been presented here is only a beginning (p. 18).

Bloom et al (2) established a hierarchy of six levels for the cognitive domain. An outline of the system levels follows:

1. Knowledge: Recognition and Recall--ability to remember facts in a form close to the way they were first presented.
2. Comprehension: Grasping the meaning and intent of information or the ability to tell or translate in one's own words.
3. Application: Use of information--the ability to apply learning to new situations and real-life circumstances.
4. Analysis: Reasoning--ability to break down information into component parts and to detect relationships of one part to another and to the whole.
5. Synthesis: Originality and creativity--ability to assemble separate parts to form a new whole.
6. Evaluation: Criteria or standards for evaluation and judgment--ability to make judgments based on criteria or standards.

Bloom's (2) hierarchy ranges from the lower elementary cognitive levels to the higher abstract cognitive process. Achievement at a particular level automatically requires functioning at the lower cognitive levels.

Curriculum and Teacher Training

Kneller (11) discusses curricula and methodology from a philosophical base, stressing the importance of a fresh, objective approach:

> We must look afresh at the way in which our curricula are drawn up, the subjects they contain, the methods that are used, the structure of administration, and the ways in which teachers are trained. These must then be reconstructed in accordance with a unified theory of human nature, rationally and scientifically derived. It follows that we must construct a curriculum whose subjects and subdivisions are related integrally rather than treated as a sequence of knowledge components (p. 65).

Kneller (11) also mentions sequencing, and cautions against allowing an untrained person to dictate the order of presentation:

> The logical presentation of subject matter is based on the theory that logical order already is built into it.
>
> Those who hold this theory are confident that if a student masters knowledge in this fashion, he will automatically think logically.....It is folly, they say, to allow an untrained, unordered mind to dictate what the order of subject matter should be or how it should be learned (p. 89).

In a discussion of teaching methods, Kneller (11) criticized those who have a preference for a particular method and emphasized that teaching should ensure learning.

> Thus, when we construe teaching as a system of actions intended to induce learning, and analyze the model of the teaching process based on it, we emerge with an objective approach to the study of teaching. Where previously research into the effectiveness of teaching methods has proceeded from definitions of teaching that reflects a preference for one method or another, the findings being inconclusive, we now see the actions of the teacher as they

> really are, relatively undistorted by our preconceptions. Thus we are, or should be, able to assess more accurately the strengths and weaknesses of different teaching methods (p. 97).

Evans and Terry (6) believe that differences and similarities exist in the competencies required in occupations, and that vocational educators should be leaders in the area of occupational change:

> It should be noted that no distinction has been made among the roles of instructors in the various vocational fields. No doubt differences in the specific competencies associated with occupational differences exist, just as they do within the several fields. But many of the other specific competencies related to the instructional process are undoubtedly very similar, if not the same. These similarities and differences are important in determining the organizational arrangements for providing preservice teacher education (p. 54).
>
> The acceptance of new practices in an occupation is gradual. Innovators may adopt a new material, process, or service twenty years or more before it is accepted everywhere. Neither the knowledge in new practices nor the skill of the vocational educator can follow the adoption of new procedures by the entire occupation; he or she must be, instead, on the "cutting edge" of change. This allows the vocational graduate to be ahead of the generality of occupational practice (p. 67).

Analysis of Learning Theories

Combs et al (7), in a discussion of the perceptual field, emphasized a number of important factors in the learning process: individual differences in learners, cognitive dissonance, continuity of information, understanding of content, and the selective effect of need in the individual.

> The need of the organism to maintain and enhance its organization produces a field of meaning with a high degree of stability in which new meanings are interpreted in light of what has gone before. In this way a selective effect is imposed upon new experience which could result in vastly enriching the field. On the other hand, existing meanings may have the effect of restricting possibilities by denying or distorting meanings antagonistic to those already in existence or, by focusing attention on the further development

> of existing meanings, they may produce such preoccupation as to preclude paying attention to a wider field of events (pp. 259-260).

Hall (10) offers strong arguments to support his contention that one's cultural background influences the way he learns, and that, once people have learned to learn in a given way, it is difficult to learn in any other way. He continues as follows:

> The educator has so much to learn about his own system of learning by immersing himself in those that are so different that they raise questions that have never been raised before. Americans in particular have too long assumed that the U.S. educational system represents the ultimate in evolution and that other systems are less advanced than our own. Even the highly elaborated and beautifully adapted educational techniques of Japan have been looked down upon. Just why we feel so complacent and smug can be explained only by the blindness that culture imposes on its members. Certainly there is very little reason for complacency when one looks, not at others, but at ourselves. The fact that so many of our children dislike school or finish their schooling uneducated suggests that we still have much to learn about learning as a process (p. 54).

Hall (10) places learning into three categories: (1) Formal Activities, taught by precept and admonition, (2) Informal Learning, taught with a model used for imitation, and (3) Technical Learning, transmitted in explicit terms from the teacher to the student. He discusses technical awareness in this manner:

> While all technical behavior has in it some of the formal as well as the informal, it is characterized by the fact that it is fully conscious behavior. Its very explicitness and the fact that it can be written down and recorded and even taught at a distance differentiates it from the other two types of integration. The very essence of the technical is that it is on the highest level of consciousness (p. 74).

According to Bruner (5), grasping the structure of a subject is understanding it in a way that permits many other things to be related to it meaningfully. He discussed structure as follows:

> The teaching and learning of structure, rather than simply the mastery of facts and techniques, is at the center of the classic problem of transfer.
>
> Given the importance of this theme, much too little is known about how to teach fundamental structure effectively or how to provide learning conditions that foster it (p. 12).
>
> By constantly reexamining material taught in elementary and secondary schools for its fundamental character, one is able to narrow the gap between advanced knowledge and elementary knowledge (p. 26).

Bruner stated that the teaching of fundamentals gives a greater breadth of applicability to new problems and emphasized two ways in which learning serves the future:

> One is through its specific applicability to tasks that are highly similar to those we originally learned to perform. Psychologists refer to this phenomenon as specific transfer of training; perhaps it should be called the extension of habits and associations.....A second way in which earlier learning renders later performance more efficient is through what is conveniently called nonspecific transfer or, more accurately, the transfer of principles and attitudes. In essence, it consists of learning initially not a skill but a general idea, which can then be used as a basis for recognizing subsequent problems as special cases of the idea originally mastered. This type of transfer is at the heart of the educational process--the continual broadening and deepening of knowledge in terms of basic and general ideas (p. 17).

According to Bruner (5), much additional effort in the actual preparation of curriculum materials, in teacher training, and in supporting research will be necessary if improvements in our educational practices are to be of an order that will meet the challenges of the scientific and social revolution through which we are now living. His discussion of the failure of a learner to be able to remember discrete items of information follows.

