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Statistical Sophistication of Research in Vocational Education.

Chi Zhang

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Statistical sophistication of research in vocational education

Zhang, Chi, Ph.D.
The Louisiana State University and Agricultural and Mechanical Col., 1991
STATISTICAL SOPHISTICATION OF RESEARCH IN VOCATIONAL EDUCATION

A Dissertation

Submitted to the Graduate Faculty of the Louisiana State University and Agricultural and Mechanical College in partial fulfillment of the requirements for the degree of Doctor of Philosophy

in

The School of Vocational Education

By

Chi Zhang
B.S., Hangzhou University, China, 1984
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# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>ACKNOWLEDGMENTS</th>
<th>ii</th>
</tr>
</thead>
<tbody>
<tr>
<td>LIST OF TABLES</td>
<td>v</td>
</tr>
<tr>
<td>LIST OF APPENDICES</td>
<td>vi</td>
</tr>
<tr>
<td>ABSTRACT</td>
<td>vii</td>
</tr>
</tbody>
</table>

## CHAPTER

### I  INTRODUCTION

- Goals and Objectives                           6
- Significance of the Study                      7

### II  REVIEW OF RELATED LITERATURE

- Brief History of Educational Research         10
- Some Attributes of Research in Vocational Education 12
- Problem Areas of Study in Vocational Education 15
- Methodological Strategies in Educational Research 27
- Statistical Sophistication in Behavioral Research 36
- Summary                                       47

### III  RESEARCH METHODOLOGY

- Population and Sample                         51
- Pilot Study                                    53
- Instrument Development                        54
- Data Collection                                59
- Data Analysis                                  60

### IV  FINDINGS OF THE STUDY

- The Use of Statistical Techniques and Level of Sophistication 63
- The Problem Areas Studied                      67
- The Relationship between the Statistical Sophistication Level and the Problem Areas Studied 68
- The Methodological Strategies Used            69
- The Relationship between Statistical Sophistication Level of Research and Methodological Strategies Used 70
The Change over Time in the Statistical Sophistication Level, Problem Areas Studied, and Methodological Strategies Used ......................... 72

V SUMMARY, CONCLUSIONS, DISCUSSIONS, AND RECOMMENDATIONS ......................... 77

Summary ........................................ 77
Conclusions, Discussions, and Recommendations ....................... 80

REFERENCES ............................................ 97

APPENDICES ............................................. 107

VITA ................................................... 119
# LIST OF TABLES

<table>
<thead>
<tr>
<th>TABLE</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Frequencies and Ranks of the Statistical Techniques Used</td>
<td>65</td>
</tr>
<tr>
<td>2</td>
<td>Statistical Techniques Used by Clusters</td>
<td>67</td>
</tr>
<tr>
<td>3</td>
<td>Cross Classification of Statistical Sophistication Levels by Problem Areas Studied</td>
<td>69</td>
</tr>
<tr>
<td>4</td>
<td>Cross Classification of Statistical Sophistication Levels by Methodological Strategies Used</td>
<td>71</td>
</tr>
<tr>
<td>5</td>
<td>Comparisons of the Use of Statistical Techniques by Clusters Between the Early 1980s (1980-83) and the Late 1980s (1986-89)</td>
<td>73</td>
</tr>
<tr>
<td>6</td>
<td>Cross Classification of Statistical Sophistication Levels by the Two Time Periods</td>
<td>74</td>
</tr>
<tr>
<td>7</td>
<td>A Comparison of the Mean Numbers of Correlational/Inferential Statistical Techniques Used Per Article between the Early 1980s (1980-83) and the Late 1980s (1986-1989)</td>
<td>75</td>
</tr>
<tr>
<td>8</td>
<td>Cross Classification of Problem Areas Studied by the Two Time Periods</td>
<td>76</td>
</tr>
<tr>
<td>9</td>
<td>Cross Classification of Methodological Strategies Used by the Two Time Periods</td>
<td>76</td>
</tr>
</tbody>
</table>
# LIST OF APPENDICES

<table>
<thead>
<tr>
<th>APPENDIX</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>A  Instrument Used in the Study</td>
<td>108</td>
</tr>
<tr>
<td>B  Letter and Questionnaire to the Panel of Experts</td>
<td>111</td>
</tr>
<tr>
<td>C  List of Additional Statistical Techniques</td>
<td>116</td>
</tr>
<tr>
<td>Identified by the Panel of Experts</td>
<td></td>
</tr>
</tbody>
</table>
ABSTRACT

The purpose of this study was to determine the status of, and changes in, the statistical sophistication of research in vocational education in the 1980s. The study also explored relationships among statistical sophistication, problem area studied, and methodological strategy used in vocational education research.

