RELATIONSHIPS BETWEEN VOCATIONAL INDUSTRIAL TEACHER BEHAVIOR IN THE SCHOOL LABORATORY AND THE ACHIEVEMENT OF VOCATIONAL INDUSTRIAL STUDENTS

by

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Chapter 1

INTRODUCTION

Researchers have tried to determine relationships between teacher performance and student learning for many years. Their studies and research reports range from one of the earliest by Barr (1929) to Borich (1977) and Medley (1977). As indicated by the current work of Borich, Medley and many other researchers, student learning and teacher performance remain a continuing concern at the present time. This is the case in that research has not yet revealed truly generalizable teacher behaviors that affect student achievement in predictable cause-effect relationships. However, progress is being made and research efforts to date have produced a number of promising relationships. Some of the more significant of these studies have been completed by Furst (1967), Medley (1977), Medley and Mitzel (1963), Nuthall (1968), Rosenshine (1971), Smith (1971), Soar (1972) and Whithall (1949). Although much of this research dealt with observing teachers in academic classrooms, there seems to be potential for applicability of results to vocational shop/laboratory settings. One application involves using the results of selected research as a basis for conducting research in vocational education. An example of this would be to conduct verification or validation studies to assure the applicability of previous research results in vocational education settings.

In the search for teacher effectiveness, researchers have identified three types of research concerned with teacher behavior and student achievement (Rosenshine and Furst, 1973:131). These include descriptive, correlational and experimental studies. Rosenshine and Furst suggest that these three types of studies provide a design for continued research on teaching. A continuing research plan is to first describe the behavior of teachers and then conduct correlational research to determine which behaviors are associated with student achievement. A next step in the continuing research process is to perform experimental studies to determine the validity of the relationships identified through descriptive and correlational studies and the degree or amount of behavior required for optimum student achievement.

Existing research on teaching which deals with teacher performance and effectiveness as revealed by teacher behavior and student achievement indicates the need for continued research (Rosenshine and Furst, 1973:162; Borich, 1977:367; Dunkin and Biddle, 1974:419; Medley, 1977:69). This additional research is necessary to test the applicability of identified teacher behavior variables as they relate to student achievement in additional contexts including different grade levels, subject areas, physical settings, etc. (Biddle, 1967:337).

THE PROBLEM AREA

The problem area for this study encompasses teacher behavior and student achievement. In order to clarify how this area of concern is contained within the universe of research on teaching, Figure 1

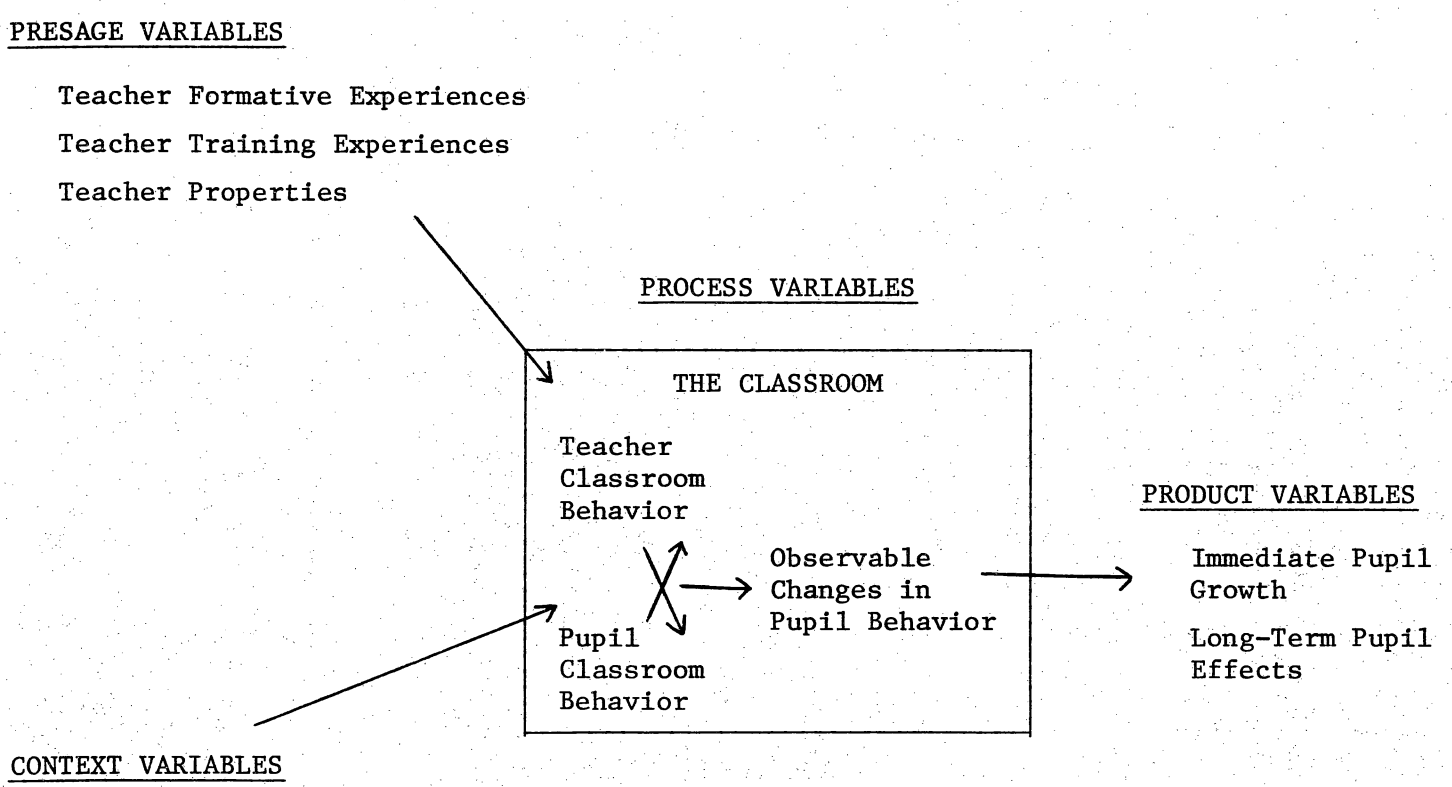

Figure 1

A Model for the Study of Classroom Teaching

illustrates a paradigm (Dunkin and Biddle, 1974:38) for the study of classroom teaching. An examination of Figure 1 indicates that teacher classroom behavior may be viewed as one of the three major areas of classroom activities identified as process variables in teaching. The diagram also identifies pupil growth as one category of the product variables of teaching. Therefore, studies involving teacher behavior and student achievement are sometimes referred to as process-product research on teaching.

Additional study of Figure 1 shows that the other process variables of teaching are pupil-classroom behavior and observable changes in pupil behavior. The paradigm indicates that changes in pupil behavior result from the interactions between teacher behavior and pupil behavior.

The focus of this study was on behavior of the teacher as teacher behavior initiated and interacted with student behavior in the learning environment. Figure 1 assumes that observable changes in pupil behavior are a function of teaching and hence evidence of the success or failure of the teacher's efforts (Duncan and Biddle, 1974:45). Although this assumption is widely accepted, it was necessary to recognize in this research activity that student behavior does affect the behavior of the teacher.

When considering the variation in activities and the use of various instructional materials and methods by teachers as a dimension of teacher behavior, it was important to acknowledge that behaviors exhibited by the teacher would be affected by students. Another view of this teacher-student behavior interaction was that since the teacher

is the authority figure and in charge of student activities, he or she must decide how to respond to student behavior and use various methods or activities; therefore, the teacher's behavior is predominant.

This research was delimited to the study of teacher behavior and student achievement. Therefore, it was necessary to accept variation in teacher behavior due to variation in student behavior as a limiting factor for which the study did not control in the observation of teacher behavior.

Another paradigm is also available to help in narrowing the focus of this study as it related to vocational teachers. Figure 2 is reproduced from Bjorkquist, et al. (1968:18). A review of this "schematic model" reveals three important points concerning this study. The first point is that teacher behavior in the class, shop or laboratory is identified as a sub-category of teacher performance. The second implication for the present research is that student in-school changes such as achievement in the teacher's area of specialization are listed as short term effects of teaching. Points one and two illustrate the application of the model in Figure 1 to vocational education settings. The third point to be noted as it relates to this research is the diverse backgrounds of trade and industrial education teachers. This diversity leads to relatively large variance in personal characteristics of trade and industrial teachers as compared to teachers of other school subjects or vocational program areas (Leighbody, 1972:139).

The need for research on teaching emerges from the conclusion that there is little knowledge concerning the actions and activities

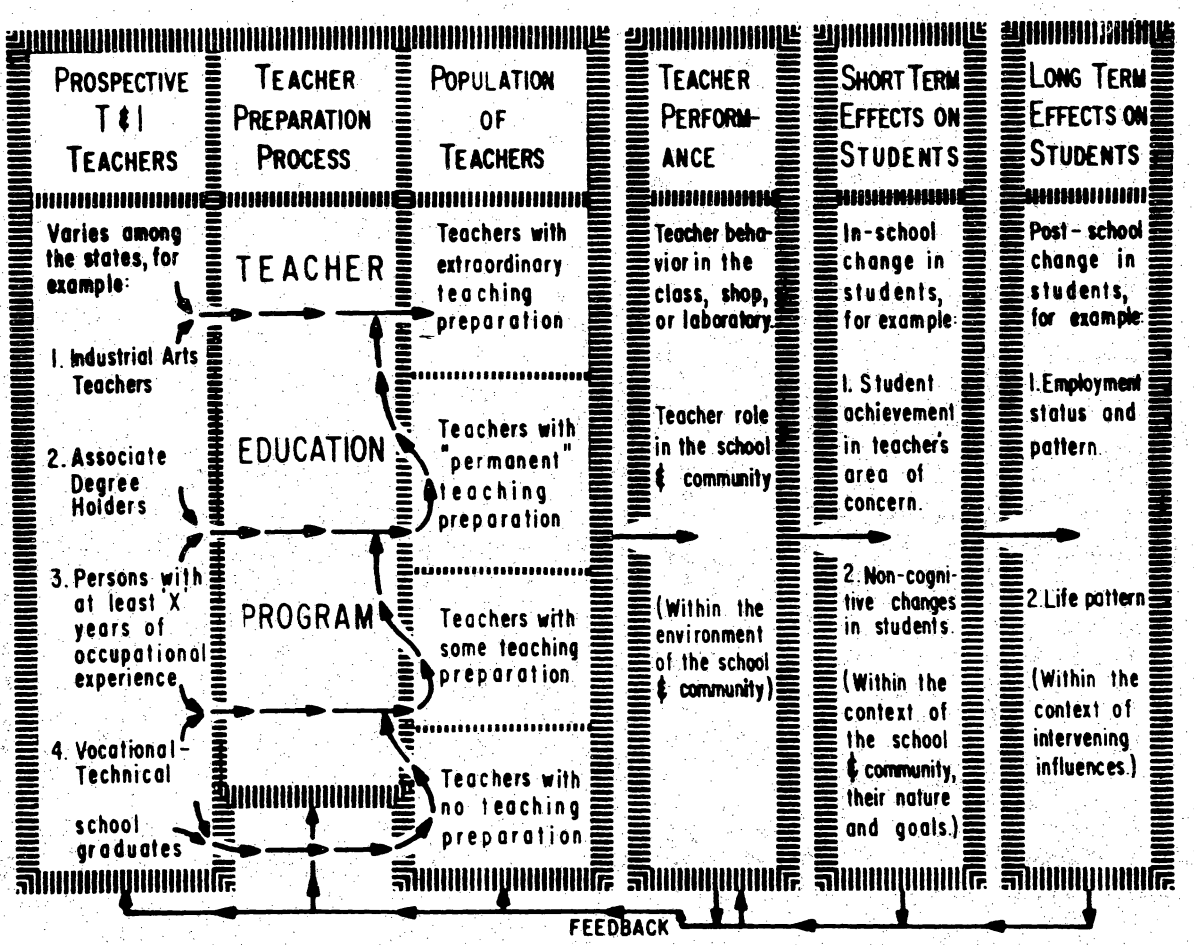

Figure 2

A Schematic Model for Research on Trade and Industrial Teacher Education

of teachers as they relate to student performance. A firm empirical base for teacher education is lacking. Movement toward the establishment of a research foundation for teacher education has begun as indicated above and as outlined in the review of literature in Chapter 2. However, additional research in this area is needed, especially that which has specific emphasis on vocational education.

The needed research must focus on our perceptions of teacher education in its totality by looking not only at teacher education programs and the students who enter and graduate from these programs but must also include the study of teachers in actual teaching situations. Research on the study of teachers in classrooms must concentrate on the behavior of the teacher as it relates to student achievement.

This research may be considered foundational to the derivation of vocational teacher competencies as derived from direct observation of teachers working with students in actual school situations. Support for this type of research is provided by Tuckman and Schaefer (1966:43) and Moss (1967:26). These authors sustain the view that trade and industrial teacher competencies may be derived by research based on direct observation of teachers. This need for the present study is further reinforced by Finch and Bjorkquist (1970:37). They report the need for conducting additional research before definite teacher evaluation rules can be established.

STATEMENT OF THE PROBLEM

The general research problem of this study was that educators have not established firm cause-effect relationships between teacher

behavior and the resultant learning of students. This issue has been examined most effectively through observation of teachers in actual school settings and relating dimensions of behavior to student achievement.

Progress has been made through investigations of teacher behavior and student achievement in various classroom environments and subject areas. However, additional research is needed, especially in the field of vocational education. This study sought to extend our knowledge through inquiry into the relationship between teacher behavior and student achievement in a specific vocational program area.

Specifically, this study sought to investigate the relationship between a selected dimension of vocational industrial automotive mechanics teacher behavior and the achievement of vocational industrial automotive mechanics students taught by these teachers. The research also included an investigation of relationships between student opportunity to learn criterion material, student achievement, teacher personal characteristics and teacher behavior in the vocational shop/laboratory.

One of the questions that arises in research dealing with teacher behavior and student achievement is whether the criterion instrument was relevant to the instruction (Rosenshine and Furst, 1973). This question centers specifically on whether or not the material on the post-test was included in the instruction provided to students. For this reason student opportunity to learn criterion material (SOL) has been included as a variable in this study.

Research concerning teacher personal characteristics, teacher behavior and student achievement has produced conflicting results at this point in time. However, continued research using these variables can be beneficial in that a trend may be detected and factors identified which lead to an explanation of the conflicting results. Continued research using these variables also permits comparisons between present and previous findings. It was, therefore, deemed advisable to include selected personal characteristics of teachers in this research.

RESEARCH QUESTIONS

The following research questions were formulated to implement the examination of the research problem.

1. What is the relationship between vocational industrial automotive mechanics teacher behavior on the dimension of variety/variability as indicated by the "Vocational Teacher Observation Of Process System" (VTOPS) Variety Quantity (VQ) score and student achievement as measured by the "Ohio Trade and Industrial Education Achievement Test for Automotive Mechanics" (OTAT)?

2. What is the relationship between vocational industrial automotive mechanics teacher behavior on the dimension of variety/variability as indicated by the VTOPS Variety Range (VR) score and student achievement as measured by the OTAT?

3. What is the relationship between "Student Opportunity to Learn Criterion Material" (SOL) as measured by the automotive mechanics teacher rating and student achievement as measured by the "Short Occupational Knowledge Test for Auto Mechanics" (SOKT)?

4. What is the relationship between selected personal characteristics of automotive mechanics teachers as indicated by the "Teacher Personal Characteristics Profile" (TPCP) and student achievement as measured by the OTAT?

5. What is the relationship between SOL as measured by the automotive mechanics teacher rating and selected personal characteristics of automotive mechanics teachers as indicated by the TPCP?

6. What is the relationship between selected personal characteristics of automotive mechanics teachers as indicated by the TPCP and teacher behavior as indicated by the VTOPS VQ score?

7. What is the relationship between selected personal characteristics of automotive mechanics teachers as indicated by the TPCP and teacher behavior as indicated by the VTOPS VR score?

DEFINITION OF TERMS

In order to clarify the meaning of selected terms associated with this research study, the following definitions are presented:

1. Category System: A tool for observing teachers in which a given teacher behavior is recorded each time it occurs and hence provides a frequency count for the occurrence of specific behaviors (Borich, 1977:16).

2. Learning: A process which enables students to modify their behavior in a more or less permanent way, so that the same modification does not have to occur again and again in each new situation (Gagńe, 1975:5).

3. Observation: Observation is the systematic recording of a variety of specific, discrete teacher behaviors that are assumed, according to a theoretical framework, to be related to student growth (Borich, 1977:9).

4. Student Achievement: The change in performance before learning as compared to performance after the learning situation (Gagné, 1977:19).

5. Teaching: Any interpersonal influence aimed at changing the ways in which other persons can or will behave (Gage, 1963:96).

6. Teacher Behavior: The actions and activities of an individual while performing the act of teaching (Gage, 1963:93).

7. Teacher Characteristics: The personal characteristics of individual teachers such as age, years of teaching experience, educational background, work experience in industry, etc.

8. Teacher Competencies: Specific teacher behaviors that include the specification of a desired quantity of behavior (Borich, 1977:5).

9. Teacher Performance: The execution of the acts of teaching (Borich, 1977:4).

10. Variety: Variation in activities, use of various instructional materials and methods, variability (Rosenshine, 1971:147).

11. Variety Quantity (VQ): The variety quantity score on the VTOPS instrument which is determined by the summation of frequencies on all items for the full twenty-five minute observation period.