> It also seems reasonable that the more one has a sense of the structure of a subject, the more densely packed and longer a learning episode one can get through without fatigue. Indeed, the amount of new information in any learning episode is

> really the amount that we cannot quite fit into place at once. And there is a severe limit .....on how much of such unassimilated information we can keep in mind. The estimate is that adults can handle about seven independent items of information at a time. No norms are available for children--a deplorable lack (pp. 51-52).

The Structure of Trades

Curricula for the four trades selected for this study, developed by MAVCC and CIMC, State of Oklahoma (15), reveal indications in support of the structure of information and tasks emphasized by Bruner (5). Several distinctive differences in the types of tasks (operations) performed in the various trades are evident. For example, auto mechanics objectives specify a high number of disassembly and assembly operations, and reflect the need for testing, measuring, analysis, and diagnosis procedures. Similar types of tasks are performed in the refrigeration-air conditioning trade, with the possibility of an even greater emphasis in the testing-diagnosis area. On the other hand, welding shows a high predominance of a repetitive type of tasks, which requires extensive practice in order to build proficiency. Welding also requires a large number of cutting operations. Machine shop operations are predominantly of the cutting type, yet they differ a great deal from those of the welding trade, with extremely close tolerances evident in the machine shop trade.

Fryklund (9) assigns operations into four categories: (1) Depicting, (2) Forming, bending, twisting, (3) Cutting away, and (4) Assembly and Disassembly. Although these four categories "type" many of the tasks performed in industrial trades, obviously some trades require testing, measuring, analyzing, diagnosing, and interpreting diagrams or blueprints--none of which "fit" the four categories listed.

Briggs (3), in a paper on competency-based vocational teacher education, stated that "competency" usually implies more than performance alone, and is the developed ability to perform at a given level, with implications for both process and product. In an illustration on the development of performance objectives, he used a work sheet to list the competencies required for the performance of an objective. Competencies were given for all three domains of learning: cognitive, affective, and psychomotor. Also listed were the fundamental skills the learner should acquire prior to an attempt to accomplish the new objective. This approach supports the theories concerning structure and the necessity for teaching fundamental skills presented by Bruner (5).

Summary

The reports of research and related investigations indicate a paucity of evidence directly related to the problem of this study. Most of the studies reviewed dealt with the characteristics of teachers and teacher competencies rather than trade characteristics and the domains of learning. Nonetheless, their conclusions and recommendations offer evidence in support of the need for a study of this type.

The report by Simpson (13) recommended that much work is needed in studying the psychomotor domain and its relationship to the other two. And this recommendation was made despite the fact that her study clearly attempted to classify psychomotor objectives as completely discrete elements.

Evans and Terry (6), Hall (10), and Kneller (11) strongly encouraged revamping teacher education with changes in curriculum design, and a more objective approach to methods of teaching.

Combs et al (7) discussed the perceptual field and offered many ideas to assist the teacher in his (her) role as a member of the "helping professions," with emphasis on the needs of the individual learner.

Fryklund (9) categorized industrial operations into four areas; a procedure which aids tremendously in making a trade analysis, as well as in the selection of learning activities and criteria for evaluation of performance. However, additional task categories are necessary for operations in some trades.

Apparently, Bruner (5) gets to the essence of the matter of learning in his discussion of the structure and character of subject material; and his emphasis on the teaching of fundamentals implies to the teacher educator, curriculum writer, and vocational teacher that trade analyses should include an in-depth examination of a trade for its intrinsic characteristics, as well as the establishment of a teaching sequence to ensure transfer of learning.

Briggs (3) epitomized Bruner's (5) theories on learning in a very practical example in which he used a work sheet to illustrate a procedure for the development of competency-based performance objectives.

Curricula reviewed by this investigator indicated some similarities in the types of motor tasks in the four trades selected for this study. However, there were distinctive differences in the types of motor tasks <u>predominant</u> in each of the trades.

An observation of students engaged in learning these trades reveals these same similarities and differences. But it must be noted that only the manual dexterity necessary to perform a task can be observed. And that, to an observer, two motor tasks might appear to be the same, or very similar, yet, the cognitive skills required for the two tasks may be quite different. Perhaps here is the area in which diversity in the types of tasks really exists--in the "type" of cognitive skills required for the performance of motor objectives.

Literature analyzed in this chapter confirms the need for empirical research into the important area of the diverse characteristics of various industrial trades. Such a study has implications for the development of competency-based performance objectives, selection of content, choice of learning activities, and the formulation of criteria for evaluation of learning.

CHAPTER III

METHODOLOGY

Introduction

With more and more teachers of industrial trades making the transition from industry to teaching, educators need empirical research which offers evidence that will aid in the selection of course content and methodology compatible with competency-based vocational education (CBVE). The major purpose of this study was to compare four industrial trades for similarities and differences, and to establish the level of cognition required for the accomplishment of each type of task in each of the selected trades. To accomplish this purpose, the following objectives had to be attained: (1) Identify the types of tasks performed in each trade, (2) Establish percentage of time a learner should perform each type of task, (3) Establish the rank-order of importance of each type of task, (4) Determine the level of cognition required for each type of task, and (5) Analyze data in order to establish a correlation between cognitive and motor skills and to compare the intrinsic characteristics of the selected trades.

The purpose of this chapter is to describe the methodology used in the design and conduct of the study. It is divided into the following sections: Study Population, Development of the Instrument, and Data Collection Procedures.

Study Population

A panel of experts, comprised of curriculum specialists and assistant state supervisors on the staff of the State Department of Vocational-Technical Education, was selected to complete the first phase of the data collection for this study. Members of this panel support and/or supervise training programs involving the four trades surveyed.

The population selected for the second phase of data collection was made up of teachers in the four trades from skills centers, inmate training centers, and area vocational-technical schools in Oklahoma.

A total of 83 respondents completed the research instrument, with 28 for automotive mechanics, 22 for welding, 16 for machine shop, and 17 for refrigeration-air conditioning.

Development of the Instrument

The instrument for collection of data for the study was initially developed by the writer, beginning with Fryklund's (9) four categories for industrial operations (types of tasks). This writer added other categories and, subsequently, field tested the instrument in teacher training workshops over a period of approximately one year. During the trial period, several modifications were made, and a list of 12 task categories was developed for use in the study. These 12 items are listed on the form-type questionnaire (Appendix B).

In the initial stages of the development of the instrument, all six levels of Bloom's (2) taxonomy of educational objectives were used to classify motor objectives in relation to their level of cognition.

However, the "Application" level was dropped after teachers demonstrated a strong propensity to mark this level of cognition for most of the types of tasks identified. In addition, cognitive levels were originally organized according to Bloom's hierarchy, on the information sheet accompanying the questionnaire (Appendix A), but levels were "mixed" before beginning data collection, in an attempt to ensure objective responses.