Data collected were obtained from 118 quantitative research reports randomly selected from the Journal of Vocational Education Research, the Journal of Agricultural Education, the Journal of Industrial Teacher Education, and the Journal of Vocational Home Economics Education published in the early (1980-1983) and the late 1980s (1986-89). The researcher developed instrument used in this study consisted of four components: background information, statistical sophistication, problem area, and methodological strategy. Each article examined was classified into one of four problem areas: teacher, student, curriculum, and setting, as proposed by Steiner (1978). Each of these articles also was classified into one of four methodological strategies: laboratory experiment, field experiment, field study and ex post facto research, and survey, as used by Schwandt (1983). The three sophistication levels used to classify each statistical technique recorded were basic, intermediate, and advanced.
The statistical sophistication level of a research report was determined by the highest level of sophistication among all techniques used in that report.

The results indicated that 30 different statistical techniques were used in the sample. The majority of research reports were classified as less than advanced in their levels of statistical sophistication. No significant changes were found in the use of statistical techniques nor did the statistical sophistication level of research change from the early 1980s to the late 1980s. The statistical sophistication of research was related to both problem areas studied and the methodological strategies used. The problem area most frequently studied was "curriculum". "Student" was the least studied problem area. Research on "student" tended to have a higher proportion classified as advanced statistical sophistication. "Survey" was found to be the most frequently identified strategy used. Very few research reports used the "laboratory experiment" strategy. Studies which used "field studies and ex post facto research" tended to have a larger proportion classified as advanced statistical sophistication than those which used "experiments" or "survey" strategies.
CHAPTER I

INTRODUCTION

The scientific approach is a powerful and reliable torch for investigators to use in lighting the way to the discovery of new knowledge. When the scientific approach is applied to the study of educational problems, educational research is the result (Ary, Jacobs, & Razavieh, 1985). "Educational research has contributed many findings concerning principles of behavior, learning, and retention. In addition, significant contributions have been made related to curriculum, instruction, instructional materials, design, measurement, and analysis" (Gay, 1979, p.6). The empirical-analytic research paradigm is useful and very important for conducting research in vocational education (Smith, 1984).

Statistics plays a number of major, interrelated roles in educational research, including selecting subjects for a study, setting forth guidelines for summarizing and describing data, and providing methods for drawing inferences from sample to population (Shavelson, 1981). Guilford and Fruchter (1973) listed six advantages of using statistics in research:

(a) They permit the most exact kind of description; (b) they force us to be definite and exact in our procedures and in our thinking; (c) they enable us to summarize our results in a meaningful and convenient form; (d) they enable us to draw general conclusions; (e) they enable us
to predict "how much" of a thing will happen under conditions we know and have measured; and (f) they enable us to analyze some of the causal factors underlying complex and otherwise bewildering events. (p. 3-4)

The use of statistical techniques is an integral part of most vocational education research. It provides a way to report results in an efficient and effective format. The impact of statistical method on educational research was recognized by Walker as early as 1956. He wrote:

Whereas statistical method was once considered a tool, now it is held to be part of the thought process involved in a study, an integral part of the experimental design.... Whereas the emphasis was once on how to treat data already gathered, questions are now asked about sources of data, sampling design, and the abstract structure of the data which determines the type of conclusion that can be drawn. (p. 333)

Oliver (1981) observed some effects of using statistical techniques in vocational education research. He noted that "more complex problems are being investigated, the information produced is becoming more meaningful and the efficiency of the research is increasing" (p. 9).

The importance of statistics in educational research also was recognized by Ferguson (1966). He believed that "training in statistics is training in scientific method" (p. 2). Moreover, he argued that statistical inference is scientific
inference, which in turn is inductive inference, the making of general statements from the study of particular cases.

Current leaders in agricultural/vocational education have acknowledged a possible deficiency of statistical expertise among vocational researchers and urged further training in this area (Warmbrod, 1986; Cheek, 1988). Warmbrod (1986) pointed out that "one area that must receive particular attention is knowledge in the use, interpretation and reporting of the more sophisticated multivariate statistical techniques" (p. 7). Cheek (1988) also suggested the inclusion of more methodological and statistical techniques in vocational education graduate curriculum.

On the other hand, development in statistics has been so rapid since the 1930s that even by the mid 1950s, it was virtually impossible "for even the most widely read professional statistician to be acquainted with the important contributions in the field" (Walker, 1956, p. 332). Nevertheless, this researcher feels that, to maintain and increase the contribution of statistical methods in vocational education, an increased statistical competency level is needed by researchers in the field.

Best (1977) defined statistics as "a body of mathematical techniques or process for gathering, organizing, analyzing, and interpreting numerical data" (p. 212). These techniques can be ordered approximately by degree of sophistication (Goodwin & Goodwin, 1985a; 1985b), because training in applied
statistics for educational researchers traditionally follows a progression from the most fundamental techniques, such as means and variances, to more sophisticated ones, such as multiple regression analysis and factor analysis. This concept of statistical sophistication is meaningful when examining the use of statistical techniques in current research practice. The use of statistical techniques is an important characteristic of educational research.

Only one study on the use of statistical techniques in vocational education research was reported (Kelly, Sproles, Camp, Hauser, & Kopf, 1989). Neither the use of specific statistical techniques or the statistical sophistication level was investigated in that study. Therefore, further study in this area was needed. Specifically, two primary questions were answered: what types of statistical techniques are employed in vocational education research, and what are the statistical sophistication levels of reported research in vocational education?