12. Variety Range (VR): The variety range score on the VTOPS instrument which indicates the total number of different items on the instrument in which a frequency of occurrence appears during the twenty-five minute observation period.

ASSUMPTIONS

This study was based on the following assumptions:

1. The variance between classes in student residual achievement scores can be attributed largely to differences in teacher behavior.

2. The variation in facilities and equipment are not sufficient to adversely affect the measurement of teacher behavior and student achievement.

3. The content of the achievement measures is included in the course of instruction for all programs in the study.

4. Teacher behavior during the observations is typical and representative of the total behavior.

5. The teacher response on the "student opportunity to learn" instrument is an accurate reflection of student opportunity to learn the criterion material.

6. Student learning takes place in the class under the teacher's direction rather than out of class through work experience or independent self-study.

LIMITATIONS

The following limitations should be considered when reviewing the results of this study:

1. This was a correlational study and as such does not imply a specified quantity of variety in teacher behavior.

2. Field based observation studies of this type do not have the degree of control associated with experimental studies.

3. The sample included automotive mechanics teachers in the state of West Virginia who agreed to participate.

4. The teacher behavior variables were selected from among many that may relate to student achievement.

5. The study does not control for variables such as social class, prejudice, conservatism, social climate or teacher traits such as personality, attitude or dogmatism.

6. Student achievement is limited to achievement in the subject matter area and does not attempt to account for other teaching outcomes such as student cooperation in working with others and student attitudes toward self, school, the subject area and citizenship.

7. The research did not include the observation or control of student behavior.

8. The effect of student behavior on teacher behavior was not considered or controlled for in measuring variation in teacher behavior.

9. The observation of teacher behavior was limited to the laboratory setting and did not include teacher observation in the formal classroom environment.

SUMMARY

This chapter has presented a background of literature and research on teaching to provide a foundation for the study. The need for

additional research in this area has been established through the general literature on the subject as well as through the literature on research in vocational education. The necessity for continued research was narrowed until it focused on and gave justification for the present research.

Research questions were presented. Definitions of key terms provided clarification for the purposes and content of the research and literature review. Assumptions upon which the study was based were stated. Presentation of the limitations of the study will provide assistance in reviewing the conclusions of this research.

Chapter 2

REVIEW OF RELATED LITERATURE

INTRODUCTION

This chapter presents a summary review of related literature and research pertaining to the rationale for and procedures applicable in this study. The chapter is sub-divided into sections to provide a basis for the research methodology and procedures. Chapter sub-divisions include teacher behavior and student achievement, teacher behavior variables related to student achievement, personal characteristics of teachers and approaches to the measurement of student achievement.

TEACHER BEHAVIOR AND STUDENT ACHIEVEMENT

Medley and Mitzel (1963:247) in their review of research on teacher behavior in the Handbook of Research on Teaching state:

> Certainly there is no more obvious approach to research on teaching than direct observation of the behavior of teachers while they teach and pupils while they learn. Yet it is a rare study indeed that includes any formal observation at all. In a typical example of research on teaching the research worker limits himself to the manipulation or study of antecedents and consequents of whatever happens in the classroom while the teaching itself is going on, but never once looks into the classroom to see how the teacher actually teaches or how the pupils actually learn.

The 1963 report by Medley and Mitzel along with other accounts of research dealing with teaching certainly stimulated additional

research on teacher behavior by direct observation. Many studies were completed during the decade of the sixties and studies of this type continue to the present time.

Several summaries of research on teacher behavior as revealed through direct observation were prepared by Rosenshine (1971), Rosenshine and Furst (1971:122), Dunkin and Biddle (1974), Simon and Boyer (1974), Borich (1977:370) and Medley (1977). Some of the most significant syntheses of this research have been done by Rosenshine and Furst in their reports in 1971 and 1973. These summary reports indicate the response of the profession concerning the identified need for research on teacher behavior and student achievement.

Nine variables have been reported as giving the most consistent or significant results from over fifty studies in which teacher behavior was correlated with student achievement. The majority of these studies adjusted measures of pupil growth through the use of pre-test scores and regression analysis (Rosenshine and Furst, 1973:155). The variables identified are:

1. Clarity
2. Variability or variety
3. Enthusiasm
4. Task-oriented and/or businesslike behaviors
5. Criticism
6. Teacher indirectness
7. Student opportunity to learn criterion material
8. Use of structuring comments
9. Multiple levels of questions or cognitive discourse

Further discussion and definition of the above variables which have a direct influence on this study are presented later in this chapter.

A review of research and literature on vocational education revealed several studies dealing with vocational teacher competencies. Walsh (1960:49) indicated that the competencies identified in his research (Walsh, 1958) were derived through committee action. The committee was composed of staff members of the U.S. Office of Education, state teacher trainers, state trade and industrial supervisors, state directors, local directors and outstanding teachers.

Nichols (1964:224) conducted research concerned with the tasks which constitute the trade and industrial education instructors total job assignment. Nichols used the descriptive survey methodology of sending a questionnaire to 430 trade and industrial instructors.

Perhaps the most recent and significant effort to identify performance requirements for teachers is the work of Cotrell, et al. (1971; 1972). In seeking the necessary performances for vocational teachers these researchers (Cotrell, et al., 1971a:xi) used the following methodology.

> Methodology for the study included an occupational analysis of the pedagogical functions of the teachers; a task force evaluation and review of pedagogical performance elements; a critical incident study to expand, verify and establish support for the performance elements identified through the occupational analysis; and the development of performance oriented general objectives for model curricula guidelines.

Tuckman and Schaefer (1966:43) reported that teacher strengths are a function of the areas most emphasized and best taught in the specific institutions from which they obtain training. They also

indicate that some institutions emphasize technical competence while others emphasize teaching methods. Research findings on the outcomes of teacher training are therefore contradictory and confusing. According to Tuckman and Schaefer (1966:43), the answer to providing competencies needed by trade and industrial teachers may lie in a job analysis of teaching tasks based on direct observation of many teachers in many settings to determine how often different skills and techniques are called for.

In the Review of Research in Vocational Teacher Education, Moss (1967) did not report any research studies involving industrial teacher behavior and student achievement. However, the need for such research is indicated. Moss (1967:26) stated:

> We must learn to measure the extent to which identified intrinsic criterion variables actually affect teacher behavior patterns. And we need to establish the relationships between teacher behavior and actual student outcomes in varying situations.

Miller (1967) reported research priorities in technical teacher education. The need was identified for the determination and analysis of technical teacher activities to be used in planning teacher education curriculums. This relates to the present study in that it identifies a need which direct observation of teacher behavior will help satisfy.

Bjorkquist, et al. (1968:9) reported on research in trade and industrial teacher education since 1963. The report indicated that many of the studies focused on the process of teacher education or on the product of the teacher education program. The review of research did not reveal any studies that were directly concerned with teacher

behavior and student achievement. However, a paradigm of the study of trade and industrial teacher education includes the two components as potential sources for research studies.

Research dealing with performance tests of instructor competence was conducted by Popham (1968). This study did use student achievement on performance tests as the indicator of instructor competence but the two groups of teachers in the experiment were not observed while teaching. The teachers were allowed to use any methods they chose in accomplishing student achievement (Popham, 1968:8).

Pautler and Schaefer (1969) prepared a review and synthesis of research in trade and industrial education. The review included a section devoted to teacher education with sub-headings for teacher competence and evaluation of teacher education programs. The review of this report did not reveal any research concerning teacher behavior and student achievement.

Four studies were reported by Samson (1968:409) which dealt with the identification of performance qualities of business and distributive education teachers. These studies used the critical incident technique. The teacher's behavior during the incident was labeled as effective or ineffective by the reporter. The studies reported did not deal with student achievement or vocational industrial teachers.

Peterson (1973) prepared a review and synthesis of research on vocational teacher education. Sections on competencies required of vocational teachers and evaluation of vocational education programs were included in the report. Although no specific references were made

to research dealing with vocational teacher behavior and student achievement, Peterson (1973:7) recommends additional research on the identification of competencies for each aspect of vocational teacher education.

In studying the teaching effectiveness of two groups of teachers with different preparatory backgrounds, Moore (1976:45) discovered differences between the groups on selected behaviors through the use of an observation system. The behavior of the teachers was related to teacher educator ratings and teaching performance tests rather than student achievement. The importance of this report to the present study is to illustrate the use of observation systems in studying vocational teachers. The study by Moore dealt with vocational agriculture teachers.

The Journal of Industrial Teacher Education issues from 1964 to the present were reviewed. Fifteen reports were found that dealt with teacher performance, teacher competencies, teacher evaluation or other aspects of industrial teachers. Four of the fifteen reports dealt with teacher behavior with one of the four reports focusing on teacher behavior and student achievement.

Doty (1973:63) identified immediate evaluation of teachers as the observation of their behavior while they were in class. Doty indicated:

> The idea, that the teacher knows the criteria he must fulfill, requires a detailed description of the behaviors (criteria) which he must possess and demonstrate at the time of evaluation (1973: 63).

The development of an observation instrument is described by Doty (1973) which requires three stages. Two of the steps in the instrument development relate to the present study. They are:

1. defining the performance elements
2. analyzing the behaviors (criteria)

The present study was concerned with the definition and analysis of performance elements (behaviors) that relate to student achievement.

Detwiler (1972:68) conducted an experiment dealing with the development of cognitive behavior of vocational industrial student teachers. The study is an example of how outcomes of the present research can be utilized in experimental studies concerning vocational industrial teacher education. The report by Detwiler does not cite any observational study as a basis for the selection of cognitive behavior. The methodology was to select teaching practices and techniques from the literature and have a jury consensus for the inclusion of a specific item.

Finch and Bjorkquist (1970:37) discuss teacher behavior in their review of process measures in occupational education evaluation such that several points relate to the present study. They are:

1. The question is posed as to whether or not teacher behavior measures actually relate to student achievement.
2. It appears that more research is needed before definite rules for evaluation can be established.
3. There is very little common agreement concerning which behaviors should be measured.
4. It is important to select measures of behavior that will help both teachers and administrators.

Several research studies that have used student achievement measures for secondary vocational education students include Popham

(1968), Finch (1971), Enderlein (1972) and O'Reilly (1972). Although these and many other studies have used vocational student achievement none have been located which attempt to relate teacher behavior and secondary vocational student achievement.

Another study which dealt with student performance of physical skills was conducted by Hughley (1973:99). This study provided feedback to student teachers in physical education based on observation of identified behavior categories. The implication for this study is that the observation instrument was designed to observe teachers while they were supervising students who were doing psychomotor tasks.

The only study located which used an observation of teaching instrument and correlations with students achievement in the context of vocational education was by Morsh, et al. (1955). This study was not at the secondary level of vocational education. The research by Morsh was reported by Rosenshine (1970:648) is summarized below.

> In the earliest study (Morsh, et al., 1955) 106 Air Force instructors taught the same material on airplane hydraulics to two different classes a month apart. Each course lasted for eight daily one hour sessions. A pretest similar to the written posttest and grades in previous phases of the program were used as predictor variables in the calculation of residual gain scores.

Morsh, et al. (1955) used the "Instructor Observation Checklist" as reported by Simon and Boyer (1974:424). The checklist focused on the instructor's cognitive verbal behavior.

The work by Morsh, et al. (1955) pertains to the present study in that this study focused on the achievement of students and the laboratory behavior of secondary level vocational industrial teachers.

The early work by Morsh is an example of the applicability of using teacher observation instruments in a specific area of vocational industrial education and relating the results to student achievement.

Teacher Behavior

The actions and activities of a teacher while performing the act of teaching are considered to be teacher behavior. Borich (1977:3) in discussing teacher performance indicates that when teacher behavior is considered as the execution of the acts of teaching then teacher behavior is the basic level of description of teacher performance.

In recent years, research on teaching has focused on teacher behavior. Soar (1972:508) reports that the period from 1958 to 1960 marked the beginning of change in the literature concerning teacher behavior. Research relating teacher behavior to pupil growth has increased sharply since 1960 (Soar, 1972:508).

Several studies were completed prior to 1958. The work of Horn (1914) was one of the early attempts to obtain objective measures of classroom behavior. Several additional early studies were done by Morrison (1926), Barr (1929), Wrightstone (1934), Urban (1943), Withall (1949), Wispe (1951) and Morsh, et al. (1955). These studies dealt with various aspects of teacher behavior and/or student achievement.

In 1958, Medley and Mitzel published their technique for measuring classroom behavior (Medley and Mitzel, 1958:86). This report included the observation instrument OScAR (Observation Schedule and Record). The work of Medley, Mitzel and others with the OScAR helped

to stimulate research dealing with teacher behavior and student achievement.

Flanders (1960) reported the development of the interaction analysis observation system which focuses on interaction of teacher and students as indicated by teacher talk and student talk. The Flanders interaction analysis instrument has also been widely used in research on teaching. The interaction analysis of Flanders concentrates on the directness or indirectness of the teacher in his or her conduct of instruction.

Ryans (1960) concentrated on the observation of teaching through the use of rating systems. The observer visited the classroom and immediately upon leaving completed the rating scale. Ryans' work dealt mainly with relating teacher characteristics and teacher behavior.

Medley and Mitzel (1963:247) made a major contribution to the literature concerning the observation of teacher behavior with their chapter titled "Measuring Classroom Behavior By Systematic Observation" which was published in the Handbook of Research on Teaching. This report helped to stimulate additional research on the study of teaching through observation of teacher behavior. Many suggestions and procedures were outlined as well as a comprehensive review of research completed up to 1963.

The studies and research reviews cited to this point are a representative sample of many other reports and publications dealing with teacher behavior. Additional literature directly related to teacher

behavior and this study are reported below under the section on teacher behavior variables that are related to student achievement.

Student Achievement

Learning is a process which enables people to modify or change their behavior (Gagńe, 1975:5). The occurrence is inferred from a difference in performance before and after being placed in a learning situation (Gagńe, 1977:19). The achievement of students can be considered as the change in performance due to learning. This view of achievement requires the consideration of student gain scores on achievement measures administered as pre- and post-tests (Berliner and Gage, 1975:86; Borich, 1977:27; Gage, 1963:116; Rosenshine, 1971:23).

Kerlinger (1973:493) makes the following statement concerning achievement tests:

> Achievement tests measure the present proficiency, mastery, and understanding of general and specific areas of knowledge. For the most part, they are measures of effectiveness of instruction and learning. They are, of course, enormously important in education and educational research. Indeed, in research involving instructional methods, achievement, as we have seen is often the dependent variable.

Remmers, Gage and Rummel (1965:181) view achievement in school as movement of students toward attainment of instructional objectives. Achievement is measured by the use of pre- and post-tests (Borich, 1977: 47). A pre-test is essentially a test to determine the level of achievement of students prior to instruction. A post-test is an achievement test in the sense that it is a test being used to measure student progress toward predetermined objectives.

Remmers, et al. (1965:106) identify two major purposes for achievement tests in addition to the research applications. The first is that achievement testing helps teachers keep themselves more reliably aware of student progress. The second is that achievement tests provide more dependable and objective bases for evaluating the educational program than subjective measures.

Scholastic aptitude tests are defined by Remmers, et al. (1965: 14) as intelligence tests that are used to predict future success in school.

> Scholastic aptitude is usually evaluated by means of grades a pupil has earned in preceding courses or tests of ability and achievement. The best single predictor of ability to succeed in future schooling is some measure of past school achivement. This information is not always available and in some instances is far from reliable. Originally tests designed to fill this need were called intelligence tests. Since many such tests have been validated on the basis of their ability to predict success in school, the more descriptive title, scholastic aptitude test, is becoming widely employed.

In continuing the discussion of academic aptitude, Remmers, et al. (1965:14) point out that achievement is described as what a student has learned while aptitude indicates how well the student may learn in the future. Aptitude focuses on previous achievement as a predictor of future achievement.

Popham (1968:2) conducted a study using student achievement in automotive mechanics as a measure of instructor effectiveness. Popham's report relates to the present study in that student achievement was represented by the classroom mean rather than achievement of individual students. Another implication for the present study was the use of

automotive mechanics student achievement for the purpose of conducting research in vocational education.

Another research study using automotive mechanics classes was reported by Finch (1969). The research was conducted at the post-high school level using students enrolled in the automotive curriculum at a community college. This study utilized student achievement in automotive mechanics as one of the major variables in a post-test only control group design (Finch, 1969:26). The major implications for the present study are the use of achievement in automotive mechanics as a criterion variable and the use of a test of mental ability as a covariate.

Finch and Bjorkquist (1970:38) in discussing process measures in occupational education evaluation make the following statement about standardized achievement measures.

> Achievement measures which are oriented toward specific vocational subject areas may provide useful information relative to the instructional process. . . . In recent years, standardized achievement tests have been developed which show great promise in the measurement of learning outcomes . . . . These measures have been painstakingly developed and report high test and subtest reliabilities.

The importance of this report to the present study is that the Ohio Trade Achievement Test is a typical example of the achievement measures described above.

Finch (1971) reported on research involving secondary students enrolled in automotive mechanics programs in area vocational centers. The study included the measurement of student performance or achievement among other variables (Finch, 1971:13). In addition to the use

of student achievement as a criterion measure, the research reported also used multiple regression analysis which is relevant to the present study (Finch, 1971:2). Occupational knowledge in automotive mechanics was also used as one of the criterion variables as reported by Finch (1971:23).