Prior to beginning data collection for the study, the instrument was reviewed by this writer's thesis committee. Their responses and personal comments were used in the finalization of the form-type questionnaire and instruction sheet.

Data Collection Procedures

Collection of data for this study was begun in July, 1977, and the analysis of data was completed in October, 1977.

The research instrument was administered to a panel of experts from the staff of the State Department of Vocational-Technical Education, which included curriculum specialists as well as occupational specialists who supervise programs involving the trades selected for this study. Their responses to the questionnaire were used as part of the data to be analyzed; and their suggestion to the writer to administer the instrument personally to teacher-respondents, rather than use a "mail-out" procedure, was followed. The recommended direct-contact with respondents ensured accurate collection of data.

The procedure for collection of data from teachers was facilitated by this writer going to the school sites, explaining the purpose to administrators, and securing their permission to conduct the study.

Purpose of the study and procedures were explained to the teachers who participated. Also, participation was voluntary; and it was further explained that all information would remain confidential and that individual anonymity was assured.

It was not always possible to pick up completed questionnaires while the researcher was at the school sites, because of time limitations. Therefore, it was necessary, from time to time, to leave the instruments for subsequent return by mail. This procedure resulted in the failure of seven of the instruments to be returned.

Some of the data collection was done in workshops on program planning for teachers, conducted by the writer and his staff, since it had been learned that the instrument aided in the selection of instructional content and teaching methodology. In an attempt to ensure objectivity, the instrument was administered in the same manner to workshop participants, as it was to all other respondents.

Approval to proceed on the study was granted by Mr. Jess Banks, State Coordinator of CETA Programs, AVTS/CETA Division, State Department of Vocational-Technical Education of Oklahoma.

CHAPTER IV

PRESENTATION AND ANALYSIS OF DATA

Introduction

Faced with a steadily increasing need for competency-based instruction to meet the influx of accountability requirements, vocational educators need empirical research which aids in the selection of competencies in all three domains of learning. The major purpose of this study was to compare the intrinsic characteristics of four industrial trades for similarities and differences, and to establish the relationships between the psychomotor objectives performed in these trades and the levels of cognition necessary for their attainment. To accomplish this purpose, the following objectives were formulated:

1. Identify the types of tasks performed in each of the four trades.
2. Establish the percentage of time a learner should normally spend in the performance of each type of task in each trade.
3. Establish the rank-order of importance of each type of task to each of the selected trades.
4. Identify the cognitive skills the learner must attain in order to accomplish motor objectives in each task category.
5. Analyze data obtained in order to compare the selected trades

for similarities and differences, and to establish the relationships between cognitive and motor skills.

The data presented in this chapter were collected from a panel of experts from the State Department of Vocational-Technical Education, and automotive mechanics, welding, machine shop, and refrigeration-air conditioning teachers in area vocational-technical schools, skills centers, and inmate training centers in Oklahoma. A total of 83 respondents completed the research instrument.

Questionnaires were administered directly to respondents either at their school sites or in teacher training workshops conducted by this writer and his staff. Each respondent indicated (1) which types of tasks he perceived as being essential in his trade, from the list given in the instrument, (2) specified an approximate percentage of time a learner should spend performing each type of task, (3) indicated the rank-order of importance of each task category, and (4) designated the level of cognition the learner should attain in order to enable him (her) to perform objectives in each task category.

Presentation and Analysis of Data

Comparisons were made between mean responses for each task category for items two and three in the paragraph above, in order to identify predominant characteristics of each trade; and for item four to establish the cognitive level for each task category. Responses are summarized in Tables I through VIII in this chapter.

Table I illustrates means for the percentage of time a learner should spend in the performance of motor objectives in each task category for each of the four trades. Additionally, time-percentage

TABLE I

SUMMARY OF RESPONSES REGARDING PERCENTAGE
OF TIME REQUIRED IN PERFORMANCE
OF TYPES OF TASKS

Category (Type of Task)	Welding		Auto Mechanics		Refrig.-Air Cond.		Machine Shop	
	Mean Percent-ages	Ranking by Time Percentage	Mean Percent-ages	Ranking by Time Percentage	Mean Percent-ages	Ranking by Time Percentage	Mean Percent-ages	Ranking by Time Percentage
DEPICTING	3.3	8	.9	12	2.8	12	3.7	7
CUTTING AWAY	12.3	3	1.8	10	3.2	11	36.6	1
FORMING etc.	16.3	2	1.5	11	6.4	6-7	3.3	9
DISASSEMBLY	2.2	10-11	19.7	2	8.4	5	2.7	11
ASSEMBLY	8.1	4	25.8	1	11.9	3	3.4	8
ORGANIZING	2.9	9	4.3	7	3.6	10	3.2	10
TESTING etc.	5.9	5	12.5	4	18.4	1	11.1	3
DIAGNOSING	2.2	10-11	14.4	3	17.4	2	5.4	6
PRACTICE	37.1	1	8.8	5	6.4	6-7	11.8	2
INTERPRETING	4.9	6	4.4	6	11.5	4	10.2	4
RECORDING	1.3	12	3.7	8	4.1	9	2.1	12
MATH COMP.	3.5	7	2.2	9	5.9	8	6.6	5

means are ranked with the numeral one (1) indicating the highest percentage of time and twelve (12) indicating the lowest.

Respondents totaled 83, with 28 completing the instrument for auto mechanics, 22 for welding, 16 for machine shop, and 17 for refrigeration-air conditioning. In order to calculate the mean percentage of time students should spend performing a type of task, percentages indicated for each category were totaled for each trade, and the sum divided by the number of respondents for the trade being surveyed.

Time-percentage figures given in Table I identify some of the predominant characteristics of each of the four trades included in the study. According to respondents, almost two-thirds of the welding student's time in training should be spent doing cutting, forming, and practice operations (65.7 percent). Cutting operations are predominant in the machine shop trade with 36.6 percent of the student's time required in this category, and 11.8 percent in practice; however, he spends only 3.3 percent of his time in forming operations. And 11.1 percent of the machine shop student's time is required for testing, measuring, and adjusting operations as compared with the welding student who spends only 5.9 percent. Additionally, 10.2 percent of the machine trade time is necessary for interpreting blueprints and other drawings, while 4.9 percent is needed for these tasks in welding.

A comparison of time-percentage responses for auto mechanics and air conditioning indicate high percentages for both trades in the area of diagnosis and testing. Combined totals for the two categories (testing and diagnosis) in air conditioning are 35.8 percent; and for auto mechanics the percentage of time required for these same types of tasks is 26.9 percent. Categories consuming the greatest amount of time for auto mechanics are assembly, 25.8 percent and disassembly, 19.7 percent. Responses for air conditioning show 11.9 percent for assembly and 8.4 percent for disassembly. Machine shop figures indicate 3.4 percent for assembly and 2.7 percent for disassembly; and welding is also lower in time-percentages in these two areas with 8.1 percent for assembly and 2.2 percent for disassembly. Air conditioning requires 11.5 percent for interpreting drawings and diagrams, which is much higher than auto mechanics, shown at 4.4. Some diversity is indicated in the mathematics computation category with 6.6 percent for machine shop, 5.9 percent for air conditioning, 3.5 percent for welding, and 2.2 percent for auto mechanics.

Table II illustrates the rank-order importance of each type of task, as perceived by the respondents. Mean responses were derived by totalling all rank-order responses on questionnaires and dividing the sum by the number of respondents who ranked the task, for each trade. Task categories were then ranked in descending order by assigning the numeral one (1) to the category having the lowest mean, numeral two (2) to the mean having the next higher mean, and so forth, with twelve (12) indicating the category perceived by respondents as being of least importance to success in the trade.

It is important to note that, although time-percentage and order of importance rankings frequently do not match, those ranked high in time-percentage are also ranked high in order of importance; and those ranked low in percentage of time usually are ranked low in order of importance. It may be of some significance that these two rankings do not match, in that those activities requiring the greatest amount of

TABLE II

SUMMARY OF RELATIONSHIPS BETWEEN ORDER OF IMPORTANCE RANKINGS AND TIME PERCENTAGE RANKINGS

Category (Type of Task)	Welding		Auto Mechanics		Air Conditioning		Machine Shop	
	Ranking by Order of Importance	Ranking by Time Percentage	Ranking by Order of Importance	Ranking by Time Percentage	Ranking by Order of Importance	Ranking by Time Percentage	Ranking by Order of Importance	Ranking by Time Percentage
DEPICTING	10	8	12	12	10	12	10	7
CUTTING AWAY	2	3	11	10	6	11	2-3	1
FORMING etc.	3	2	10	11	5	6-7	11	9
DISASSEMBLY	11	10-11	4	2	8	5	9	11
ASSEMBLY	9	4	3	1	4	3	7	8
ORGANIZING	8	9	5	7	9	10	8	10
TESTING etc.	4	5	2	4	2	1	2-3	3
DIAGNOSING	7	10-11	1	3	1	2	5	6
PRACTICE	1	1	8	5	12	6-7	6	2
INTERPRETING	5	6	6	6	3	4	1	4
RECORDING	12	12	9	8	11	9	12	12
MATH COMP.	6	7	7	9	7	8	4	5

time in which to build proficiency may not be the most important for success in a trade.

An analysis of machine shop responses indicate that the highest percentage of time is spent in cutting operations, while this item ranked "2-3" in order of importance along with "testing, measuring, and adjusting. "Interpreting" was ranked one (1) in order of importance.

Auto mechanics respondents indicated the highest percent of time was needed in "assembly" with the "disassembly" category slightly lower. However, respondents ranked "diagnosing" first and "testing" second, in order of importance. These four categories required a combined total of 72.4 percent of the student's time.

Similarly, air conditioning responses indicated the highest order of importance for "diagnosing," with "testing" ranked second, and "assembly" third. "Interpreting" was ranked fourth in this trade; and combined time-percentages totaled 59.2 percent for these four categories.

Welding respondents perceived "practice" as most important, and assigned the highest time-percentage to this category. They ranked "cutting" second and "forming" third in order of importance. In time-percentage, they ranked "forming" second and "cutting" third.

Since "time-percentage" and "order of importance" rankings were established for the purpose of identifying predominant characteristics in each of the trades, and to compare these characteristics for similarity and diversity, it was not deemed necessary to include all of the task categories in these discussions. Categories that were ranked of little importance, and low in the time-percentage requirement, did not significantly affect the results of this study.

It should be noted that Tables I and II compare the task categories for similarities and differences as respondents perceived them in terms of manipulative skills, or observable performance. Table III summarizes responses regarding the respondents' perception of the relationships between the motor objectives performed in each category and the levels of cognition required to enable a student to perform those objectives.

In order to compile responses and to establish a mean response for each task category in each trade, numerical weights were assigned to the five cognitive levels as follows:

Knowledge ---------------1
Comprehension -----------2
Analysis ----------------3
Synthesis ---------------4
Evaluation --------------5

These numerical weights were recorded on respondents' forms, to replace the "letter" responses they used to identify cognitive levels. Numerical weights were then transferred to the computation form (Appendix C), on which a mean for each category was determined by totalling responses and dividing the sum by the number of respondents who ranked the category.

A wide range of responses are recorded in Table III, with means ranging from 1.1 for "practice" in air conditioning, to 4.4 for "diagnosing" in that same trade. Similarly, auto mechanics ranges from 1.8 in "practice" to 4.3 in "diagnosing." Machine shop means vary from 1.7 in "disassembly" to 3.9 for "testing, measuring, and adjusting." Means for welding range from 1.7 for "recording" to 3.8 for "diagnosing."

Although some diversity exists between mean responses for the four trades--in the same task category--similarities and differences are significant to the vocational educator. For this reason, a mean cognitive level was calculated for each category by totalling the means for each, and dividing the sum by four. Deviations from the mean for each task category are also given in Table III.

It was deemed necessary, for the purpose of this study, to establish a formula for ranking mean responses into a hierarchy in order to get an overall view of cognitive-psychomotor relationships as respondents perceived them. Because the numerical weight of five was given to the highest (evaluation) level, and the numerical weight of one to the lowest (knowledge) level, it was realized that subsequent values obtained in computations would range between one and five. For this reason, the writer was required to make an arbitrary decision regarding a point of departure for establishing numerical "ranges" for each cognitive level. The following procedure was used:

1. The two lowest means (1.95 and 1.78) for the four trades were totaled and the sum divided by two. The quotient obtained was 1.865. The figure, 1.87, was arbitrarily established as the highest numerical value of means in the "knowledge" level.
2. The highest mean cognitive level for the four trades was 4.05. Subtracting 1.87 from 4.05 left 2.18 which was divided by four to establish numerical levels and range for the remaining four cognitive levels. The quotient was .545.
3. This figure, .545, was added once (to 1.87) to establish the highest "comprehension" level, twice to establish the highest "analysis" level, and three times to establish the highest "synthesis" level.

4. Numerical responses above the "synthesis" level were ranked "E" for the "evaluation" level.

5. Results of these calculations were as follows:

"K"	Knowledge	1.87 - down
"C"	Comprehension	1.88 - 2.41
"A"	Analysis	2.42 - 2.96
"S"	Synthesis	2.97 - 3.50
"E"	Evaluation	3.51 - up

The "code" letters above are used in Table III to illustrate cognitive levels for the various means for each task category as obtained by the procedure. It should be emphasized that the "formula" used here is merely a method for the presentation of approximate results of an analysis of data, and the writer makes no implications that this procedure will either enhance or inhibit other studies of this type. Nonetheless, the formula serves the purpose of this study; and the letters, K-C-A-S-E, simplify comparisons between categories and between the different trades by indicating approximate levels in the cognitive hierarchy.