> It is virtually impossible to obtain comprehensive information about a person's occupational knowledge in a short period of time. As an alternative to this, it was decided to employ the Short Occupational Knowledge Test (Auto Mechanics) which has been developed by Science Research Associates (Campbell and Johnson, 1970). This test, which consists of twenty multiple choice items, has an adequate reliability index and has been shown to discriminate between auto mechanics and non-auto mechanics with a great deal of precision.

Use of the SOKT was particularly relevant to the present research as the "Short Occupational Knowledge Test" was used as one of two measures of automotive mechanics student achievement in the present study.

Janeczko (1972:14) reported on research which included college students enrolled in an advanced power mechanics course. The study dealt with instructional objectives and psychomotor performance of the students. The major implications for the present study are the use of video tapes in conducting research in power mechanics and the identification of the need for additional research concerning the differences between teachers and their use of instructional objectives.

Enderlein (1972:10) reports on a research study in vocational education which examined the relationship between student characteristics and shop or laboratory achievement as measured by the Ohio Trade

Achievement Test (OTAT) and end-of-course shop grades. This research is important to the present study since the Ohio Trade Achievement Test was used in conducting research with secondary eleventh and twelfth grade vocational students. Enderlein (1972:12) in discussing the development of objective means of assessing student learning states:

> One successful undertaking in this field of standardized testing in vocational education has been completed by the Instructional Materials Laboratory of the Ohio State University, with the development of the Ohio Trade and Industrial Education Test (OTAT).

Enderlein (1972:12) also refers to a report by Baldwin (1969):

> Baldwin (1969) states the feasibility of developing standardized instruments for measuring student learning in vocational-industrial education. It is demonstrated that valid and reliable measures for assessing student achievement can be produced with careful attention to test construction procedures which involve curriculum analysis, the use of a committee of experts to generate items, validation testing analysis and norming.

A research study by O'Reilly (1972) was reported as a part of a continuation study of vocational development. The report builds upon the work of Enderlein (1972) and others. O'Reilly's research dealt with the evaluation of in-school success criteria for vocational-technical students. The major implications for the present study by the research reported by O'Reilly (1972:21) are the use of the OTAT as one of the dependent variables used to indicate in-school achievement, the use of regression analysis and secondary level vocational students.

During the search for automotive mechanics achievement tests for use in this study several sources were considered. The test for automotive mechanics developed by the National Institute for Automotive Service Excellence (NIASE) was one possibility.

NIASE was established in June of 1972. McNulty (1974:15) reports on the purposes of NIASE.

> NIASE was organized to encourage and promote the highest standards of automotive service in the public interest. The institute conducts continuing research to determine the best methods of training automotive mechanics, encourages the development of effective training programs and evaluates the competence of mechanics through a testing and certification program.

The activities of NIASE were of interest in the present study in that a competency testing program is conducted for automotive mechanics. The test security regulations prevented the NIASE competency test from being used in this study. However, Herbert Fuhrman (1976), President of NIASE, refers to the test development procedures in a speech delivered to the National Association of State Directors of Vocational Education. Fuhrman (1976:4) indicated the use of an in-depth, empirically developed task analyses of the automotive mechanic occupation as basic input for the development of test specification and test items. Since this process is essentially the same as that used in developing the OTAT, Fuhrman's comments support the developmental procedures used for the OTAT.

TEACHER BEHAVIOR VARIABLES RELATED TO STUDENT ACHIEVEMENT

Process-product research has produced some of the most promising variables on the relationship between teacher behavior and student achievement (Rosenshine and Furst, 1971:42). Rosenshine (1971) reported on a review of over fifty process-product studies. Rosenshine

identified various teacher behavior variables and lists the authors of studies along with significant and non-significant results. Rosenshine (1971:11) indicated that the publication focused on a relatively new type of educational research and states:

> This book focuses on the state of our knowledge of the relationship between teacher behaviors and student achievement. The emphasis is on the observed or perceived behaviors (or activities) of teachers during instruction, and on the relationship between these behaviors and measures of student gain.

Rosenshine and Furst (1971) present a more interpretive discussion of the findings in reviewing the same group of studies. The review of research on teacher behavior and student achievement was continued by Rosenshine and Furst (1973:122) and reported in the Second Handbook of Research on Teaching.

Borich (1977:71) reports on five relatively recent large scale studies of teacher behavior and student outcomes. In addition to presenting results of the recent studies, Borich (1977:71) makes the following statement about previous research:

> Many early studies of teacher effectiveness were ably reviewed by Rosenshine and Furst (1971), who identified from all relevant research to that date, eleven teacher variables that have shown promising relationships to pupil gains in cognitive achievement. Five of those variables, the authors contend, have strong support from correlational studies, while six have less support but appear to warrant further study. The five teacher variables that have yielded the strongest relationships to pupil achievement and the number of studies supporting these variables are listed below:
>
> 1. Clarity: The cognitive clarity of teacher presentation (seven studies);
> 2. Variability: teacher's use of variety or variability during the lesson (eight studies);
> 3. Enthusiasm: teacher's vigor, power, involvement, excitement, or interest during classroom presentation (six studies);

4. Task-oriented or business-like behavior: Degree to which teacher is task-oriented, achievement oriented, and/or business-like (seven studies);
5. Student opportunity to learn criterion material: relationship between material covered in class and criterion pupil performance (four studies).

The five research studies completed since 1971 are reported in summary table form for comparison to the results of previous studies by Borich (1977:72). Rosenshine (1977) also attempts to analyze and report on the recent research since 1971.

Rosenshine (1977:118) reports the following elements for direct instruction based on the more recent research studies.

1. Time is structured by the teacher.
2. Questions are direct and narrow usually with a single answer and structured to obtain a high percentage of correct answers.
3. Teachers or materials provide immediate feedback.
4. Students work in small or large groups supervised by the teacher. There is little free time or independent-unsupervised activity.
5. There is less off-task student behavior.

It must be noted that the research analyzed by Rosenshine (1977) dealt primarily with low socio-economic students.

Research reviewed since the 1971 Rosenshine report does not refute, but tends to support, the use of variables suggested for further study at that time. The present study focused on the variables of variety/variability and student opportunity to learn criterion material.

Variety/Variability

Research devoted to teacher behavior and student achievement indicates the importance of the use of variety by teachers. Rosenshine and Furst (1971:45) report that a number of studies have focused on teacher use of variety or variability during a lesson.

Anthony (1967) counted the variety of the instructional materials, types of tests and types of teaching devices used by the teacher (Rosenshine and Furst, 1971:45). Significant results favoring variability were also reported in three additional studies.

Other studies focused on the flexibility of the teacher in procedures, whether the teacher was adaptable or inflexible, the amount of extra equipment, books, displays, resource materials and student activities used (Rosenshine and Furst, 1971:45). Correlations ranged from .24 to .54.

In summarizing their presentation on this variable, Rosenshine and Furst (1971:45) state:

> Both high-inference and low-inference correlational studies have indicated that student achievement is positively related to classrooms where a variety of instructional procedures and materials is provided, and where the teacher varies the cognitive level of discourse and of student tasks. It seems worthwhile to study experimentally the effects of training teachers to use this variety.

The continued use of this variable in research on teaching is supported by Rosenshine and Furst (1973:156). Two studies that used this variable were completed since 1973 (Borich, 1977:77). They were by Stallings and McDonald.

Stallings (1974) reported positive significant correlations for a "wide variety of activities occur concurrently" and a "wide variety of activities occur during the day." Stallings also found postiive relationships supporting the use of small groups and the use of text and workbooks.

McDonald (1977:131) reports that a variety of instructional materials was a positive predictor of student achievement. Direct instruction with individual students was also indicated as important in improving student performance (McDonald, 1977:131).

Student Opportunity to Learn Criterion Material

A question which often arises in research dealing with teacher behavior and student achievement is whether a criterion instrument is relevant to the instruction (Rosenshine and Furst, 1971:48). This question centers specifically on whether or not the material on the post-test was covered in the instruction provided to students after the pre-test was administered.

Rosenshine (1971:196) reports that: "Overall, the correlations between measures of student opportunity to learn and student achievement are positive, significant, and consistent." A study by Chang and Raths (1971:272) supports Rosenshine's report.

Rosenshine and Furst (1973:157) state:

> A measure of the student's opportunity to learn the criterion material appears to have value not only as a correlate of student achievement but also as a covariate in studies of student growth.

Several methods of determining student opportunity to learn are reported by Rosenshine and Furst (1973:137). These include reviewing lesson transcripts (Rosenshine, 1968; Shutes, 1969), coding by topic and sub-topic (Bellack, et al., 1966), by asking the teacher to estimate the number of students who had the opportunity to learn the items on the criterion test (Husen, 1967) and by asking the teacher to

estimate the amount of emphasis they gave to specific topics covered in a standardized test (Chang and Raths, 1971).

The study by Bellack was the only research reported above that did not show significant correlations between student opportunity to learn and student achievement. This is possibly due to the general coding by topic rather than focusing more specifically on the criterion items of the post-test.

These studies may be interpreted as indicating that it is possible to measure the degree to which teachers prepare their students on the criterion items of the post-test. Rosenshine and Furst (1971:49) report that such information has implications for consideration in statistical analyses of research on teaching.

PERSONAL CHARACTERISTICS OF TEACHERS

One of the most significant research studies dealing with characteristics of teachers was reported by Ryans (1960). Ryans (1960:1) states that relatively little reliable information is available regarding the nature of good teaching and the teacher characteristics which contribute to it. The focus of Ryans' research sponsored by the American Council on Education was toward identification and estimation of major patterns for teacher characteristics underlying teacher behavior (Ryans, 1960:1).

In reporting the characteristics of outstanding teachers, Ryans identified several characteristics of interest in the present study.

Ryans concluded that age must be taken into account as a relevant independent variable whenever teacher characteristics are considered in research (Ryans, 1960:390). The teacher characteristics study by Ryans (1960:390) indicates that teachers over fifty-five years of age were consistently rated higher than younger teachers on business-like behavior. However, the younger teachers were consistently higher on the other variables in the study.

In reporting on the number of years of teaching experience, Ryans (1960:391) states:

> As might be expected, trends with regard to extent of teaching experience are not substantially different from those noted when teachers were classified according to age. There was a general tendency for teachers with extended experience to score lower than less experienced teachers on most of the variables. Y_{CO} (responsible, businesslike behavior in the classroom), however, was a notable exception; in this case the more experienced teachers scoring significantly higher than the less experienced.

Additional variables which show correlations of .32 or greater, that are of interest in the present study, as reported by Ryans (1960: 355), are: reading of books and magazines, community service activities, volunteer worker with youth organizations, membership in clubs and associations and amount of college credits earned.

Hartlage and Schlagel (1974:191) confirm the findings of Ryans in that teacher age was found to be a significant variable as related to student classroom behavior. The effect of years of teaching experience on teacher effectiveness as rated by students was found to be significant in a study reported by Hardy and Bohren (1975:162).

Lipsitz (1971:151) reported that flexibility and other variables were related to positive pupil classroom behavior. It should be pointed out that Lipsitz and Ryans seem to be identifying teacher behavior variables at times and referring to them as teacher characteristics and at other times refer to personal characteristics as teacher characteristics. Obviously, some researchers have combined teacher personal characteristics and behavior variables under one heading of teacher traits or characteristics.

Several studies were located which dealt with characteristics of vocational teachers. Finch (1969:55) reported on research designed to identify personal attributes of trade and industrial teachers related to personal and interpersonal values and attitudes. The primary personal characteristics used by Finch (1969:57) were: age in years, years of occupational experience, years worked on teacher certification, undergraduate credits in vocational teacher education, other undergraduate credits, and graduate credits. Significant relationships were reported between teacher attitude and the following teacher variables: teaching certificate held, undergraduate credits other than vocational, and graduate credits.

Swartz (1974) conducted research to determine the effects of years of trade experience, years of teaching experience, and semester credit hours of professional education on the teaching performance of secondary vocational industrial teachers. Teaching performance was rated by school administrators, supervisors, teacher-peers, teacher's self-rating, and students. Swartz (1974:101) reported the following

results. Teacher performance was not significantly influenced by varying levels of trade experience, teaching experience, or professional education when ratings by all five rating groups were analyzed together. However, when rated by supervisors, trade experience significantly affected performance ratings. Increased trade experience also influenced performance when rated by a self-rating by teachers. Levels of professional education significantly affected teachers' self-ratings of their own performance. Swartz also indicated that teachers who reported high levels of professional education had high levels of vocational industrial education (Swartz, 1974:106).

A research report by Bisbee (1975:18) included only beginning vocational teachers, their characteristics and role perceptions. The study divided beginning teachers into three groups according to pre-service educational preparation. Findings indicate that the three groups were different in terms of work experience and their role perceptions of the position of vocational teacher (Bisbee, 1975:21). The three major personal characteristics included in the study were age, educational preparation, teaching experience other than vocational, and occupational work experience (Bisbee, 1975:20).

Oscarson (1977:25) studied the personal characteristics of vocational teachers as a means of identifying adoption-proneness. The independent variables used by Oscarson (1977:28) which are relevant to the present study are: age, number of years in teaching, level of educational achievement, recency of professional education, number of publications read monthly, membership in professional organizations, number

of school districts in which the teacher has taught, and the number of years teaching in the present school system.

The data on the personal characteristics identified above was obtained by using a biographical data form (Oscarson, 1977:29). Oscarson reports on the choice of these variables as follows: "Content validity for this instrument was established from the literature search based on what other studies have shown to be valid predictor variables."

In reporting results, Oscarson (1977:33) identified five variables through regression analysis that are predictive of adoption-proneness. The three variables, among the five, that are of interest in the present study include age, number of publications read monthly, and number of years teaching in the present school district. These results are of interest in the research herein reported since they establish relationships between personal characteristics of teachers and criterion variables used in research studies.

Personal Characteristics of Teachers and Teacher Behavior

In discussing a review of research concerning teacher characteristics and teacher behavior, Jansen, et al. (1972:529) state:

> . . . there are quite a few studies which link teacher characteristics with teacher behavior. These studies have not produced uniform results, but on the whole they show little or no relationships.

While the above quotation on the surface appears to discourage additional research concerning the relationships of teacher characteristics and teacher behavior, an in-depth review of the research reported

by Jansen, et al. (1972:529) reveals that the majority of the teacher characteristics studied were identified from personality tests or focused on teacher expectations of achievement. Only one of the studies reported by Jansen, et al. (1972:534) included personal biographic type variables discussed in the previous section of this review of literature. This study was by Biddle and Adams (1967). Biddle and Adams reported that selected teacher behaviors were found to be differentially affected by sex and age.

Perham (1973) reported a research study which investigated the multiple relationships among teacher characteristics, teaching beahviors and student performance. The teaching behaviors were defined as the verbal behaviors of the teachers, structuring the classroom by the teacher, and the structuring comments by the teacher. Teacher characteristics included in the study were years of teaching experience, inservice courses and the opinion of the teacher concerning the research program. Results included several significant relationships between the dependent variables, teacher characteristics, and the criterion variables of teacher behavior.

Personal Characteristics of Teachers and Student Achievement

Many studies have been conducted which deal with teacher characteristics and student achievement. One of the more recent studies was reported by Kapes and Pawlowski (1976:5). The Kapes and Pawlowski (1976:5) study is relevant to the present research in that secondary

vocational students were used including those enrolled in auto mechanics. Additionally, OTAT scores were used to represent student achievement. Kapes and Pawlowski (1976:5) state:

> To make valid judgements about the relationship between student achievement and teacher characteristics, it is essential that differential achievement be associated with specific teacher characteristics.

Teacher characteristics used in the study by Kapes and Pawlowski (1976:7) were teaching experience in years, industrial experience in years, and college credits earned. The findings indicated that credits earned had more effect on student achievement than the other two characteristics examined. A trend was also reported that teachers with more teaching experience and less industrial experience were effective in producing greater student achievement. However, this trend was not statistically significant.

Kapes and Pawlowski (1976:8) report other studies that support the use of OTAT scores in research. These included research by Kapes and Long (1971) and Kapes and O'Reilly (1973). The studies were reported to have shown the OTAT to be highly reliable and a valid measure of student shop achievement.

Shoemaker (1971) reported on research relating OTAT scores to selected teacher characteristics. This research involving secondary vocational auto mechanics and machine shop students indicated that age, college credits, and teaching experience have no significant relationship to student achievement. The number of years of occupational work experience was reported as having a significant relationship to student achievement (Shoemaker, 1971).

Rumpf (1954) reported research involving teacher characteristics and teacher performance. The findings indicated that there were no significant relationships between industrial experience and teacher performance. The number of college credits earned and teaching experience yielded low positive correlations with teaching performance (Rumpf, 1954).

The Ohio Trade and Industrial Education Service (1965) reported a pilot study used to validate tests of student achievement. This research indicated that a teacher's skill in and knowledge of the occupation are the two most important factors contributing to student achievement. The occupational experience of the teacher was reported as a significant factor related to student achievement. Teacher characteristics not related to student achievement reported by this study were age, grade level, education completed, years of teaching experience in present trade, total teaching experience, and degrees held.

It was concluded that the research concerning teacher characteristics and student achievement has produced conflicting results at this point in time. However, continued research using these variables can be beneficial in that a trend may be detected and factors identified which lead to an explanation of the conflicting results. Continued research using these variables also permits comparisons between present and previous findings.