It would be extremely difficult to explore all of the implications of the responses summarized in Table III, and no attempt will be made to discuss the myriad possibilities. However, several of the similarities and differences may be significant to the vocational educator, and warrant further analysis. As a general observation, a total of 19, or about 40 percent, of the 48 mean responses for the four trades summarized in the first four columns are ranked in the first two levels of cognition: knowledge and comprehension. These levels require the learner to recognize and recall facts, and grasp the meaning and intent of information. Categories in these two levels may predominantly include those tasks which require repetition of the same type of

TABLE III

SUMMARY OF RESPONSES REGARDING
COGNITIVE-PSYCHOMOTOR
CORRELATION

CATEGORY (Type of Task)	Mean Cognitive Level * Welding	Mean Cognitive Level * Auto Mech	Mean Cognitive Level * Air Cond	Mean Cognitive Level * Machine	Mean Cognitive Level * Four Trades	Deviation from the Mean for the Four Trades Weld.	Auto.	A/C	M/S
DEPICTING	2.3 C	2.7 A	2.7 A	2.7 A	2.6 A	-.3	+.1	+.1	+.1
CUTTING AWAY	2.5 A	2.8 A	2.3 C	2.8 A	2.6 A	-.1	+.2	-.3	+.2
FORMING etc.	2.4 C	2.8 A	2.3 C	1.9 C	2.35 C	+.05	+.45	-.05	-.45
DISASSEMBLY	2.5 A	2.0 C	1.6 K	1.7 K	1.95 C	+.55	+.05	-.35	-.25
ASSEMBLY	3.3 S	3.4 S	3.1 S	2.6 A	3.1 S	+.2	+.3	----	-.5
ORGANIZING	2.5 A	2.6 A	3.0 S	3.3 S	2.85 A	-.35	-.25	+.15	+.45
TESTING etc.	3.0 S	3.6 E	3.7 E	3.9 E	3.55 E	-.55	+.05	+.15	+.35
DIAGNOSING	3.8 E	4.3 E	4.4 E	3.7 E	4.05 E	-.25	+.25	+.35	-.35
PRACTICE	2.2 C	1.8 K	1.1 K	2.0 C	1.78 K	+.42	+.02	-.68	+.22
INTERPRETING	2.9 A	3.1 S	3.1 S	3.0 S	3.05 S	-.15	+.05	+.05	-.05
RECORDING	1.7 K	2.0 C	1.9 C	2.4 C	2.0 C	-.3	----	-.1	+.4
MATH COMP.	2.2 C	2.2 C	1.5 K	3.0 S	2.23 C	-.03	-.03	-.73	+.77

* Legend: Knowledge - K Comprehension - C Analysis - A Synthesis - S Evaluation - E

manipulative skills; in other words, proficiency is developed until it becomes habit.

Approximately 60 percent of the mean responses indicated cognition requirements in the three higher levels: analysis, synthesis, and evaluation. Welding, auto mechanics, and air conditioning respondents ranked "assembly" at the synthesis level, while machine shop respondents ranked the same category at the analysis (lower) level. This diversity may be attributed to the possibility that most assembly operations in the machine shop trade are similar because the "set-ups" made on lathes and other equipment can become repetitive--to some extent. Math computation is ranked in the first two levels in three of the trades; however, in the machine shop trade, it is ranked two levels higher at the synthesis level. This deviation might indicate that a much higher level of math is required to function in the machine trade as compared with the other three trades.

The evaluation level of cognition requires the learner to be able to make judgments based on criteria or standards. Two task categories, "testing, measuring, and adjusting," and "diagnosing" are ranked in the evaluation level on Table III, with one exception: welding respondents ranked the "testing" category at the synthesis level.

Table III ranked levels of cognition on a continuum from the lowest (knowledge) level to the highest (evaluation) level. This manner of data presentation assumes that the accomplishment of motor objectives in each of the four trades will require cognition at all five levels.

Data in Table III is presented in a different manner than in Tables IV, V, VI, VII, and VIII. In the latter tables, task categories have been rearranged and are listed in a rank-order compatible with their level of cognition. Means from Table III are recorded on these tables, and the five cognitive levels are listed in proximity to the means.

Table IV illustrates the means for welding, auto mechanics means are in Table V, air conditioning in Table VI, and machine shop in Table VII. Table VIII summarizes responses for the four trades.

It should be noted that the presentation of the same data in different ways, i.e., Table III versus Tables IV through VIII, did not change the relative hierarchial positions of task categories. The use of a "formula" for establishing cognitive levels and their range (Table III) ranked some task categories for each trade in each level. On the other hand, the proximity of means to their cognitive levels in Tables IV, V, VI, VII, and VIII place all categories above "knowledge" and below "evaluation."

A count of responses revealed that air conditioning respondents ranked items at or near the ends of a continuum as follows: "Knowledge" was indicated for the practice category by 13 of the 17 respondents; "knowledge" was specified for the math computation category by 10 of the 17 respondents; "knowledge" was ranked for the disassembly category by 11 respondents; and 12 of the 17 respondents ranked "diagnosing" at the evaluation level.

A count of responses for auto mechanics for task categories ranked at the ends of a continuum showed that, of 28 respondents, 18 indicated "evaluation" for the diagnosing category; and that 16 ranked the practice category as requiring "knowledge." Apparently, responses indicate that all five levels of cognition are necessary.

TABLE IV

IDENTIFICATION OF COGNITIVE LEVELS OF TASK CATEGORIES ACCORDING TO MEANS FOR WELDING

Category (Type of Task)	Mean Responses Welding	Cognitive Level
		V Evaluation
		IV Synthesis
DIAGNOSING	3.8	
ASSEMBLY	3.3	
TESTING, measuring, adjusting	3.0	III Analysis
INTERPRETING drawings, diagrams	2.9	
DISASSEMBLY	2.5	
CUTTING AWAY	2.5	
ORGANIZING	2.5	
FORMING, bending, twisting	2.4	
DEPICTING	2.3	
MATH COMPUTATION	2.2	
PRACTICE	2.2	II Comprehension
RECORDING	1.7	
		I Knowledge

TABLE V

IDENTIFICATION OF COGNITIVE LEVELS OF TASK CATEGORIES ACCORDING TO MEANS FOR AUTO MECHANICS

Category (Type of Task)	Mean Responses Auto Mechanics	Cognitive Level
		V Evaluation
DIAGNOSING	4.3	
		IV Synthesis
TESTING, measuring, adjusting	3.6	
ASSEMBLY	3.4	
INTERPRETING drawings, diagrams	3.1	
		III Analysis
FORMING, bending, twisting	2.8	
CUTTING AWAY	2.8	
DEPICTING	2.7	
ORGANIZING	2.6	
MATH COMPUTATION	2.2	
DISASSEMBLY	2.0	
RECORDING	2.0	II Comprehension
PRACTICE	1.8	
		I Knowledge