APPROACHES TO MEASUREMENT OF STUDENT ACHIEVEMENT

Several approaches to the measurement of student learning exist. Rosenshine (1971:23) in reporting on research on teacher behavior and student achievement states:

> Almost all of the investigations used regression procedures to adjust the post-test scores for initial differences. When correlational analyses were used, the most common procedure was to compute the residual gain scores; that is, the difference between the actual post-test score and the score that would have been expected on the basis of the initial score. This technique is identical to partialling out the initial score.

Rosenshine (1971:24) also reported that the use of difference scores, that is, the score obtained by subtracting the pre-test scores from the post-test scores are not considered acceptable statistics. Reference is also made by Rosenshine to the article by Cronbach and Furby (1970) which questions the use of regression scores to adjust for initial differences in samples which are not randomly selected (Rosenshine, 1971:24).

Cronbach and Furby (1970:68) make the following statement concerning the measurement of change.

> "Raw change" or "raw gain" scores formed by subtracting pre-test scores from post-test scores lead to fallicious conclusions, primarily because such scores are systematically related to any random error of measurement . . . gain scores are rarely useful no matter how they may be adjusted or refined.

Much confusion in the literature is caused by a failure of researchers to clearly distinguish purposes of their research and to match appropriate methodological designs to the identified purposes (Cronbach and Furby, 1970:78). Four types of studies were identified by Cronbach and Furby (1970) in which gain scores had been used. The studies are:

1. The randomized experiment
2. Comparison of treatment groups not formed at random
3. One-group designs
4. Criteria in correlational studies

Only one of the above types of studies should use gain scores according to Cronbach and Furby (1970:68). It is suggested that studies involving comparison of treatment groups not formed at random be analyzed by calculating within group regression functions relating post-test scores to pre-test scores with a covariate considered and use the covariance matrix for true scores. It is important to note that Cronbach and Furby (1970) and Cronbach, et al. (1972) are extending the work of Lord (1963), Harris (1963) and others referenced in their 1970 report.

Cronbach and Snow (1977:23) devoted a section to "gain scores as the dependent variable." They reported that some new relationships have developed since the report of Cronbach and Furby in 1970 and that this information helps to interpret studies already in the literature where gain scores or residual gains have been analyzed. Cronbach and Snow (1977:75) state:

> This is important . . . because it means that previous workers who have taken gain or adjusted outcomes as a dependent variable have reported accurate information about the differences in slopes. The same difference should have been reported if unadjusted outcomes had been the dependent variable.

Cronbach and Snow (1977:76) in continuing to discuss this problem, state that it is not clear which form of the dependent variable will generally give the least error variance and hence the greater power. They identify three possibilities for the dependent variable: (1) the adjusted post-test scores, (2) the raw post-test scores, and (3) difference scores determined by subtracting the pre-test scores from the post-test scores.

Kerlinger (1973:337) after discussing the problems outlined above makes the following recommendation concerning difference scores.

> The generally recommended procedure is to use so-called residualized or regressed gain scores, which are scores calculated by predicting the post-test scores from the pre-test scores on the basis of the correlation between the pre-test and post-test and then subtracting these predicted scores from the post-test scores to obtain the residual gain.

This basic procedure is also discussed and supported by Borich (1977: 165), Medley (1977:11), Medley, et al. (1975:30), and Rosenshine (1971: 23).

SUMMARY

The review of research and literature relative to this study reveals that:

1. Research into teacher behavior has been conducted through direct observation of teaching in classrooms (Medley and Mitzel, 1963; Rosenshine, 1971; Soar, 1972; Rosenshine and Furst, 1973; and Borich, 1977).

2. In considering student achievement in research on teacher behavior, pre- and post-tests have been used to determine student gain scores (Berliner and Gage, 1975; Borich, 1977; Gage, 1963; and Rosenshine, 1971).

3. In conducting research on instructional methods, achievement tests are often used as the dependent variable (Kerlinger, 1973).

4. Aptitude measures focus on previous achievement as a predictor of future achievement (Remmers, et al., 1965).

5. Achievement measures have been used in conducting research in vocational automotive mechanics programs (Popham, 1968; Finch, 1969; and Finch, 1971).

6. The OTAT and SOKT have been used in conducting research in vocational education (Finch and Bjorkquist, 1970; Finch, 1971; Enderlein, 1972; and O'Reilly, 1972).

7. Written tests based on a task analysis and developed by a committee with test specifications and items being generated from the analysis represent effective measures of occupational performance (Fuhrman, 1976).

8. Teacher behavior variables that are related to student achievement include variety/variability and student opportunity to learn (Rosenshine, 1971; Rosenshine and Furst, 1973; and Borich, 1977).

9. Student opportunity to learn criterion material has been reported as a significant component of teacher behavior related to student achievement and is also recommended for use as a covariate in studies of student growth (Rosenshine and Furst, 1973).

10. Research dealing with teacher personal characteristics has yielded conflicting results with some studies reporting significant findings for certain variables and other research indicating non-significant results for the same variables (Ryans, 1960; Lipsitz, 1971; Hartlage and Schlagel, 1974; Finch, 1969; Swartz, 1974; Bisbee, 1975; and Oscarson, 1977).

11. Research involving teacher behavior has yielded significant relationships to selected personal characteristics of teachers (Biddle and Adams, 1967; and Perham, 1973).

12. Personal characteristics of vocational education teachers have been correlated with student achievement resulting in conflicting findings (Kapes and Pawlowski, 1976; Shoemaker, 1971; and Rumpf, 1954).

13. It is recommended that many variables from previous research be used in current research to maintain a degree of replication and aid in the comparison of results from one study to another (Medley, 1977).

14. Regressed gain scores (residual scores) are recommended for use in research using pre-tests and post-tests (Rosenshine, 1971; Medley, 1975; Medley, 1977; Borich, 1977; and Kerlinger, 1973).

Chapter 3

RESEARCH METHODOLOGY

INTRODUCTION

The primary objective of this research was to investigate the relationship between a selected index of vocational industrial automotive mechanics teacher behavior and the achievement of vocational industrial automotive mechanics students taught by these teachers. The research also focused on student opportunity to learn and personal teacher characteristics. This was a direct observation process-product study. Teacher behavior was observed in actual shop/laboratory settings. This chapter presents sections on research design, sample, instruments, data collection, treatment of data, pilot study, and reliability.

RESEARCH DESIGN

The basic research design for this study was ex post facto. Kerlinger (1973:379) defines ex post facto research as indicated below:

> Ex post facto research is systematic empirical inquiry in which the scientist does not have direct control of independent variables because their manifestations have already occurred or because they are inherently not manipulable. Inferences about relations among variables are made without direct intervention, from concomitant variation of independent and dependent variables.

Ex post facto research is contrasted to experimental research in that in an experimental design the investigator manipulates at least one independent variable (Kerlinger, 1973:315; Campbell and Stanley, 1963:1). The present study used the ex post facto model in that it was the intent of the research to determine the relationship between naturally occurring classroom teacher behavior on a selected variable, student achievement, student opportunity to learn and selected personal characteristics. Kerlinger (1973:408) in discussing field studies indicates that direct observation research is considered to be a field study and therefore ex post facto.

The vocational automotive mechanics class achievement, teacher personal characteristics, student opportunity to learn and teacher behavior were the basic areas of measurement. Pre-tests were administered near the beginning of a given semester and post-tests later during the same school year. Achievement was indicated by the class mean of the residual gain scores. Student opportunity to learn criterion material on the SOKT was also measured. Student academic aptitude was used as a covariate in determining residual gain scores.

SAMPLE

The automotive mechanics teacher is similar to other vocational industrial teachers in that the program of instruction requires teaching activities concentrating on technical information and skilled performance in a proportion that is comparable to other vocational industrial programs. Automotive mechanics teachers are characterized by having

occupational experience, teaching knowledge and skills, and taking in-service teacher education courses. These and other characteristics compare favorably with the characteristics of other vocational industrial teachers. The population of teachers for this study consisted of thirty-five secondary level automotive mechanics teachers in West Virginia during the 1978-79 school year. The sample of teachers consisted of thirty-two of the thirty-five teachers. All thirty-five teachers were invited to participate. Thirty-two accepted and participated.

Automotive mechanics teachers were selected in this study for two major reasons: (1) there were more secondary level automotive mechanics programs in West Virginia than any other single program area within vocational industrial education and (2) automotive mechanics teachers are generally similar to other vocational industrial education teachers. This research provided for an in-depth study with a specific sub-group that has similar characteristics to other vocational industrial teachers. This approach also controls for the variable of the teaching area within vocational education.

Since some automotive mechanics programs in West Virginia are designed for special needs students, the programs from which the population was selected were those that had been identified by the State Department of Education as "regular" secondary vocational automotive mechanics programs. This selection was verified by the State Supervisor of Industrial and Technical Education for West Virginia. Also, persons

who teach only the first year of the program with another teacher conducting the second year of the program were eliminated from the population.

INSTRUMENTS

Five basic types of information generating instruments were used in this study:

1. The teacher observation instrument
2. Student achievement measures
3. Teacher personal characteristics
4. Student opportunity to learn criterion material
5. Student academic aptitude.

Teacher Observation Instrument

The review of literature relative to teacher observation revealed a number of observation instruments for this type of study; however, they were not appropriate to the present research in the context of vocational education. Therefore, a teacher observation instrument was developed as a part of the research through the use of a pilot study and reliability calculations. The instrument has been named "Vocational Teacher Observation of Process System" (VTOPS).

The observation instrument was designed to reflect one of the dimensions of teacher behavior identified from the review of literature (variety/variability). VTOPS was developed through an extensive review of items used in more than twenty other observation instruments that had been developed to investigate one or more facets of the index of

behavior identified for this study. Development of the observation instrument is discussed in detail later in this section. Appendix A presents the VTOPS instrument.

Seventeen separate teacher behavior items were selected for the VTOPS instrument because they describe separate activities in which teachers may be engaged while teaching students in laboratory/shop settings. Item inclusion was based on previous use in teacher observation research and to describe possible vocational teacher behavior in actual laboratory/shop teaching situations. The rationale for the inclusion of each item is given below:

Item 1 - Teacher looks at notes or a reference. This item was included on the instrument since vocational teachers typically look at specifications, plans, shop manuals, etc. as a part of their teaching activity. Other instruments which have included this item were used by Morsh; Brown, Ober, Soar and Webb (Simon and Boyer, 1974).

Item 2 - Teacher gives information (facts). This item indicates that the teacher is giving factual information through lecture, discussion, individual conversation, etc. This item is different from item 3 in that item 3 includes details of examples or the consequences or effects of previously stated facts. This item has been used in many studies. Some of the previous researchers using this item are: Morsh; Medley; Amidon; Amidon and Hunter; Anderson; Bellack; Brown; Brown, Ober, Soar and Webb; Flanders; Ober; Smith and Meux; Solomon; and Wright (Simon and Boyer, 1974).

Item 3 - Teacher explains, gives examples and details. This item is an outgrowth of item 2 as explained above. Previous researchers who have used this item are: Morsh; Medley; Amidon and Hunter; Anderson; Anderson and Bingman; Bellack, Brown, Ober, Smith and Meux; Solomon; Stukat and Engstrom; and Wright (Simon and Boyer, 1974).

Item 5 - Teacher asks a question. This item is to be tallied any time the teacher asks a question. Many researchers have investigated teacher questioning behavior. Instruments using this or a similar item are reported in Simon and Boyer (1974) for the following researchers: Morsh; Medley; Amidon; Amidon and Hunter; Anderson; Brown; Flanders; Stukat and Engstrom; Wallen, Moohr, Hall and Weisberg; and Withall. This item is also given additional emphasis by Rosenshine (1977).

Item 6 - Teacher asks for questions. This item focuses on the teacher asking for questions from students. Several studies have included this item. They are: Morsh, Medley, Bellack, and Stukat and Engstrom.

Item 7 - Teacher answers question. This item identifies the frequency with which students ask questions which are answered by the teacher. Some of the researchers who have used this item in previous studies are: Morsh, Medley, Anderson, Bellack, Brown, Ober, and Wright (Simon and Boyer, 1974).

Item 8 - Teacher gives directions. This item tallies the frequency with which the teacher gives directions to one or more students. Many researchers have used this item previously. Several of them are: Morsh; Medley; Amidon; Amidon and Hunter; Anderson; Bellack; Brown;

Brown, Ober, Soar and Webb; Flanders; Ober; Smith and Meux; Stukat and Engstrom; Withall; and Wright (Simon and Boyer, 1974).

Item 9 - Teacher uses trade tools. This item was added to the observation instrument due to a knowledge of vocational teacher use of materials and methods in actual teaching situations. This item did not appear on any other observation instruments that were reviewed.

Item 10 - Teacher uses a training aid. For the purpose of this instrument training aid refers to any mock-up, cut-away, or other simulation device which may be used as an aid in teaching the vocational specialization. Several other researchers have used this item. They include Morsh, Bellack, Solomon, Stukat and Engstrom (Simon and Boyer, 1974).

Item 11 - Teacher uses A-V device. A-V device in this item means any audio or visual aid, machine, chart, etc. which is used by the teacher to help bring about learning in students. Morsh, Bellack, Flanders, Solomon, and Stukat and Engstrom are other researchers who have previously used this item as reported in Simon and Boyer (1974).

Item 12 - Teacher demonstration of skill. This item focuses on the teacher showing the student or students how to do something. This item has been used by Morsh; Brown; Ober, Soar, and Webb; Smith and Meux; and Solomon (Simon and Boyer, 1974).

Item 13 - Monitoring. Teacher observations of student activity. This item is designed to tally the frequency with which the teacher observes student activity including movement from one student or group

of students to another. Flanders and Wright have also used this item according to Simon and Boyer (1974).

Item 14 - Teacher participates in student activity (helps). The frequency on this item indicated the extent to which the teacher provides direct assistance to a student or students performing an assigned learning activity. Simon and Boyer (1974) report that Anderson; Brown; and Wallen, Moohr, Hall and Weisberg have also used this item in conducting research.

Item 15 - Teacher works with an individual. This item indicates that the teacher is working with a single student on a one to one basis. Other researchers who have used this item are: Brown; Flanders; Stukat and Engstrom; Wallen, Moohr, Hall and Weisberg according to Simon and Boyer (1974). More recent research on this item was also reported by McDonald (1977) and Rosenshine (1977).

Item 16 - Teacher works with small group. Small group as used in this item is defined as any number of students between two and eight inclusive. Other researchers who have focused on teachers working with small groups of students include: Brown; Flanders; Stukat and Engstrom; and Wallen, Moohr, Hall and Weisberg according to the instruments reported by Simon and Boyer (1974). Additional research reports that have used this item are described by Stallings (1974) and Rosenshine (1977).

Item 17 - Teacher works with large group. This item is defined as any group of students having nine or more students including

the entire class. Simon and Boyer (1974) reported that other researchers who have used this item are Brown; Flanders; Stukat and Engstrom; and Wallen, Moohr, Hall and Weisberg.

These items were selected because they are descriptive of teacher behavior in the use of instructional methods, materials, devices, activities and procedures. Variation in the frequency of use of these seventeen items by teachers result in two distinct overall scores. A total of all frequencies for the seventeen items during a given observation period yields a quantity score. This score is defined as the variety quantity (VQ) score. The other overall score is the total number of separate items the teacher uses in a given observation period. This is defined as the variety range (VR) score.

Although the VR score is contained within the VQ score in terms of frequency counts, and VQ correlation with VR is expected, the VR score logically describes a dimension of variety that is not revealed by the VQ score. Therefore, both scores are desirable in seeking to describe the dimension of variety/variability as a measure of teacher behavior. The VTOPS instrument is designed for an observation period of twenty-five minutes. This period is sub-divided into five segments of five minutes each.

VTOPS is basically a category system. Rosenshine (1971:18) reports that category systems are observation instruments in which each behavior of the teacher is counted whenever it occurs. The rating system is identified as a questionnaire that an outside observer uses

to estimate (rate) the behavior of the teacher on a five-point or seven-point scale (Rosenshine, 1977:18).

The use of an observation instrument for research requires objectivity on the part of the observer. Objectivity in this context means that the observer must be objective in the sense of being unbiased and relatively free from injecting personal feelings and prejudice into the observations. Objectivity in this sense means validity of observation.

Ober, et al. (1971:79) discuss the comparison of observations by an observer to the observations of an expert as inter-rater agreement. It is recommended by Ober, et al. that in determining inter-rater agreement the observations be made by the two observers from the same classroom presentation at the same time or by the use of recordings.

This accuracy of judgment in classifying teacher behavior is referred to by Ober, et al. (1971:79) as validity of observation. They recommend the use of Scott's coefficient in computing this inter-rater agreement. Thus validity of observation when using the Scott coefficient is a percentage of rater agreement between the observer and expert, with correction for chance factors and the perfect rating (Ober, et al., 1971: 79). Scott's coefficient was reported by Scott (1955:321). This procedure was followed as a preparation step prior to conducting the pilot study.

The consistency of judging observed behavior by the same observer is referred to as intra-observer reliability or simply observer reliability by Ober, et al. (1971:79). This requires repetition of data

collection on the same classroom situation. Ober, et al. (1971:79) suggest that data be collected from a taped classroom presentation at one time and after a period of time has elapsed the same observer is to categorize the behavior from the same tape under similar circumstances. Comparison of the two observations by use of Scott's coefficient is then an index of observer reliability.

For the purpose of this study a video tape was used along with an expert observer to compute inter-rater reliability or agreement for the researcher. The video tape was also used by the researcher to conduct observations necessary for computation of intra-observer reliability. Scott's coefficients computed for inter-rater agreement and intra-observer consistency represent validity of observation and observer reliability respectively.

As reported by Ober, et al. (1971:85), Scott's formula is:

$$r = \frac{P_o - P_e}{1.00 - P_e}$$

where:

P_o = Total agreement between observers or between two observations by the same observer

P_e = Chance agreement

1.00 = Greatest possible agreement

In discussing reliability of observational studies, Rosenshine and Furst (1973:168) state that the term reliability has been given several meanings. They report that observer agreement is the most common form of reliability. This is supported by Medley and Mitzel

(1963:253) and Rosenshine (1971:21). Rosenshine (1971:21) and Rosenshine and Furst (1973:168) report that rater consistency is the second most common meaning of reliability in observational studies.

According to Medley and Mitzel (1963:250), the validity of behavior measurement is dependent on three conditions. The three conditions are:

1. A representative sample of the behavior to be measured must be observed.
2. An accurate record of the observed behavior must be made.
3. The records must be scored so as to faithfully reflect differences in behavior.

Each of these conditions were met in the present study. This assures validity of measurement of behavior. The section on data collection, presented later in this chapter, describes how these standards were achieved.

Student Achievement Instruments

Two student achievement instruments were used in this study. These instruments included the Short Occupational Knowledge Test for Auto Mechanics (SOKT) and the Ohio Trade and Industrial Education Achievement Test for Automotive Mechanics (OTAT).

The SOKT was designed to determine how familiar a person is with the current information and concepts of a given occupation. The object of the test is to discriminate between the person with only limited knoweldge as compared to competent experienced workers, last-year apprentices and advanced vocational school students (Campbell and Johnson, 1970:2).

The reliability of the SOKT for Auto Mechanics is reported by Wiseman (1972:1522) as a measure of internal consistency by using the Kuder-Richardson Formula 20. The reliability for the pre-test group was .81, and for the validation sample the reliability was reported as .88. Alternate form correlations of test Form A versus Form B produced reliabilities of .87 for the pre-test sample and .93 for the validation sample.

Concurrent validity of the SOKT was reported as how often the people who were actually specialists and control group subjects were correctly classified by the test. The concurrent validity for the Auto Mechanics test is given as .875 for the pre-test group (Campbell and Johnson, 1970:5). Wiseman (1972:1522) reports that content validity appears to be adequate for the SOKT for Auto Mechanics as a result of the method of question selection. Criterion related validity for the SOKT Auto Mechanics test is indicated by a significant correlation between SOKT scores and skill proficiency of automotive students (Finch, 1971:50).

Kapes and Long (1971:13) recommend that the Ohio Trade Achievement Tests be used in planning and conducting research and evaluation studies. They state:

> For research purposes, the battery would be specially useful in providing a standardized basic series of observations for longitudinal studies of student development as trainees move through the vocational program.

The automotive mechanics portion of the OTAT was revised and brought up to date in 1977. Automotive mechanics OTAT reliability coefficients reported for high school seniors are given below:

K-20 reliability = .970

K-21 reliability = .965

Content validity of the OTAT is assured by the procedures and personnel used in test development. A committee is organized to develop or review a test. The committee includes a member of the state supervisory staff, a teacher educator, a local supervisor of trade and industrial education, selected teachers of the vocational specialization and a non-teacher member of the occupation. The committee bases its work on a comprehensive occupational task analysis, develops and revises questions, performs an item analysis, and reviews the test annually for applicability to current occupational practice and requirements (Davis, 1977:1).

Kapes and Long (1971:12) report a stability coefficient of .69 for the OTAT in a one year longitudinal comparison of the same students. Students were tested as high school juniors and one year later the same students were tested as seniors. Kapes and Long (1971:12) conclude that the OTAT appears to validly measure those aspects of occupational achievement that can be determined with a written test instrument.

Personal Characteristics

The personal characteristics of the automotive mechanics teachers included in the study were acquired through the use of the "Teacher Personal Characteristics Profile" (see Appendix B). This instrument was used to collect the data to describe the teachers and to supply information needed for the correlation of selected teacher characteristics with

teacher behavior, student achievement, and student opportunity to learn. The instrument includes six nominal variables and thirteen interval scale variables.

Item eight on the TPCP was vocational education and training. Since many of the teachers accumulated hours from various sources, it was desirable to score this item to convert total clock hours to equivalent years of vocational training. This was accomplished by dividing the total hours of vocational education and training by 540 hours. This yielded a number equivalent to the number of years of vocational education based on three hours per day for 180 days per year.

Student Opportunity to Learn Criterion Material

The instrument used in determining student opportunity to learn criterion material was constructed such that each automotive mechanics teacher would read each question on the SOKT for Auto Mechanics and respond on a Likert type scale indicating the extent of the opportunity that the students in his class had to learn the material required to answer each question correctly. Scale items were from one to four. The number one indicated that there was no opportunity to learn that particular information. Two represented limited opportunity to learn. Three indicated that the material was included in the class and the student should be able to answer the question based on attending the class. Four indicated that the material was given substantial emphasis and most students in the class should know the answer to the question. This activity required the teacher to recall or remember the degree of emphasis given to the criterion questions during instruction.

The Likert scale item ratings were summed for all questions on the SOKT with the total for each teacher representing the variable of student opportunity to learn for that class. The instrument used for SOL is presented in Appendix G.

Although it was most desirable to use the OTAT as the criterion instrument in studying SOL, the SOKT was used instead. Test security regulations for the OTAT prevented the researcher from using it as the measure of achievement for student opportunity to learn criterion material.

Student Academic Aptitude

Student academic aptitude was measured by the California Short Form Test of Academic Aptitude (CTAA). The test was administered as a sub-test of the OTAT. The CTAA is made up of two sections, language and non-language. The language section contains forty-five items designed to measure vocabulary development and memory. The non-language section has forty items which measure logical reasoning and quantitative relations (Davis, 1977:4).

Davis (1977:15) also reports on the reliability of the CTAA. The KR-20 reliability coefficients reported are: non-language section, .88; language section, .90; total test, .93.

DATA COLLECTION PROCEDURES

The instruments described above were used to collect data needed to examine the research questions of this study. Basic data collection procedures and scheduling are described in this section.

Teacher behavior was observed and categorized during the school year after the pre-test and before the post-test. The various behaviors contributed to variety-variability measured by the VQ and VR scores on the VTOPS instrument.

The observation instrument VTOPS was used to collect the data relative to the index of teacher behavior. VTOPS was used four times in each class. Collection of data on teacher behavior was accomplished by these four observations. Teachers were not made aware of the exact time or day of the observation visits. Visits were random in terms of content presentation and teacher behavior.

The preparation of the VTOPS instrument and the intra-observer reliability of the researcher provided an accurate record of the sample of behavior. All necessary scoring of observed data was done after the observation visit. This procedure was followed to assure that the scoring process did not interfere with observation accuracy. Steps were also taken to reduce observer influence on teacher behavior and students during the visit. These steps included standing in the background, moving quietly and unobtrusively in the shop, and keeping the observation record from the view of both teacher and students.

Collection of student achievement data required two separate testing periods. Pre-tests were administered to each class as early as possible in the fall semester of school year 1978-79. Post-tests were administered in March of 1979 to the same classes that took the pre-tests. Supervisory or guidance personnel in each school administered the SOKT. The OTAT was administered through the Instructional Materials Laboratory,

Ohio State University, in accordance with their established policies and procedures.

Selected teacher personal characteristics were quantified by having the automotive mechanics teachers complete a questionnaire through interview techniques. Interviews were conducted by the researcher during the second observation visit. Personal characteristics had been selected to describe the automotive mechanics teachers included in the sample and to serve as possible correlates of teacher behavior, student achievement, and student opportunity to learn.

Student opportunity to learn was determined at the time of the post-test administration. After students had completed all tests, teachers responded to the questions on the student opportunity to learn instrument. The SOL instruments were mailed to teachers during the same time period that post-tests were being given. This was done immediately upon conclusion of the teacher observation activity in March, 1979. Teachers were instructed to read each question on the SOKT and indicate the degree of opportunity their students had in class to learn the material required to answer the question correctly. Upon completion of the SOL instrument teachers mailed them to the researcher.

Data collection concerning student academic aptitude was accomplished by administering the Short Form of the California Test of Academic Aptitude. The academic aptitude test (CTAA) is a part of the OTAT; therefore, the CTAA was administered at the same time and under the same conditions as the OTAT.

TREATMENT OF DATA

Research questions were formulated and presented in Chapter 1 to facilitate the examination of the research problem. This section explains the data treatment and procedures for analyzing the data with respect to each research question.

Data were analyzed using the statistical procedures available through the computer programs of the Statistical Package for the Social Sciences (Nie, et al., 1975) and the Statistical Analysis System (Barr, et al., 1976). The specific computer programs included Pearson product moment correlations, multiple regression analysis, analysis of variance, and computation of descriptive statistics.

Analysis of variance computations were performed by use of the SAS ANOVA procedure. Pearson product moment correlations were computed through the PEARSON CORR program in SPSS. Computation of descriptive statistics was achieved with the SPSS CONDESCRIPTIVE computer program. The multiple regression analysis was computed by using the SPSS REGRESSION procedure.

Regression analysis using pre-test scores on the OTAT and the California Short Form Test of Academic Aptitude (CTAA) were performed to predict post-test scores on the OTAT. The regression analysis was repeated for the SOKT. CTAA and SOKT pre-test scores were used to predict SOKT post-test scores. Residual gain scores were computed by subtracting predicted post-test scores from the actual post-test scores. These residual gain scores represented the variables for student achievement. The class mean residual gain scores were then computed.

Pearson product moment correlations were calculated for each of the seven research questions. Table 1 illustrates the variables included in each research question.

PILOT STUDY

A pilot study was conducted by using six teachers and two observations. The VTOPS instrument was used in the form intended for the main study in that the instrument had not been previously used in an actual research study. The purposes of this study were to test the VTOPS instrument under actual conditions of the main study and to compute a preliminary reliability coefficient.

Six teachers selected for the pilot study were located in south-central West Virginia since they were in relatively close commuting distance for the researcher. The observations were made during the week of November 13, 1978.

Reliability was calculated by using the formula described by Medley and Mitzel (1963:309). Although the first estimate of reliability was relatively low, it was expected to increase by using the thirty-two classes and four observations.

While reviewing the results of the pilot study VQ scores, the researcher noted that for one teacher the difference between the two observed scores were substantially greater than the differences between the VQ scores for the other teachers. This observed difference stimulated reflective thought on the two observations for the teacher with

Table 1

Matrix of Variables and Research Questions

	VTOPS VQ Score	VTOPS VR Score	OTAT	SOKT	SOL	TPCP
VTOPS VQ Score						
VTOPS VR Score						
OTAT	RQ-1	RQ-2				RQ-4
SOKT					RQ-3	
SOL						RQ-5
TPCP	RQ-6	RQ-7				

the large difference. This reflection revealed that during one of the two observation visits the teacher was engaged in non-productive behavior for a portion of one of the observations due to class interruptions. This must be contrasted to the observations of the other teachers who were engaged in developmental learning activities for the entire length of both of the observation visits.

For these reasons it was decided to calculate a new pilot study reliability coefficient using a different teacher. It was also decided to visit the teacher who exhibited the non-productive behavior in order to obtain new data to be included in the main study.

A second reliability coefficient for the pilot study using a different teacher was computed. This was considered to be a more realistic estimate of reliability in that when the teacher with the earlier non-productive behavior was observed on four additional occasions the non-productive behavior did not re-occur.

The first step in preparing for actual teacher observation was the training of the observer to use the VTOPS instrument consistently. This was achieved by the production of a video-tape of a typical automotive mechanics teacher working with students in a school automotive laboratory. The teacher used for this purpose was not included in subsequent observations included in the pilot study or main study.

The video-tape and the VTOPS instrument were used by the researcher in practice sessions. Scott's coefficient was computed periodically to determine intra-observer reliability. This training of

the researcher was continued until an index of intra-observer reliability of 0.830 was achieved.

The next step in the preparation for teacher observation was to determine the inter-rater agreement (reliability) or to compare the observations of the researcher to the observations of an expert. This is a measure of the validity of observation and is also computed by the use of Scott's coefficient. The expert observer used was the State Supervisor of Industrial and Technical Education for West Virginia. After training sessions with the video-tape and the VTOPS instrument, the expert and researcher both observed the video-tape simultaneously. Scott's coefficient was computed based on the results of the observations which yielded a coefficient for inter-rater (reliability) agreement of 0.819. After computing these measures of inter-rater agreement and intra-observer consistency, the researcher proceeded with the pilot study observations. The researcher was the only observer involved in conducting the pilot and main studies. Computation of inter-rater reliability was the only activity which required two observers--the researcher and the expert.

RELIABILITY

In the development and use of teacher behavior observation instruments, Medley and Mitzel (1963) recommend the application of analysis of variance in computing reliability. They report that the analysis can be simplified by certain procedures (Medley and Mitzel, 1963:309).

> Analysis will be vastly simplified if each teacher is visited in the same number of situations as each other teacher, and if the same recorders visit each teacher in each situation.

The following formula is given for the computation of reliability by the analysis of variance procedure (Medley and Mitzel, 1963: 309).

$$P_{xx} = \frac{\sigma_t^2}{\sigma_x^2}$$

In this formula, expressed in population parameters, P_{xx} represents the reliability coefficient, σ_t^2 represents the variance of the true scores about the mean of all true scores in the population of classes represented by the classes actually visited, and σ_x^2 represents the variance of the obtained scores of all teachers in the population about their own mean.

This procedure for determining reliability is a variation of the formula for reliability which uses the standard error of measurement. Since σ_t^2 represents the "true" variance and σ_x^2 represents the total variance or the variance of the obtained scores the error variance is contained within σ_x^2. The true variance (σ_t^2) can then be estimated by subtracting the error variance from the total (or observed) variance. This procedure leads to the formula for computing reliability by using the standard error of measurement. The formula described by Medley and Mitzel is a variation of this procedure in that "true" variance and "observed" variance are expressed in terms of observation instrument items, observation situations, observers, classes, and components of variance for these factors including their interaction and error variance. Analysis of variance is used to determine components of total variance that are attributed to each factor, their interaction, and error variance.

In implementing the formula, Medley and Mitzel (1963:311) redefine the population parameters in terms of estimates of population parameters by stating:

$$\sigma_t^2 = (qjt)^2 \sigma_c^2$$

where:

q = recorders (or observers)

j = items

t = situations (or observations)

σ_c^2 = the variance due to differences among classes

"Since the variance of obtained scores may be defined differently for different purposes," according to Medley and Mitzel (1963:311), a general expression is given by them to represent σ_x^2. However, the general expression is greatly simplified when applied to a particular research situation in that any component all of whose subscripts remain constant in all obtained scores is dropped from the general expression.

By following the example derived by Medley and Mitzel (1963), which is similar to the present study, the variance of the obtained scores σ_x^2 is represented by:

$$jt(jt\sigma_c^2 + j\sigma_s^2 + j\sigma_{cs}^2 + \sigma^2)$$

where:

j = items

t = situations

σ_c^2 = variance due to differences among classes

σ_s^2 = variance due to differences among situations

σ_{cs}^2 = variance due to interaction among classes and situations

σ^2 = residual

This reliability is based on the assumption that if a large number of observations are made for each class (situations) the within class variance will be less than the between class variance. The observation reliability computed for this study utilized the basic procedure described by Medley and Mitzel (1963:312) and paralleled the procedure followed by Dodl (1965:30) in that one observer was used in the present research.

The reliability coefficient is essentially reporting the proportion of obtained variance that is "true" variance. This is an indication of the amount of variation in the measurements that is attributable to variation in "true" scores. The remaining variance is due to error.

In computing pilot and main study reliabilities three way analysis of variance was employed. Components of variance were computed for classes, instrument items, observations and their interactions. Individual item scores were used for each class and each observation in computing these variances.

Pilot Study Reliability

As indicated in the methodology plan, the pilot study consisted of observing six teachers for two observations or situations each. These observations were conducted under the same conditions as planned

for the main study. The data from these observations were used in a three way analysis of variance to estimate the reliability of measured differences between classes. Results of the analysis are reported in Appendix E along with the first estimation of reliability. The reliability computed was 0.305.

Due to the reasons cited previously a second pilot study reliability was computed. The analysis and estimation of reliability are presented in Appendix E. The resultant pilot study estimate of reliability based on this analysis was 0.672.

Main Study Reliability

The main study reliability was computed in essentially the same manner as the pilot study reliabilities previously reported. This reliability calculation was based on four observations of thirty-two teachers using the VTOPS observation instrument. Appendix F illustrates the estimation of reliability and the analysis. The computed estimate of reliability of measured differences between classes was 0.832 for the main study.

SUMMARY

This chapter has presented the research methodology including the design, population, sample, description of instruments, data collection procedures, data analysis, pilot study and reliability estimation. Data generated through implementation of these activities provided information for examining the research questions, writing results of the study, drawing conclusions, and making recommendations in chapters that follow.

CHAPTER 4

RESULTS

INTRODUCTION

This chapter presents results of the research. Sections are included on teacher personal characteristics, observation of teacher behavior, student opportunity to learn, achievement of students, and data analysis.