TABLE VI

IDENTIFICATION OF COGNITIVE LEVELS OF TASK CATEGORIES ACCORDING TO MEANS FOR AIR CONDITIONING

Category (Type of Task)	Mean Responses Air Conditioning	Cognitive Level
		V Evaluation
DIAGNOSING	4.4	
		IV Synthesis
TESTING, measuring, adjusting	3.7	
INTERPRETING drawings, diagrams	3.1	
ASSEMBLY	3.1	
ORGANIZING	3.0	III Analysis
DEPICTING	2.7	
FORMING, bending, twisting	2.3	
CUTTING AWAY	2.3	
		II Comprehension
RECORDING	1.9	
DISASSEMBLY	1.6	
MATH COMPUTATION	1.5	
PRACTICE	1.1	
		I Knowledge

TABLE VII

IDENTIFICATION OF COGNITIVE LEVELS OF TASK CATEGORIES ACCORDING TO MEANS FOR MACHINE SHOP

Category (Type of Task)	Mean Responses Machine Shop	Cognitive Level
		V Evaluation
		IV Synthesis
TESTING	3.9	
DIAGNOSING	3.7	
ORGANIZING	3.3	
INTERPRETING drawings, diagrams	3.0	
MATH COMPUTATION	3.0	III Analysis
CUTTING AWAY	2.8	
DEPICTING	2.7	
ASSEMBLY	2.6	
RECORDING	2.4	
PRACTICE	2.0	II Comprehension
FORMING, bending, twisting	1.9	
DISASSEMBLY	1.7	
		I Knowledge

TABLE VIII

SUMMARY OF RESPONSES REGARDING THE LEVELS OF COGNITION FOR THE MEANS OF THE FOUR TRADES

Category (Type of Task)	Mean Responses Four Trades	Cognitive Level
		V Evaluation
DIAGNOSIS	4.05	
		IV Synthesis
TESTING, measuring adjusting	3.55	
ASSEMBLY	3.10	
INTERPRETING drawings, diagrams	3.05	
		III Analysis
ORGANIZING	2.85	
CUTTING AWAY	2.60	
DEPICTING	2.60	
FORMING, bending, twisting	2.35	
MATH COMPUTATION	2.23	
RECORDING	2.00	II Comprehension
DISASSEMBLY	1.95	
PRACTICE	1.78	
		I Knowledge

Verbal comments from respondents indicated a need for changes in the list of major task categories used in the research instrument for the following reasons:

1. "Practice" is a teaching method, not a task category, and should be omitted. It also caused "splitting" of responses.
2. "Organizing" is a task which is a part of many operations and should not be designated as a separate category.
3. "Recording" is a task which is a part of some operations and should not be designated as a separate category.
4. Major task categories should include, and be limited to, motor objectives which require similar manipulative skills, and similar levels of cognition.
5. Major categories should be designated for high-priority manipulative skills of the same type and which are performed a high percentage of time.

Additionally, a computation of the sum of ranks for time percentages and priorities for the four trades (from Table II) reveals that the three task categories of lowest rank are "organizing" 10th with a sum of ranks of 66, "depicting" 11th with a sum of ranks of 81, and "recording" 12th with a sum of ranks of 85.

Table IX illustrates results of a correlation made of responses within categories. High correlation was expected between time percentages and order of importance rankings, as respondents would normally be expected to rank those activities requiring a high percent of time as highly important. High correlation was indicated for all categories and was significant within the .05 level.

No correlation was expected between time percentage and cognitive

TABLE IX

CORRELATIONS OF RESPONSES WITHIN CATEGORIES

Category (Type of Task)	Correlation of Time Percentage and Priorities	Correlation of Time Percentage and Cognitive Levels	Correlation of Priorities and Cognitive Levels
DEPICTING	.53 *	.03	-.13
FORMING	.64 *	-.02	-.14
CUTTING	.72 *	-.15	.08
DISASSEMBLY	.76 *	-.08	-.01
ASSEMBLY	.66 *	.16	.14
ORGANIZING	.66 *	-.06	-.10
TESTING	.58 *	.16	-.03
DIAGNOSIS	.75 *	.17	.22
PRACTICE	.74 *	.16	.32 *
INTERPRETING	.52 *	-.12	.06
RECORDING	.70 *	.22	.22
MATH COMPUTATION	.48 *	-.08	.29 *

* Significant at .05 Level

level responses, and no correlation is indicated within the .05 level of significance.

No correlation was expected between order of importance priorities and responses for the levels of cognition. However, high correlation between these two areas (priorities and cognition) is indicated for the "practice" and "math computation" categories within the .05 level

TABLE X

CHI-SQUARE COMPARISONS
OF COGNITIVE LEVELS

Category (Type of Task)	X^2	Probability
DEPICTING	3.03	.38
CUTTING	1.29	.73
FORMING	3.95	.26
DISASSEMBLY	10.55	.01 *
ASSEMBLY	7.52	.05 *
ORGANIZING	4.55	.20
TESTING	10.08	.12
DIAGNOSIS	9.18	.02 *
PRACTICE	10.04	.01 *
INTERPRETING	8.11	.22
RECORDING	1.06	.78
MATH COMPUTATION	14.47	.02 *

* Significant at .05 Level

of significance. This researcher can offer no explanation of the reason for this occurrence.

A chi-square analysis was made to compare cognitive level responses between the four trades, and results are recorded in Table X. Similarity of responses within categories for all four trades are significant within the .05 level for five categories: disassembly, assembly, diagnosis, practice, and math computation.

Summary

In the presentation and analysis of data in this chapter, the intrinsic characteristics of the four trades selected for the study were compared for similarities and differences--specifically in four ways: (1) identification of task categories, (2) establishment of time-percentages for performance of tasks by type, (3) establishment of priorities for task categories, and (4) identification of the level of cognition which enables the learner to accomplish psychomotor objectives in each category. The writer attempted to discuss only those data deemed compatible with the purpose of this study.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

The Problem

Educators at all levels are constantly faced with the problem of what to teach and how to teach it. Advisory committees, in this era of accountability and technological growth, are stressing more and more the importance of a machine operator or welder being able to construct a project according to the specifications on a blueprint. And the representatives from auto and refrigeration industries identify a need for employees who can "locate a problem cause and make the necessary repairs." In short, they want competent technicians, not parts changers.

Beginning teachers, fresh out of industry, enter an entirely new environment, the teaching profession, complacently unaware of the implications and challenges they face in an unfamiliar role. Teacher educators emphasize "survival skills" in preservice and inservice training. But teaching competency for the novice teacher is developed slowly.