PERSONAL CHARACTERISTICS OF TEACHERS

Personal characteristics of the thirty-one automotive mechanics teachers included in the research study are reported in Table 2. This table is a summary of data generated by the "Teacher Personal Characteristics Profile" (TPCP) which is presented in Appendix B.

Results of the TPCP are divided into two categories. Six of the nineteen items are nominal variables with the remaining thirteen being interval variables. The results for the nominal variables are reported below. Results for the interval variables are presented in Table 2 as descriptive statistics.

Item 3 on the TPCP dealt with diplomas or degrees earned. The teachers were to check all that were applicable. Two of the thirty-one teachers (6 percent) indicated they had not graduated from high school but had earned the General Educational Development (high school

Table 2

Descriptive Statistics for Selected Teacher Personal Characteristics

Variable	Minimum	Maximum	Range	Mean	Standard Deviation
Age	26	62	36	47.097	9.724
Years of School Completed	8	16	8	12.419	1.361
Years of Wage Earning Experience	6	39	33	18.484	8.563
Years Since Worked in Industry	0	27	27	8.806	6.779
Vocational Education and Training	.50	8.36	7.86	2.669	1.981
Years Since Last Vocational Teacher Education Course	0	9	9	1.613	2.376
Years Teaching Experience	2	30	28	10.806	7.409
Association Membership	1	11	10	5.871	2.907
Youth Leadership Activity	0	4	4	2.032	1.197
Teacher Development Activity	6	137	131	37.710	28.187
Teacher Education Credits	7	86	79	34.774	16.585
Total College Credits	0	175	175	53.774	42.689
Grade Point Average	2.5	3.5	1.00	3.145	.346

equivalency) certificate. The remaining 29 teachers (94 percent) indicated they had graduated from high school. Of those who had graduated from high school 8 teachers (26 percent) reported other degrees, diplomas, or certificates earned in addition to the high school diploma. The eight additional certificates or degrees were five (16 percent) vocational program certificates, one (3 percent) associate in science degree, one (3 percent) associate in arts degree, and one (3 percent) bachelor of arts degree.

Teacher certification status was the fourth item on the TPCP. Two of the teachers (6 percent) were teaching with a second year permit, two (6 percent) with a third year permit, ten (32 percent) were certified with their first five year certificate, seven (23 percent) held their second five year certificate, six (19 percent) held their third five year certificate, and four held permanent teacher certificates.

Vocational specialization was the fifth item included on the TPCP. All of the teachers were teaching the area of automotive mechanics.

The next nominal variable was item 13 which indicated those teachers who had been or were presently VICA advisors. Twenty-four of the thirty-one teachers reported that they had been VICA advisors. This represented 77 percent of the thirty-one teachers.

The next item in this category of personal characteristics was item 14 which indicated the number of teachers who had been a student member of a vocational youth organization. Only three of the thirty-one teachers reported having been members as students. This is approximately 10 percent of the total.

The last nominal variable on the TPCP was the degree candidate status concerning working toward the BS degree in vocational technical education. Six (19 percent) of the teachers reported they were currently degree candidates, seven (23 percent) indicated that they planned to become degree candidates in the future, while eighteen (58 percent) did not plan to pursue the BS degree. This represents a total of thirteen (42 percent) of the thirty-one teachers who are currently or plan to become candidates for the degree.

TEACHER BEHAVIOR OBSERVATION

Each teacher was observed four times. The VQ and VR scores for each observation were determined. The mean scores for each teacher on VQ and VR were then calculated. These mean scores represented the variables of VQ and VR which were used in analyzing the research questions. Appendix H gives a summary of the VQ and VR mean scores for the thirty-one teachers included in the final study.

Table 3 presents descriptive statistics for VQ and VR variables. These statistics were generated by the SPSS program CONDESCRIPTIVE. For the thirty-one teachers included in the statistical analysis, Table 3 reveals a minimum VQ score of 132 and a maximum of 277. This yields a range of 145 and a mean of 185.290 which indicates that the observation instrument and observer detected fairly broad differences in teacher behavior on this variable. VR as reported in Table 3 had a minimum score of 10 with a maximum of 15. A range of 5 and a mean of 11.742 are also indicated for variable VR.

Table 3

VQ and VR Descriptive Statistics

Variable	Minimum	Maximum	Range	Mean	Standard Deviation
VQ	132	277	145	185.290	35.422
VR	10	15	5	11.742	1.182

STUDENT OPPORTUNITY TO LEARN

Student opportunity to learn the criterion material on the "Short Occupational Knowledge Test" (SOKT) was measured with the "Student Opportunity to Learn" instrument shown in Appendix G. After post-tests were administered, each teacher was asked to rate the degree of opportunity their students had to learn the material on the SOKT.

Instruments were scored by multiplying the sum of the items for each category (opportunity, etc.) by the score value for that category and then summing the products on the four categories for each teacher. The maximum possible score was eighty in that there were twenty items with a maximum possible score value of four on each item.

Table 4 presents the descriptive statistics for student opportunity to learn. Scores ranged from a minimum of 48 to a maximum of 79 with a mean of 62.330.

STUDENT ACHIEVEMENT

Student achievement was measured with the OTAT and SOKT. Pre- and post-tests were administered to thirty-one classes for each of the achievement measures.

Table 5 reports the summary of class mean residual gain on the OTAT and SOKT. In that class mean gain was determined by predicting post-test scores through regression analysis and subtracting the predicted post-test scores from the actual post-test scores, it was possible to have negative gain or loss scores. As indicated by Table 5,

Table 4

SOL (Student Opportunity to Learn) Descriptive Statistics

Variable	Minimum	Maximum	Range	Mean	Standard Deviation
SOL	48	79	31	62.330	8.398

Table 5

Summary of Class Mean Residual Gain
on the SOKT and OTAT

Class Code	Mean Class SOKT	Mean Class OTAT	Class Code	Mean Class SOKT	Mean Class OTAT
1	-0.80	- 7.20	17	2.00	4.82
2	2.90	- 0.70	18	0.71	- 5.14
3	-0.10	14.60	19	-2.00	-11.18
4	0.57	- 4.00	20	-2.27	-16.55
5	-2.00	- 1.13	21	0.30	9.30
6	7.33	3.50	22	1.86	23.43
7	-2.25	-14.00	23	-1.33	-12.00
8	-0.18	6.19	24	0.00	1.17
9	0.00	- 1.00	25	-1.40	-11.00
10	-1.85	- 1.77	26	0.91	13.55
11	1.25	- 2.00	27	1.00	1.67
12	-1.44	- 6.44	28	-0.33	-11.56
13	-0.70	- 7.60	29	-2.57	10.57
14	0.00	- 8.25	30	-1.70	- 5.10
15	-0.40	0.50	31	-1.20	4.00
16	5.64	14.00			

several of the classes had loss scores for the class mean residual gain on one or both of the achievement measures. The class mean residual gain scores reported in Table 5 represented student achievement on each of the tests for purposes of determining relationships to other variables in this research as indicated by the research questions.

The pre-test data and the CTAA scores were used to predict the post-test scores for the OTAT and SOKT through regression analysis. This was done to permit the computation of residual class mean gain scores. Table 6 reports the regression analysis for predicting OTAT post-test scores. Table 7 indicates the same information for the SOKT.

The equations reported in Tables 6 and 7 were used to predict the post-scores. Class mean residual gain was then determined for each class as indicated earlier in this section.

Achievement and aptitude test descriptive statistics are reported in Table 8. The minimum, maximum, range, mean, and standard deviation are indicated. This information is given for both pre-tests, post-tests, CTAA, predicted post-test scores, and residual gain scores. Table 8 data is based on the 264 students in all 31 classes who completed all of the achievement and aptitude tests.

DATA ANALYSIS

Data analysis required in addition to the previous descriptions in this chapter on results consisted of Pearson product moment correlations needed to answer the research questions. However, it was also

Table 6

Regression Analysis for Predicting OTAT Post-Test Scores

Variable	B	Beta	Standard Error B	F
OTAT Pre-test	0.826	0.759	0.038	471.895
CTAA	0.654	0.195	0.117	31.183
(Constant)	-0.405			

Summary Table

Variable	Multiple R	R Square	RSQ Change	Simple R
OTAT Pre-Test	0.86141	0.74203	0.74203	0.86141
CTAA	0.87725	0.76957	0.02753	0.59408

Prediction Equation

OTAT Predicted Post-test Score = 0.826 OTAT Pre-test Score + 0.654 CTAA - 0.405

Table 7

Regression Analysis for Predicting SOKT Post-Test Scores

Variable	B	Beta	Standard Error B	F
SOKT Pre-test	0.573	0.44785	0.07039	66.222
CTAA	0.065	0.20769	0.01722	14.243
(Constant)	2.571			

Summary Table

Variable	Multiple R	R Square	RSQ Change	Simple R
OTAT Pre-test	0.52191	0.27239	0.27239	0.52191
CTAA	0.55681	0.31004	0.03765	0.36740

Prediction Equation

SOKT Predicted Post-test Score = 0.573 SOKT Pre-test Score + 0.065 CTAA + 2.571

Table 8

Achievement and Aptitude Test Descriptive Statistics for All Classes
N = 264

Variable	Minimum	Maximum	Range	Mean	Standard Deviation
SOKT Pre-test	2	17	15	8.716	2.933
OTAT Pre-test	47	244	197	131.909	36.944
SOKT Post-test	2	19	17	10.837	3.751
OTAT Post-test	63	247	184	141.489	40.206
CTAA	20	77	57	50.383	11.990
OTAT Predicted Post-test Scores	51	235	183	141.502	35.276
SOKT Predicted Post-test Scores	5	16	11	10.840	2.089
OTAT Gain Scores	-73	105	177	- 0.013	19.301
SOKT Gain Scores	- 7	10	17	- 0.003	3.116

deemed advisable to report correlations for all basic scores to help explain the research results. This was done to permit further review of the relationships between all basic variables included in the study.

Table 9 presents the correlations between achievement, aptitude, and student opportunity to learn variables. Since predicted scores and residual gain scores were computed for the achievement measures, correlations are also reported in Table 9 which show the degree of correlation of predicted and residual gain scores with the other variables. Table 9 reports correlations based on the 264 students included in the main research study.

The next area of data analysis presented is Table 10, which shows the Pearson product moment correlations between the OTAT and SOKT class mean residual gain scores, variety quantity, variety range, and student opportunity to learn criterion material on the SOKT. Table 10 reports the data necessary for examining research questions one through three.

Table 11 reports the Pearson product moment correlations between OTAT class mean residual gain, SOL, VQ, VR, and selected (interval variable) teacher personal characteristics. Table 11 presents the information needed for reviewing research questions four through seven.

Since some of the teacher personal characteristics reported in Table 11 are measuring similar types of information such as years of school completed and total college credits earned, it was necessary to present intercorrelations of the teacher personal characteristics to assist in interpretation of results related to the research questions.

Table 9

Pearson Product Moment Correlations Among Student Achievement, Aptitude, and SOL Variables

N = 264

	OTAT Pre-Test	SOKT Post-Test	OTAT Post-Test	CTAA	SOL	OTAT Predicted Scores	SOKT Predicted Scores	OTAT Gain Scores	SOKT Gain Scores
SOKT Pre-Test	0.578**	0.522**	0.597**	0.357**	0.130*	0.580**	0.937**	0.186**	0.000[a]
OTAT Pre-Test		0.551**	0.861**	0.526**	0.139*	0.982**	0.661**	0.000[a]	0.220
SOKT Post-Test			0.623**	0.367**	0.076	0.558**	0.557**	0.279**	0.831**
OTAT Post-Test				0.594**	0.118	0.877**	0.702*	0.480**	0.280**
CTAA					0.032	0.677**	0.660**	0.000[a]	0.000[a]
SOL						0.128*	0.116*	0.013	0.014
OTAT Predicted Scores							0.718**	0.000[a]	0.190**
SOKT Predicted Scores								0.149**	0.000[a]
OTAT Gain Scores									0.236**

* = $p < .05$

** = $p < .01$

[a] = zero r resulted from partialling out the initial score

Table 10

Pearson Product Moment Correlations Between OTAT and SOKT Class Mean Residual Gain Scores, VQ, VR and SOL
N = 31

	SOKT Class Mean Gain	VQ	VR	SOL
OTAT Class Mean Gain	0.463**	0.401*	0.443**	0.044
SOKT Class Mean Gain		0.038	-0.014	-0.040
VQ			0.779**	-0.267
VR				-0.209

* = $p < .05$

** = $p < .01$

Table 11

Pearson Product Moment Correlations Between OTAT Class Mean Residual Gain, SOL, VQ, VR, and Teacher Personal Characteristics

	OTAT Class Mean Gain	SOL	VQ	VR
Age	0.003	0.304*	-0.057	-0.007
Years of School Completed	0.044	-0.467**	0.281	0.525**
Years of Wage Earning Experience	-0.222	0.165	-0.182	-0.231
Years Since Worked in Industry	0.052	0.147	0.249	0.297
Vocational Education and Training	-0.065	-0.140	0.128	0.187
Years Since Last Vocational Teacher Education Course	-0.142	0.055	0.005	0.094
Years Teaching Experience	0.272	0.019	0.268	0.310*
Association Membership	0.257	0.286	0.157	0.029
Youth Leadership Activity	0.000	-0.039	0.022	0.053
Teacher Development Activity	0.180	-0.201	0.114	0.002
Teacher Education Credits	0.230	-0.213	0.230	0.289
Total College Credits	0.099	-0.274	0.181	0.480**
Grade Point Average	0.180	-0.115	0.009	-0.109

* = $p < .05$

** = $p < .01$

Therefore, Pearson product moment correlations of the teacher personal characteristics are presented in Appendix I.

SUMMARY

The purpose of this chapter was to present the results of the study. The following summary emphasizes the results as they relate to each research question.

Student achievement represented by class mean residual gain on the SOKT and OTAT was computed and reported for each class. Descriptive statistics for these measures were also reported.

The personal characteristics of teachers as reported on the TPCP were summarized. The nominal variable characteristics were reported and discussed in narrative form. The interval variables were used as possible correlates of achievement, student opportunity to learn, and teacher behavior.

The data were analyzed in order to examine the research questions. Pearson product moment correlations were used for this purpose.

The results of the correlation analysis for each research question are presented below.

The first research question sought to determine the degree of association between achievement on the OTAT and the VTOPS VQ score. Table 10 reported a correlation of 0.401. This correlation was significant ($p < .05$).

Research question two dealt with the relationship of achievement on the OTAT and the VTOPS VR score. A correlation of 0.443 was given in

Table 10 for this relationship. A probability significance level of less than .01 is indicated for this correlation.

The third research question explored the association between SOKT class mean gain as a measure of achievement and student opportunity to learn the material on the test. Table 10 indicates a correlation of -0.040. This correlation was not significant ($p > .05$).

Research question four was an inquiry into the relationships between teacher personal characteristics and student achievement on the OTAT. None of the thirteen personal characteristics that were correlated with OTAT class mean residual gain yielded significant correlations at the .05 level (see Table 11).

The fifth research question examined the association of each of the thirteen teacher personal characteristics with student opportunity to learn (SOL) the material on the SOKT. Two of the personal characteristics yielded significant correlations. They were: (1) age with a correlation of 0.304 ($p < .05$) and (2) years of school completed with a correlation of -0.467 ($p < .01$).

Research question six dealt with the relationship of each of the thirteen personal characteristic variables and the VTOPS VQ score. None of the correlations were significant ($p > .05$).

The seventh and last research question examined the association between the personal characteristic variables and the VTOPS VR score. Three of the thirteen variables yielded significant correlations. They were: (1) years of school completed with a correlation of 0.525

($p < .01$), (2) years teaching experience with a correlation of 0.310 ($p < .05$), and (3) total college credits with a correlation of 0.480 ($p < .01$).

This chapter has reported the results of the research activity The information necessary for responding to the research questions has also been presented. Chapter 5 presents the conclusions associated with each of the research questions.

Chapter 5

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

INTRODUCTION

This chapter provides a summary of the research study along with conclusions and recommendations. The summary section includes the problem, research questions, methodology, and results.

SUMMARY

Problem

The general research problem of this study was that educators have not established firm cause-effect relationships between teacher behavior and the resultant learning of students. This issue has been examined most effectively through observation of teachers in actual school settings and relating dimensions of behavior to student achievement.

Progress has been made through investigations of teacher behavior and student achievement in various classroom environments and subject areas. However, additional research is needed, especially in the field of vocational education. This study sought to extend our knowledge through inquiry into the relationship between teacher behavior and student achievement in a specific vocational program area.

Specifically, this study sought to investigate the relationship between variety/variability as a dimension of vocational industrial automotive mechanics teacher behavior and the achievement of students taught by these teachers. The research also included an investigation of relationships between student opportunity to learn criterion material, student achievement, teacher personal characteristics, and teacher behavior in the vocational shop/laboratory.

Research Questions

The research problem was investigated through examination of the following research questions:

1. What is the relationship between vocational industrial automotive mechanics teacher behavior on the dimension of variety/variability as indicated by the "Vocational Teacher Observation of Process System" (VTOPS) Variety Quantity (VQ) score and student achievement as measured by the "Ohio Trade and Industrial Education Achievement Test for Automotive Mechanics" (OTAT)?

2. What is the relationship between vocational industrial automotive mechanics teacher behavior on the dimension of variety/variability as indicated by the VTOPS Variety Range (VR) score and student achievement as measured by the OTAT?

3. What is the relationship between "Student Opportunity to Learn Criterion Material" (SOL) as measured by the automotive mechanics teacher rating and student achievement as measured by the "Short Occupational Knowledge Test for Automotive Mechanics" (SOKT)?

4. What is the relationship between selected personal characteristics of automotive mechanics teachers as indicated by the "Teacher Personal Characteristics Profile" (TPCP) and student achievement as measured by the OTAT?

5. What is the relationship between SOL as measured by the automotive mechanics teacher rating and selected personal characteristics of automotive mechanics teachers as indicated by the TPCP?

6. What is the relationship between selected personal characteristics of automotive mechanics teachers as indicated by the TPCP and teacher behavior as indicated by the VTOPS VQ score?

7. What is the relationship between selected personal characteristics of automotive mechanics teachers as indicated by the TPCP and teacher behavior as indicated by the VTOPS VR score?

Methodology

This study was a direct observation field study of teacher behavior. The research was ex post facto in that relationships between variables were sought without direct intervention in the teaching process.

The population of teachers included thirty-five secondary level automotive mechanics teachers teaching in West Virginia during the 1978-79 school year. The sample of teachers consisted of thirty-two of the teachers who agreed to participate in the study.

The VTOPS teacher observation instrument was used to observe teachers in four situations on two separate visits. Visits were random

in that the teachers were not made aware in advance of the observation date or time. However, the time intervals between visits to all classes were made as near equal as possible.

Intra-observer reliability was computed after training in observation with a video-tape. Inter-rater reliability of observation was also computed by using the same video-tape and an expert. Scott's coefficient was used in each of these cases in deriving the estimation of reliability for the observations.

Three way analysis of variance was used to estimate the reliability of measured differences between classes for teacher behavior. This procedure was utilized for two pilot study calculations as well as the computation for the main study.

Two student achievement instruments were used in the study--the "Short Occupational Knowledge Test" and the "Ohio Trade and Industrial Education Achievement Test." Both of these tests are for automotive mechanics.

Teacher personal characteristics for the automotive mechanics teachers included in the research study were also documented. The "Teacher Personal Characteristics Profile" was used in gathering this information.

Student opportunity to learn the criterion material on the SOKT was also determined. Teachers rated each question on the SOKT in terms of the opportunity that students in their class had to learn the information required to answer the question.

Student academic aptitude was measured by the short form of the "California Test of Academic Aptitude" (CTAA). This test was administered as a sub-part of the OTAT. The CTAA results were used as a covariate in predicting post-test achievement scores.

The instruments were used to collect data needed to examine the research questions and describe the sample of teachers. The pre-tests were administered in November of 1978.

After the administration of the pre-test observations were conducted, each teacher was observed four times during two separate visits to each school. These observations continued until March of 1979. Immediately upon completion of the observations, post-tests were administered. The TPCP was completed by interview techniques during the second observation visit with the researcher interviewing the teacher to complete the instrument. After the post-tests were completed the teachers responded on the SOL instrument.

Data treatment included preparing summary tables and statistical analysis. Regression analysis was used to write prediction equations for post-test scores on the OTAT and SOKT. The pre-test scores and CTAA scores were used as predictors of post-test scores. Gain scores were determined by subtracting predicted post-test scores from actual post-test scores. Class mean residual gain scores were then computed to represent class achievement.

Personal characteristics of the teachers were also summarized and reported. These characteristics were identified by the Teacher Personal Characteristics Profile (TPCP).

Teacher behavior observations were also summarized in preparation for data analysis. Teacher behavior was represented by mean observation scores (VQ and VR) from the VTOPS.

Student opportunity to learn (SOL) the material on the SOKT instrument was scored. The SOL scores represented the variable SOL in the correlations.

Data on teacher behavior, student achievement, student opportunity to learn, and teacher personal characteristics were prepared for the final correlational analysis. Pearson product moment correlations were performend to permit the examination of each research question.

Results

Results revealed that both of the VTOPS variety/variability scores (VQ and VR) were significantly associated with student achievement on the OTAT. Student opportunity to learn (SOL) was not associated with SOKT class mean gain. None of the teacher personal characteristics were related significantly to student achievement on the OTAT. Two teacher personal characteristics were correlated with SOL. They were age and years of school completed. Age and SOL had a positive association while years of school completed and SOL correlated negatively. There were no significant correlations between the VQ score and teacher personal characteristics. The VTOPS VR score was associated with three teacher characteristics. They were: years of school completed, years

teaching experience, and total college credits earned. Table 12 shows the correlation values for the significant correlations by research question.

CONCLUSIONS

This section presents conclusions based on the results given in Chapter 4. Each research question is identified and followed by conclusions based on the findings for that particular question.

The first research question dealt with the association between student achievement on the OTAT and teacher behavior on variety/variability in terms of the VTOPS VQ score. The positive correlation of 0.401 significant at less than the .05 level indicated that those teachers who scored higher on the VQ (variety quantity) score tended to have higher class mean achievement in their class as measured by the OTAT. This correlation indicates that approximately 16 percent of the variance in achievement may be attributed to fluctuation in the use of variety as measured by the VQ score.

This information adds to our knowledge concerning teacher behavior and student achievement in that there is an association between the use of variety/variability and the achievement of their students. The finding supports and extends research reported by Rosenshine (1971), Rosenshine and Furst (1973:122) and Borich (1977:71).

Previous research is supported since it has indicated positive significant relationships between teacher use of variety and student

Table 12

Summary of Significant Correlation Results by Research Question

Research Question	Variables	Correlated	Correlation Coefficient	Probability Level
1	VTOPS VQ Score	OTAT Class Mean Gain	0.401	.05
2	VTOPS VR Score	OTAT Class Mean Gain	0.443	.01
3	SOL	SOKT Class Mean Gain	Not Significant	.05
4	TPCP	OTAT Class Mean Gain	Not Significant	.05
5	TPCP Age	SOL	0.304	.05
	TPCP Years of School Completed	SOL	-0.467	.01
6	TPCP	VTOPS VQ Score	Not Significant	.05
7	TPCP Years of School Completed	VTOPS VR Score	0.525	.01
	TPCP Years Teaching Experience	VTOPS VR Score	0.310	.05
	TPCP Total College Credits Earned	VTOPS VR Score	0.480	.01

achievement in general academic classrooms. Earlier research is extended in that similar relationships were found to exist in the vocational automotive shop/laboratory setting as previously reported for general studies academic classes.

The second research question continued the search for association between teacher behavior on variety/variability and student achievement. This question focused on the relationship between the VTOPS VR score and achievement on the OTAT. The correlation was positive, significant at less than the .01 level and had a value of 0.443. A correlation of this value shows that approximately 20 percent of the variance in achievement may be attributed to variation in use of variety as indicated by the VR score.

It is concluded that the VR score may also be used as an index of variety/variability in measuring teacher behavior. The strength of the association for the VR score is higher than for the VQ score indicating that the VR score may be a better indicator of variety than the VQ score. However, both scores appear to have promise in providing information about teacher behavior in the vocational shop/laboratory environment. The findings of the VR score also support and extend the research reported by Rosenshine (1971), Rosenshine and Furst (1973:122), and Borich (1977: 71).

Research question three examined the degree of relationship between student opportunity to learn (SOL) the material on the SOKT and achievement on the SOKT as represented by class mean residual gain scores.

The correlation of -0.040 indicated that there was no association between these variables as measured in this study. Although there was considerable variation in the SOL scores (a minimum of 48, with a maximum of 79, a range of 31, and maximum possible score of 80), there was no concomitant variation with achievement as measured by the SOKT.

This finding is not supported generally by other research with this variable. Rosenshine (1971:196) reports that: "Overall, the correlations between measures of student opportunity to learn and student achievement are positive, significant and consistent." However, one other study was reported that did not find a significant relationship between student opportunity to learn and student achievement (Bellack, et al., 1966). The Bellack study reported general coding by topic and sub-topic while the present study used a teacher rating of specific criterion based questions.

The fact that no relationship was found presents more questions than answers. One of these questions is whether or not the instrument was actually measuring student opportunity to learn. However, the face validity of the instrument appears to be adequate. This poses a question about the perceptions of teachers in responding to the instrument. The point here is that perhaps certain teachers believed adequate opportunities had been given for learning while in reality learning had not occurred.

Other information concerning student opportunity to learn was generated and reported in this study. The information was useful in examining findings for this research question. Teacher age was reported

to correlate with SOL at the .05 level with a value of 0.304. This indicates a tendency of older teachers to rate SOL higher. Another confounding finding concerns SOL and educational attainment. Years of school completed had a significant negative relationship to SOL ratings by teachers ($r = -0.467$, $p < .01$). These correlations indicate that the greater the education of the teacher the lower the teacher tended to rate SOL. This seems to refute the idea concerning teacher perceptions and SOL ratings. Perhaps the correlation between education and low SOL ratings indicates that teachers with more years of education were more conservative in stating that their students had received an adequate opportunity to learn the criterion material. It is thus concluded that the student opportunity to learn variable will require more research and study before any firm generalization may be made.

The fourth research question sought the degree of association between personal characteristics of teachers and student achievement on the OTAT. None of the correlations were significant at the .05 level.

However, two of the teacher characteristics approached significance. They were years of teaching experience and association membership.

Based on these trends, it can be concluded that experience as a teacher tends to increase the capability of the teacher in bringing about learning in students in vocational automotive mechanics classes and that association membership by teachers may be helpful to them in teaching students. The finding concerning teaching experience supports research reported by Ryans (1960:391), Hardy and Bohren (1973:162), and

the 1965 pilot study conducted for the Ohio Trade Test. This finding was not supported by research reported by Shoemaker (1971). The results concerning association membership are supported by research findings reported by Ryans (1960:391).

The fifth research question explored relationships between student opportunity to learn and the thirteen teacher personal characteristics. Two of these correlations were significant. They included age ($r = 0.304$, $p < .05$) and years of school completed ($r = -0.467$, $p < .01$). Two additional personal characteristics approached significance at the .05 level. They were association membership and total college credits.

Since years of school completed and total college credits had an intercorrelation value of 0.695 ($p < .01$) the two will be discussed together as educational attainment for purposes of drawing conclusions.

The negative relationship between SOL and educational attainment indicates that the more years of school teachers had completed, the lower they tended to rate SOL. Questions were raised in discussing research question three concerning this relationship. It is concluded that additional research is needed concerning the relationship of SOL and educational attainment.

The correlation between age and SOL signifies that older teachers tended to rate SOL higher. Several of the personal characteristic intercorrelations in Appendix I help to explain this relationship. Age was significantly and positively related to several of the other

variables. The correlations between years of wage earning experience and years of teaching experience with age were 0.603 ($p < .01$) and 0.421 ($p < .01$) respectively. This indicates that older teachers had a broader work experience as automotive mechanics and more years of teaching which would include more contact with the curriculum or course of instruction. The conclusion concerning association membership and student opportunity to learn was that the association membership may have provided a broader knowledge of the automotive mechanics curriculum content and components through association with other teachers and specialty workshops.

Research question six examined relationships between the VTOPS VQ score and teacher personal characteristics. None of the correlations were significant at the .05 level. Two of the thirteen personal characteristics did approach significance. They were years of school completed ($r = 0.281$) and years of teaching experience ($r = 0.268$).

Findings for the variables that were not related to teacher behavior as indicated by the VQ score supports results of previous research by Jansen, et al. (1972:529). The results that indicated trends toward relationships in this study support and extend the research reported by Biddle and Adams (1967) and Perham (1973). Perham reported association between teaching experience and teacher behavior. Biddle and Adams indicated relationships between teacher behavior and age.

It is concluded that the findings for this question tend to support continuing education programs for in-service vocational automotive

teachers. The relationship reported earlier between the VQ score and achievement tends to support participation in continuing education programs.

The final research question sought relationships between teacher characteristics and teacher behavior as measured by the VTOPS VR score. Three of the characteristic variables were positively correlated with VR scores. They were: years of school completed ($r = 0.525$, $p < .01$), years teaching experience ($r = 0.310$, $p < .05$), and total college credits ($r = 0.480$, $p < .01$).

Since years of school completed and total college credits both represent education, conclusions will be drawn for educational attainment and years teaching experience as they relate to VR scores.

The significant correlations reveal that VR is associated with both educational attainment and years teaching experience. This indicates that the more education a teacher has including teacher education and other college credits the higher he will tend to score on the VR dimension of variety/variability. In that the VR score is significantly related to achievement, implications are possible concerning the need for additional vocational teacher education and general college work for many vocational industrial automotive teachers who have limited credits in these areas. Additional research is needed in other vocational industrial occupational areas before these findings may be generalized to all vocational industrial occupations.

The relationship between years teaching experience and VR scores also indicates that persons with greater teaching experience tend to

score higher on the VR score. This may be attributed to two areas. One area is that as the teacher teaches the trial and error tactics of trying to bring about learning tend to be reinforced by positive results of learning. The other area is the relationship of teaching experience and educational attainment. In that vocational industrial teachers employed initially on permits are required to continue their education by taking vocational teacher education courses this contributes to total educational attainment while increasing teaching experience at the same time. This is supported by correlations reported in Appendix I between years teaching experience and teacher education credits ($r = 0.626$, $p < .01$) and between teaching experience and total college credits ($r = 0.443$, $p < .01$).

The conclusions for this variable are supported by the same research as reported in support of research question six in that VQ and VR are both measures of variety/variability. Another conclusion for this research is that the variable VR seems to be related to student achievement to a higher degree than the VQ score and, therefore, may have more strength as a measure of variety/variability.

RECOMMENDATIONS

This research has provided information about specific questions dealing with teacher behavior in actual school shop/laboratory situations, student achievement, student opportunity to learn and teacher personal characteristics. This section presents recommendations for

use of the results in future research and practical application in education.

The first and most important recommendation is that the results of this study be used as a basis for additional research on teaching. This research serves as a foundation for experimental studies which deal with the amount of variety that will bring about optimum learning. Research is needed not only in the area of vocational automotive mechanics but also in other areas of vocational industrial education as well as in other types of educational programs.

Variety is an important dimension of teacher behavior. However, as it is possible to have too little variety in teaching, it is also possible to have too much. This is the reason that experimental research is the most important recommendation from the research herein reported.

Another recommendation is for the replication of this investigation in other vocational service areas and programs. In that this research was done with secondary level students, studies are also needed at the community college and/or post-secondary vocational level for cross validation purposes.

This research illustrates research on teaching through direct observation. There are many other promising dimensions of teacher behavior that may be associated with student learning in vocational education settings. These should be explored through correlational and experimental studies.

The need for additional research dealing with student opportunity to learn was also indicated. This research could deal with the development of instruments to measure student opportunity to learn as well as teacher perceptions concerning this important aspect of learning.

It is recommended that vocational industrial teachers be encouraged to continue their education through vocational teacher education courses and other college level credit courses. These attributes are related to teacher behavior in such a way that they may tend to stimulate higher levels of student growth.

Although practical applications of the present study must be undertaken with caution due to the lack of experimental cause-effect data, several implications exist. These implications are in the areas of teacher education and supervision of instruction.

Teacher educators should at least make their students aware of the fact that variety in teaching is needed. The VTOPS and other instruments could be used in assisting pre-service and in-service teachers become more aware of variety in many forms and combinations.

Pre-service teachers could be more adequately prepared for directed teaching experiences by being sensitized to teacher behavior through the process of observing other teachers in actual school settings and on video-tape and recording the behavior on an observation instrument. Teacher educators could also use the instrument in observing and conferring with students participating in directed teaching experiences. These same implications exist for beginning and in-service

vocational industrial teachers. The delivery system for in-service teachers would perhaps be different than for pre-service teachers, but the possibilities for learning exist.

There are also implications of a similar nature for supervision of instruction. If supervisors of instruction were educated to the use of observation instruments which focus on identifying teacher behavior related to student learning, they could assist the teacher in identifying goals for the development of this behavior.

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APPENDICES

APPENDIX A

VOCATIONAL TEACHER OBSERVATION OF PROCESS SYSTEM (VTOPS)

Vocational Teacher Observation of Process System
(VTOPS)
Definitions and Observation Directions

1. Before beginning the observation, study the complete VTOPS observation instrument carefully.
2. Definitions for abbreviations and terms:
   a. T = Teacher
   b. S = Student
   c. Q = Question(s)
   d. A-V = Audio-visual
   e. Indiv. = Individual student
   f. Small group - Two to eight students
   g. Large group = Nine or more students including entire class
3. At the end of each five minutes of observation, the observer is to move from one interval marking area to the next on the VTOPS instrument.
4. When each behavior occurs on the part of the teacher a tally mark is to be placed in the appropriate space for each respective five minute period in which the behavior occurs. If a behavior is continued for more than thirty (30) seconds, the tally mark should be entered again. If two or more behaviors occur at the same time all are to be tallied.

VOCATIONAL TEACHER OBSERVATION OF PROCESS SYSTEM

(VTOPS)

Observer _____ Date _____

Teacher Observed _____ Time _____

Vocational Program _____ School _____

Others Present _____ _____

Distractions _____ Number of students in

_____ the class _____

Directions

I. Complete the information above as part of the preparation phase of conducting the observation.

II. The teacher should be requested to conduct the class as it would be conducted if no observer were present. The goal is to observe the vocational program as it normally operates.