Vocational training programs stress performance simply because the student must be able to perform motor skills in order to function in the job market. Consequently, "what to teach" usually becomes a matter of identifying the performance objectives for a trade--with little emphasis placed on objectives in the cognitive domain above the lower levels.

The archaic stigma of the "dirty" trades has almost disappeared. Nonetheless, residuals from this stigma probably contribute a great deal to the fact that vocational educators sometimes ignore the importance of what to teach in terms of technical information (theory). Emphasis mainly in manipulative skills frequently negates the significance of cognitive objectives in the so-called higher domains. The simple fact is, these types of objectives are difficult to measure. But just being difficult to measure does not make them unnecessary; and it is folly to pretend that the need to measure them does not exist.

The import of all of this is clear: Technological expansion requires "competent" employees; and vocational training programs need competency-based instruction. Competency-based vocational teacher education can and must become a guiding force in training vocational teachers in the implementation of competency-based instruction.

Purpose

The purpose of this study was to identify similarities and differences in the intrinsic characteristics of four industrial trades, and to determine the relationship between the psychomotor objectives performed in these trades and the level of cognition necessary for their accomplishment. Results of the study provide evidence of value to curriculum writers, teachers, supervisors, and teacher educators in the planning and development of training programs in the trades researched, as well as in other trades involving similar skills.

Objectives

To accomplish the purpose of this study, the following objectives were formulated:

1. Identify the types of tasks performed in each of the four selected trades.
2. Establish the approximate percentage of time a learner should spend in the performance of each type of task in each trade.
3. Establish the rank-order of importance of each type of task to each of the selected trades.
4. Identify the cognitive level the learner must attain in order to accomplish motor objectives for each task category.
5. Analyze data obtained in order to compare the four trades for similarities and differences, and to establish the relationships between motor skills and levels of cognition.

Procedure

The procedure followed in this study was divided into four major steps: (1) a review and research of literature related to the problem, (2) the accumulation of the data for the study, (3) the presentation and the analysis of the data, and (4) the writing of the research paper.

Methodology

The sources of data were curriculum specialists, state level supervisory personnel, and vocational teachers in the selected trades. A total of 83 respondents completed the form-type questionnaire used to collect data. Specifically, the instrument listed 12 categories of tasks: depicting, cutting, forming, disassembly, assembly, organizing, testing, diagnosing, practice, interpreting, recording, and mathematic computation. Responses were solicited for four items: (1) indicate type of tasks essential in the trade, (2) indicate percentage of time learners should perform tasks by type, (3) identify rank-order of importance of each type of task, and (4) designate the level of cognition needed by the learner to enable him to accomplish a type of task.

Two problems were experienced with the research instrument which caused some concern, one early in the development stage, and the other became evident while it was being administered to respondents. During a pilot study, prior to collection of data, it was found that teachers were strongly inclined to rank task categories in the "application" level of cognition. Because the researcher believed that other levels of cognition were required for the learner to be able to perform tasks, and with the permission of the thesis committee as well as on the recommendation of the panel of experts, the application category was dropped.

During the data collection period, it was pointed out that the "practice" category should be classified as a teaching method, rather than a task category. This error caused some confusion in that it resulted in "splitting" some of the time-percentages which might have been placed elsewhere. Additionally, several respondents commented that "organizing" should be a part of most operations, and not a task category. However, the instrument was deemed adequate for the purpose of this study, and no further changes were made after data collection was begun.

Although questionnaires were presented directly to respondents, it was necessary in many cases, due to time limitations, to leave them for completion later, and subsequent mailing back to the researcher. Only seven questionnaires were not returned.

After accumulation of the completed questionnaires, responses were hand tabulated to disclose mean responses, then analyzed and summarized.

Conclusions

Based on the results of this study, distinctive differences were identified in the four trades, both in the manipulative aspects as well as in the cognitive domain. These differences point out some of the predominant characteristics of each of the trades; and those revealed in the study analysis are listed below.

1. The percentage of time a student normally spends in performing motor tasks, by type, varies between task categories within each of the trades.
2. The percentage of time required in the performance of each type of task varies between the four trades.
3. The rank-order importance of the various task categories is different for the four trades for the most part; however, some similarities do exist.
4. Manipulative skills, which require hand to-eye coordination, differ between the task categories. Such differences can be observed, and are readily identifiable.
5. Some manipulative skills require extensive practice for the learner to build proficiency in the task (become competent).

6. Differences in cognitive levels for the same type of task, but for a different trade, may indicate that the task which requires a lower level of cognition involves less-complex thought processes, or might indicate that the task is one that involves "habit strength" developed with practice.
7. Differences for the same type of task at the higher levels of cognition may indicate (for example, in testing or diagnosing) that a difference exists in the type of measuring or testing equipment used, i.e., the level of sophistication of the equipment such as a tape measure versus a micrometer, or an oscilloscope versus a tachometer.

The name of a task category describes, to some extent, the manipulative skills involved. Differences between the categories, then, are readily observable. However, manipulative skills in two or more categories sometimes appear to be very similar, yet a more subtle difference exists--one which is much more difficult to measure--and this difference is in the level of cognition.

One of the most prominent examples revealed in this study can be seen in a comparison of responses for the "assembly" and "disassembly" categories. Although manipulative skills required for the assembly and disassembly of the same piece of equipment are normally very similar, higher levels of cognition are necessary for assembly than for disassembly, according to the results of this study. Ostensibly, one must have different cognitive skills as well as exercise more care to ensure that each part, in an assembly operation, is correctly installed; thus, the higher ranking indicated by respondents for the level of cognition.

Deviations of .5 or more from the mean cognitive levels for the four trades, in the same task category, occurred in five instances. (1) Welding responses indicated +.55 for "disassembly" which might indicate that the welder considers this a higher cognitive level operation because disassembly involves unfamiliar complexities for him. (2) Welding responses for "testing, measuring, and adjusting" were -.55 lower than the mean for the four trades, which may indicate that most testing operations for the welder are simple "bend-tests" and that measuring operations usually involve only the use of the rule or steel tape. (3) Air conditioning responses for "practice" were low at -.68, which might indicate that operations in this category are considered easy to accomplish. "Practice" was also ranked lowest (12th) in order of importance for this trade. (4) Air conditioning responses for math computation were low at -.73, which may indicate that a lower level of math is required for this trade as compared to the other three trades. (5) The cognitive level indicated for math computation in machine shop was much higher that the mean for the four trades at +.77, which points out that the math requirements for this trade are more complex.

Similarities most evident in this study were indicated by the fact that, of the 48 mean responses for cognitive levels, 43 deviated less than .5 from the mean for the four trades. The occurrence of only slight deviations here may suggest that motor objectives in a particular task category require approximately the same level of cognition in each of the four trades. Chi-square comparisons (Table X) support this.