III. The observer should read the enclosed list of devinitions and observation directions.

V T O P S

Event recording by 5 Minute Intervals

Interval / Behavior		I	II	III	IV	V	TOTAL
T looks at notes or references	1						
T gives information (facts)	2						
T explains (gives examples and details)	3						
T repeats key points	4						
T asks Q	5						
T asks for Q	6						
T answers Q	7						
T gives directions	8						
T uses trade tools	9						
T uses training aid	10						
T uses A-V device	11						
T demonstration of skill	12						
Monitoring T Obs S Activity	13						
T participates in S Activity (Helps)	14						
T works with Individual	15						
T works with Small Group	16						
T works with Large Group	17						

VR Total _____ VQ Total _____

APPENDIX B

TEACHER PERSONAL CHARACTERISTICS PROFILE (TPCP)

TEACHER PERSONAL CHARACTERISTICS PROFILE

1. Age at last birthday _____

2. Highest year of school completed (Check one)

8th grade or less	____	13 Freshman in college	____
9th grade	____	14 Sophomore in college	____
10th grade	____	15 Junior in college	____
11th grade	____	16 Senior in college	____
12th grade	____	17 Graduate School	____

3. Diplomas or degrees earned (Check all that apply)

   1. General Educational Development (H.S. Equivalent) ____
   2. High School Diploma ____
   3. Vocational Program Certificate ____
   4. Associate in Science Degree ____
   5. Associate in Arts Degree ____
   6. Bachelor of Science Degree ____
   7. Bachelor of Arts Degree ____
   8. Masters Degree

4. Teacher certification status (Check one)

   1. First year permit ____
   2. Second year permit ____
   3. Third year permit ____
   4. Fourth year permit ____
   5. Fifth year permit ____
   6. First 5-year certificate ____
   7. Second 5-year certificate ____
   8. Third 5-year certificate ____
   9. Permanent certificate ____

5. Field of vocational specialization _____
   (Name of the vocational program you teach)

6. Total years of wage earning work experience _____
   (other than teaching)

   1. Years of work experience in your vocational specialization ____
   2. Years of work experience in occupations other than your vocational specialization ____

7. Number of years since your last full time work experience in business or industry _____

8. Vocational Education and Training Total _____

   1. Number of years of vocational education in your vocational specialization (include military) Total Hours _____ (approx.)
   2. Number of years of vocational education not in your vocational specialization (include military) Total Hours _____ (approx.)
   3. Have you participated in special workshops, training programs, factory schools, etc., sponsored by employers? Yes ___ No ___ If yes, how many? ____ Approximate total clock hours _____

9. Number of years since your last teacher education course was taken _____

10. Total years teaching experience _____

    1. Number of years teaching experience in your vocational specialization _____
    2. Number of years teaching experience other than in your vocational specialization _____
    3. Number of years of military teaching experience _____

11. Membership in Associations, etc. Total _____

    1. List the number of Education Associations in which you are a member _____
    2. List the number of Trade Uniors or Associations in which you are a member _____
    3. List the total number of community organizations, civic clubs, church, etc., in which you are a member _____

12. Youth Leadership Activities Total _____

    1. List the number of school related youth organizations, clubs, etc., for which you have served as leader, advisor, or sponsor _____
    2. List the number of non-school related youth organizations, clubs, etc., for which you have served as leader, advisor, or sponsor _____

13. Have you ever been a VICA advisor? (1) Yes ___ (0) No ___

14. Have you ever been a student member of a vocational youth organization? (1) Yes ___ (0) No ___

15. Teacher Development Activities Total _____

    1. List the number of trade magazines you read monthly _____
    2. List the number of educational magazines you read monthly _____
    3. List the average number of books you read per year that help you as a teacher _____ (books dealing with teaching or your vocational specialization) _____
    4. List the number of vocational education workshops and conferences you attended last year _____
    5. List the average number of books and magazines you read per year for your personal reading enjoyment _____

16. Professional Teacher Education Total _____
(Semester hours credit)

    1. List the total number of semester hours credit you have earned in vocational teacher education courses _____
    2. List the total number of semester hours credit you have earned in teacher education courses other than vocational _____

17. List the total number of semester hours of college credit you have earned _____

18. Check the space below which indicates your approximate grade point average on all of the college courses you have taken.

    3.5 to 4.0 ____
    3.0 to 3.49 ____
    2.5 to 2.99 ____
    2.0 to 2.49 ____
    1.5 to 1.99 ____
    Less than 1.5 ____

19. Check the appropriate space below to indicate your status as a candidate for the BS degree in vocational-technical education

    1. I am a degree candidate now ____
    2. I plan to become a degree candidate ____
    3. I do not plan to become a degree candidate ____

APPENDIX C

VTOPS INTRA-OBSERVER RELIABILITY

INTRA-OBSERVER RELIABILITY

Item No.	Tallies Obs. 1	Percent Obs. 1	Tallies Obs. 2	Percent Obs. 2	Difference Percent
1	0	0	0	0	0
2	13	10	27	18	8
3	25	19	26	18	1
4	4	3	4	3	0
5	2	2	2	2	0
6	4	3	4	3	0
7	10	8	9	6	2
8	19	15	22	15	0
9	0	0	0	0	0
10	12	9	12	8	1
11	0	0	0	0	0
12	0	0	0	0	0
13	20	16	20	14	2
14	20	16	20	14	2
15	0	0	0	0	0
16	0	0	0	0	0
17	0	0	0	0	0
Totals	129	101	146	101	16

$P_o = 1.00 - .16 = .84$

$P_e = .19^2 + .16^2 = .0617$

$$r = \frac{P_o - P_e}{1.00 - P_e} = \frac{.84 - .0617}{1.00 - .0617} = 0.8295$$

APPENDIX D

VTOPS INTER-RATER RELIABILITY

INTER-RATER RELIABILITY

Item No.	Tallies Expert	Percent Expert	Tallies Obs. 2	Percent Obs. 2	Difference Percent
1	0	0	0	0	0
2	27	20	27	18	2
3	20	15	26	18	3
4	7	5	4	3	2
5	3	2	2	2	0
6	3	2	4	3	1
7	9	7	9	6	1
8	20	15	22	15	0
9	3	2	2	2	0
10	12	9	12	8	1
11	0	0	0	0	0
12	2	2	0	0	2
13	16	12	20	14	2
14	1	1	1	1	0
15	4	3	6	5	2
16	5	4	6	5	1
17	0	0	0	0	0
Totals	132	99	146	100	17

$P_o = 1 - .17 = .83$

$P_e = .20^2 + .15^2 = .063$

$$r = \frac{P_o - P_e}{1.00 - P_e} = \frac{.83 - .063}{1.00 - .063} = 0.819$$

APPENDIX E

VTOPS PILOT STUDY RELIABILITY

Pilot Study First Estimation of Reliability
Analysis of Variance

Source of Variation	Sum of Squares	Degrees of Freedom	Obtained Mean Square	Expected Mean Square
c (class)	659.275	5	131.855	$34\sigma_c^2 + 17\sigma_{cs}^2 + \sigma^2$
i (item)	18,568.871	16	1,160.554	$12\sigma_i^2 + 2\sigma_{ci}^2 + 6\sigma_{is}^2 + \sigma^2$
s (situation)	501.961	1	501.961	$102\sigma_s^2 + 17\sigma_c^2 s + \sigma^2$
c x i	4,302.898	80	53.786	$2\sigma_{ci}^2 + \sigma^2$
c x s	348.745	5	69.749	$17\sigma^2 cs + \sigma^2$
i x s	749.539	16	46.846	$6\sigma^2 is + \sigma^2$
Residual	2,353.437	80	29.418	σ^2
Total	27,484.723	203		

Components of Variance
(derived from expected mean square)

$\sigma_c^2 = 1.827$ $\sigma_{ci}^2 = 12.184$

$\sigma_i^2 = 90.778$ $\sigma_{cs}^2 = 2.372$

$\sigma_s^2 = 4.237$ $\sigma_{is}^2 = 2.905$

for t = 2, r = 0.305

for t = 4, r = 0.467

$$r = \frac{\sigma_t^2}{\sigma_x^2}$$

$$r = \frac{(17t)^2 \sigma_c^2}{17t(17t\sigma_c^2 + 17\sigma_s^2 + 17\sigma^2 cs + \sigma^2)}$$

$$r = \frac{t}{t + 4.564}$$

Pilot Study Second Estimation of Relaibility
Analysis of Variance

Source of Variation	Sum of Squares	Degrees of Freedom	Obtained Mean Square	Expected Mean Square
c (class)	676.162	5	135.232	$34\sigma_c^2 + 17\sigma_{cs}^2 + \sigma^2$
i (item)	19,171.186	16	1,198.199	$12\sigma_i^2 + 2\sigma_{ci}^2 + 6\sigma_{is}^2 + \sigma^2$
s (situation)	178.828	1	178.828	$102\sigma_s^2 + 17\sigma_c^2 s + \sigma^2$
c x i	4,444.755	80	55.559	$2\sigma_{ci}^2 + \sigma^2$
c x s	136.907	5	27.381	$17\sigma^2 cs + \sigma^2$
i x s	477.088	16	29.818	$6\sigma^2 is + \sigma^2$
Residual	2,179.676	80	27.246	σ^2
Total	27,264.603	203		

Components of Variance
(derived from expected mean square)

$\sigma_c^2 = 3.172$ $\sigma_{ci}^2 = 14.157$

$\sigma_i^2 = 95.005$ $\sigma_{cs}^2 = 0.008$

$\sigma_s^2 = 1.485$ $\sigma_{is}^2 = 0.429$

for t = 2, r = 0.672

for t = 4, r = 0.804

$$r = \frac{\sigma_t^2}{\sigma_x^2}$$

$$r = \frac{(17t)^2 \sigma_c^2}{17t(17t\sigma_c^2 + 17\sigma_s^2 + 17\sigma^2 cs + \sigma^2)}$$

$$r = \frac{t}{t + 0.976}$$

APPENDIX F

VTOPS MAIN STUDY RELIABILITY

Main Study Estimation of Reliability
Analysis of Variance

Source of Variation	Sum of Squares	Degrees of Freedom	Obtained Mean Square	Expected Mean Square
c (class)	9,693.689	31	312.700	$68\sigma_c^2 + 17\sigma_{cs}^2 + \sigma^2$
i (item)	208,270.124	16	13,016.883	$128\sigma_i^2 + 4\sigma_{ci}^2 + 32\sigma_{is}^2 + \sigma^2$
s (situation)	1,066.142	3	355.381	$544\sigma_s^2 + 17\sigma_{cs}^2 + \sigma^2$
c x i	65,656.921	496	132.373	$4\sigma_{ci}^2 + \sigma^2$
c x s	4, 131.964	93	44.430	$17\sigma_{cs}^2 + \sigma^2$
i x s	7, 492.155	48	156.087	$32\sigma_{is}^2 + \sigma^2$
Residual	45,798.239	1,488	30.778	σ^2
Total	342,109.233	2,175		

Components of Variance
(derived from expected mean square)

$\sigma_c^2 = 3.945$ $\sigma_{ci}^2 = 25.399$

$\sigma_i^2 = 99.681$ $\sigma_{cs}^2 = 0.803$

$\sigma_s^2 = 0.572$ $\sigma_{is}^2 = 3.916$

for t = 4, r = 0.832

$$r = \frac{\sigma_t^2}{\sigma_x^2}$$

$$r = \frac{(17t)^2 \sigma_c^2}{17t(17t\sigma_c^2 + 17\sigma_s^2 + 17\sigma_{cs}^2 + \sigma^2)}$$

$$r = \frac{t}{t + 0.808}$$

APPENDIX G

STUDENT OPPORTUNITY TO LEARN INSTRUMENT

AUTO MECHANICS TEACHER'S RATING OF STUDENT'S OPPORTUNITY TO LEARN TEST MATERIAL

DIRECTIONS

Read each question on the Auto Mechanics Knowledge Test carefully. After reading each question, indicate on the scale below the extent of opportunity that your students had to learn the material required to answer each question correctly.

After each question number, circle the number indicating your answer. Numbers are defined below:

1 = There was no opportunity to learn the information in the class.
2 = There was limited opportunity to learn the information in the class (textbook content, etc.).
3 = The material was presented to the class and the student should be able to answer the question based on attending the class.
4 = The material was emphasized and most students in the class should know the answer.

Question	No Opportunity	Limited Opportunity	Material Presented	Material Emphasized
1.	1	2	3	4
2.	1	2	3	4
3.	1	2	3	4
4.	1	2	3	4
5.	1	2	3	4
6.	1	2	3	4
7.	1	2	3	4
8.	1	2	3	4
9.	1	2	3	4
10.	1	2	3	4
11.	1	2	3	4
12.	1	2	3	4
13.	1	2	3	4
14.	1	2	3	4
15.	1	2	3	4
16.	1	2	3	4
17.	1	2	3	4
18.	1	2	3	4
19.	1	2	3	4
20.	1	2	3	4

APPENDIX H

SUMMARY OF VARIETY QUANTITY AND VARIETY RANGE MEAN SCORES

Summary of Variety Quantity and Variety Range Mean Scores

Class Code	Variety Quantity	Variety Range
1	167	12
2	138	11
3	205	13
4	184	11
5	189	11
6	188	11
7	144	10
8	217	11
9	181	12
10	191	12
11	136	11
12	192	12
13	182	12
14	132	10
15	175	12
16	158	11
17	186	11
18	180	11
19	212	12
20	148	11
21	193	14
22	270	14
23	207	13
24	231	12
25	195	11
26	182	12
27	277	15
28	161	11
29	163	12
30	133	10
31	226	13

APPENDIX I

PEARSON PRODUCT MOMENT CORRELATIONS OF SELECTED PERSONAL CHARACTERISTICS

Pearson Product Moment Correlations of Selected Personal Characteristics

	Years of School Completed	Years of Wage Earning Experience	Years Since Worked in Industry	Vocational Education and Training	Years Since Last Voca-Teacher Education Course	Years Teaching Experience	Association Membership	Youth Leadership Activity	Teacher Development Activity	Teacher Education Credits	Total College Credits	Grade Point Average
Age	.023	.603**	.378*	.275	.586**	.421**	.268	.149	.132	.141	.132	.108
Years of School Completed		-.244	.237	.060	.207	.223	-.315*	.032	.107	.263	.695**	-.381*
Years of Wage Earning Experience			-.244*	.454**	.211	-.388	.204	.125	.008	-.316*	-.240	.184
Years Since Worked in Industry				-.226	.585**	.634**	.241	.235	-.088	.216	.214	-.236
Vocational Education and Training					-.026	-.133	-.153	-.303*	-.051	-.156	.033	.294
Years Since Last Voc. Teacher Ed. Course						.469**	.166	.227	-.013	.209	.279	-.112
Years Teaching Experience							.212	.012	-.197*	.626**	.443**	-.262
Association Membership								.404*	.021	.121	-.209	.152
Youth Leadership Activities									.132	.272	.181	-.293
Teacher Development Activity										-.042	-.133	.148
Teacher Education Credits											.653**	-.107
Total College Credits												-.344*

* = P < .05
** = P < .01

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RELATIONSHIPS BETWEEN VOCATIONAL INDUSTRIAL TEACHER BEHAVIOR IN THE SCHOOL LABORATORY AND THE ACHIEVEMENT OF VOCATIONAL INDUSTRIAL STUDENTS

by

Lorraine S. McKinney

(ABSTRACT)

The primary purpose of this investigation was to study the relationships between vocational industrial automotive mechanics teacher behavior on the index of variety/variability and the achievement of students in their classes. Relationships between student opportunity to learn criterion material, teacher personal characteristics, student achievement, and teacher behavior were also examined.

This was a state-wide study conducted in West Virginia during the 1978-79 school year. The population was limited to automotive mechanics teachers. Thirty-five teachers were invited to participate in the study while thirty-one teachers accepted the invitation and completed all research activities.

Five instruments were employed to collect the data for this study. Two of the instruments were achievement measures. They were the "Ohio Trade and Industrial Education Achievement Test" (OTAT) and the "Short Occupational Knowledge Test" (SOKT). Teacher behavior was measured by the "Vocational Teacher Observation of Process System" (VTOPS) instrument. Teacher ratings were used to measure Student Opportunity to Learn (SOL) the material on the SOKT. Teacher personal

characteristics were obtained by using the "Teacher Personal Characteristics Profile" (TPCP).

The research utilized pre-tests, post-tests, and class residual mean gain scores to represent achievement. Pre-tests were administered prior to the beginning of teacher observations. Teachers were observed four times on two separate visits prior to giving the post-tests. Teacher personal characteristics were obtained at the conclusion of the second visit by interviewing the teachers. SOL was determined at the conclusion of the post-test session for the SOKT. VTOPS provided two measures of teacher behavior on variety. They were the VQ (variety quantity) score and the VR (variety range) score.

The data were analyzed through Pearson product moment correlations. The correlations provided results for the examination of the seven research questions.

Analysis of data for the first two research questions revealed significant correlations between student achievement and the VQ and VR scores. VTOPS VQ and VR scores are measures of variety/variability in teacher behavior.

The third research question data analysis indicated no association between SOL and achievement on the SOKT. Research question four correlations indicated no significant association between achievement and teacher personal characteristics.

Analysis of data for the fifth research question revealed significant relationships between two teacher personal characteristics and SOL. Age correlated positively with SOL while years of school completed was associated negatively.

The sixth research question correlations indicated that there was no relationship between the VQ score and the personal characteristics of teachers. Data analysis for the seventh research question revealed correlations between the VR score and three teacher personal characteristics. The personal characteristics were: years of school completed, years teaching experience, and total college credits earned.