One very significant result of this study, for the vocational educator, was the positive acceptance of the task categories listed on the research instrument. Although respondents' comments suggested that the "practice" category should be omitted from the research instrument because practice is a teaching method, and that "organizing" and "recording" are each part of other operations, 83.1 percent (69) of the respondents identified all 12 categories as essential in the four trades. Such a list of categories is of value to vocational educators in the selection of teaching methods. Results regarding cognitive-psychomotor relationships are also of value, in that they offer evidence which aids in the choice of motor and cognitive objectives for competency-based instruction.

Recommendations

Since different areas in the state and nation have diverse requirements for job-readiness, broad application of the results of this study can be claimed only as job requirements in a particular field are compatible with those of the sample group surveyed. Much additional study is needed in the trade analysis area attempted in this study if competency-based vocational education is to become a reality. However, the researcher claims positive acceptance of the task categories (with changes as noted) as well as evidence of a high correlation between psychomotor objectives and the levels of cognition necessary for their accomplishment. Therefore, based on the results of this study, the following recommendations are made:

1. "Practice," "organizing," and "recording" should be omitted from the list of task categories for the four trades surveyed in this study.
2. The following task categories are of value to vocational educators in making trade analyses for competency-based

vocational education--specifically in the identification of psychomotor and cognitive objectives, in the selection of instructional content, and in the identification of compatible teaching methods, for industrial trades:

a. Depicting (sketching, drawing, writing symbols)

b. Cutting away (to change shape, size)

c. Forming, bending, twisting (to change shape, size)

d. Disassembly

e. Assembly

f. Testing, measuring, adjusting (with tools, meters, instruments)

g. Diagnosis (applying procedures to identify problem causes, solutions)

h. Interpreting drawings, diagrams, blueprints

i. Mathematic Computation

3. More comprehensive studies should be conducted for each trade, in which a unit-by-unit analysis is made, utilizing the above list of categories as well as procedures similar to those used in this study.

4. Additional research should be made to identify teaching methods and/or learning outcomes most compatible with each of the task categories listed above.

5. Studies should be undertaken to establish valid testing procedures for measuring cognitive objectives in the higher (difficult to measure) levels of analysis, synthesis, and evaluation.

6. Research should be conducted to identify teaching practices

which aid in the transfer of learning.

7. Studies are also needed to identify the "structure characteristics" of each industrial trade in order to establish criteria for sequencing and methodology.
8. The effect of the teaching of fundamental knowledge and skills, on learning transfer, should be researched.
9. Much research is needed in establishing the interrelationships between objectives in all three learning domains.
10. Studies should be designed to determine the proficiency standards for competency-based instruction in each trade and/or occupation in vocational-technical education.

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APPENDIX A

INFORMATION SHEET

INFORMATION SHEET

Some knowledge is necessary, of course, in order to be able to perform <u>any</u> motor objective. The purpose of this study is to attempt to classify various types of psychomotor objectives according to their relationship to the cognitive skills required for their accomplishment.

The table below contains information which will assist in completing the form-type questionnaire (Appendix B). Information was adapted from "Bloom's Taxonomy of Educational Objectives." Since a learner, when performing a motor objective, is engaged in the "application" of skills, Bloom's <u>Application</u> category is omitted from this table.

COMPREHENSION (code C)	Demonstrates the ability to grasp the meaning and intent of information--can translate into his (her) own words; understands. Able to explain, illustrate, describe, summarize, interpret, expand, convert, measure.
ANALYSIS (code A)	Demonstrates the ability to reason--breaks down information into component parts and detects relationships of one part to another and to the whole. Picks out the most important points in material presented. Analyzes, debates, differentiates.
KNOWLEDGE (code K)	Demonstrates recognition and recall--the ability to remember facts close to the way they were first presented. Identifies, labels, locates, recognizes. Remembers specifics, and ways and means of dealing with specifics.
EVALUATION (code E)	Demonstrates the ability to judge and evaluate ideas, information, procedures, and solutions. Compares, makes decisions, evaluates, draws conclusions, contrasts, develops criteria, appraises.
SYNTHESIS (code S)	Demonstrates originality and creativity--the ability to assemble separate parts to form a whole. Combines concepts to create an original or new idea. Ability to create, design, plan, produce, compile, and develop.

APPENDIX B

QUESTIONNAIRE

QUESTIONNAIRE

1. Please place an "X" in each appropriate block under #(1) to indicate performance of this type task is essential in the trade.
2. Under #(2), indicate the approximate percentage of time a learner spends, while in training, in the performance of each type of task. (Column #2 must total 100%.)
3. Under #(3), identify the rank-order importance--to success in the trade--of each type of task. (Rank 1, for most important; 2 for next in importance, etc.)
4. Under #(4), designate, using one code letter from the table, Appendix A, that which best describes the cognitive skill required for the performance of each type of task. (Examples: "C" for comprehension, "S" for synthesis, "K" for knowledge, etc.)

CATEGORIES (TYPES OF TASKS)	(1)	(2)	(3)	(4)
DEPICTING (sketching, drawing, writing symbols)				
CUTTING AWAY (to change shape, size)				
FORMING, BENDING, TWISTING (to change shape, size)				
DISASSEMBLY				
ASSEMBLY				
ORGANIZING (sorting, listing, arranging)				
TESTING, MEASURING, ADJUSTING (with tools, meters, instruments)				
DIAGNOSING (applying procedures to identify problem causes, solutions)				
PRACTICE (repeating same type tasks)				
INTERPRETING DRAWINGS, DIAGRAMS				
RECORDING (written or printed information, verbal instructions)				
MATHEMATIC COMPUTATION				
OTHER (specify)				
TOTAL PERCENT				

Trade ______________________________

Name (optional) ______________________

APPENDIX C

COMPUTATION SHEET

COMPUTATION SHEET

CATEGORIES (Types of Tasks)	RESPONDENT NUMBER																			TOTALS	Divided by *	MEANS
DEPICTING																						
CUTTING AWAY																						
FORMING etc.																						
DISASSEMBLY																						
ASSEMBLY																						
ORGANIZING																						
TESTING etc.																						
DIAGNOSING																						
PRACTICE																						
INTERPRETING																						
RECORDING																						
MATH COMP.																						

* NOTE: (1) Percentage means computed by dividing totals by the total number of respondents.

(2) Cognitive level means computed by dividing totals by the number of respondents who ranked that item.

VITA - 2

Eugene Maxfield Dollar

Candidate for the Degree of

Master of Science

Thesis: A COMPARISON OF SELECTED INDUSTRIAL TRADES TO DETERMINE THE RELATIONSHIP BETWEEN PSYCHOMOTOR OBJECTIVES AND THE COGNITIVE SKILLS NECESSARY FOR THEIR ACCOMPLISHMENT

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