Educational research is an ongoing process which starts at the selection and definition of a problem followed by execution of research procedures (Gay, 1979). While the impact of statistics could be found in many stages of this ongoing process, the most direct use of statistical analysis is concentrated in the data analysis stage. Since the determination of a research problem precedes data analysis, the specific nature of the problem logically should influence
the research activities incorporated in the subsequent stages of the process, including data analysis. Specifically, the following two questions should be answered through an empirical study: What problem areas have been most studied in vocational education? And does the problem areas studied relate to the statistical sophistication level of research?

After a research problem is selected and defined, a logical next step in the ongoing research process is formulating the research design (Bailey, 1978). Among the many factors to be considered, researchers must first decide which methodological strategy to use to conduct a study. McGrath (1981) defined methodological strategies as "generic classes of research settings for gaining knowledge about a research problem" (p. 182). Some of the methodological strategies used in vocational education are survey, field studies, ex post facto research, field experiments, and laboratory experiments (Schwandt, 1983).

A number of researchers have discussed the advantages and limitations of different methodological strategies in educational research (Baker & Schultz, 1972; Runkel & McGrath, 1972; Kerlinger, 1973; McGrath, 1981). They concurred that all methodological strategies involve compromise based on numerous practical considerations. Burnett (1986) pointed out that "there is no one 'correct' design that can be used in all situations" (p. 2).
One of the major criticisms of vocational education research is that it has relied too heavily on descriptive studies, especially surveys (Cheek, 1988; Hillison, 1990). Support for these claims has been found in a previous study by Schwandt (1983). He reviewed 83 articles published in Volumes 16 and 17 of the *Journal of Vocational Education Research* and Volumes IV and V of the *Journal of Industrial Teacher Education*, and found that the survey strategy was used in more than half of the studies. Further study is needed to verify such criticism of vocational education research in the 1980s.

Changes in educational research can be examined by studying trends of its many characteristics, including the statistical sophistication, problem studied, and methodological strategies used. Several studies in the field of general education indicated that there were no significant changes in the use of statistical techniques and research methodologies in the 1980s (Eason & Daniel, 1989; Elmore & Woehlke, 1988). However, a trend toward using a greater variety of methodological strategies in vocational education research was found in recent years (Schultz, 1988). A study of the past trends of vocational education research should enhance the understanding of its current status.

**Goals and Objectives**

The purpose of this study was to describe the status of, and changes in, the statistical sophistication of research in vocational education in the 1980s. The study also sought to
determine relationships among the statistical sophistication level, the problem area studied, and the methodological strategy used in vocational education research. Specific objectives of the study were to:

1. describe the statistical techniques used and determine the statistical sophistication of vocational education research reported in the 1980s;

2. describe the problem areas studied in vocational education research reported in the 1980s;

3. determine if a relationship existed between the statistical sophistication of research and the problem areas studied in vocational education reported in the 1980s;

4. describe the methodological strategies used in vocational education research reported in the 1980s;

5. determine if a relationship existed between the statistical sophistication levels and methodological strategies used in vocational education research reported in the 1980s;

6. determine changes over time in the statistical techniques employed, the statistical sophistication levels, the types of problems studied, and the types of methodological strategies used in vocational education research reported in the 1980s.

Significance of the Study

This study could provide insights into characteristics of the practices of vocational education research in the 1980s.
Some implications from this study could be found in the following aspects:

1. Results of this study could serve as bases to set appropriate statistical proficiency levels needed by consumers and practitioners of vocational education research. One of the common means to keep professionals in vocational education up-to-date is to read professional literature, including research reports. To comprehend most of the research literature, consumers should have preparation in the area of statistics comparable to the level of its use in the literature. In practice, potential benefits can be found both in determining curriculum requirements of statistics for the professionals in preparation and in further development for those who are already in service.

2. The knowledge of what kinds of problems were being studied in vocational education research can provide a clear framework of where research efforts were made in the 1980s. Such a framework may reveal emphases and shortfalls of research efforts in vocational education research. Knowing what studies have been done in the past could help identify those problems that have not been adequately studied. Planning for future research should thus be enhanced.

3. Patterns of methodological strategies used in vocational education research can be identified through this study. Because there are advantages and limitations for each methodological strategy, knowledge of these patterns may also
suggest the needed strategies for further research in various content areas. Moreover, this study can be used to assess the validity of some criticisms of practices in vocational education research.

4. This study could identify some directional changes in vocational education research in the 1980s. Identification of such patterns can reveal emerging research topics as well as trends in the use of research methodology. For example, if a significant increase in the use of multivariate techniques was identified, current vocational education researchers would need to be prepared to understand these techniques.
CHAPTER II

REVIEW OF RELATED LITERATURE

Brief History of Educational Research

Although Barnard, Mann, and Harris played crucial roles in laying the foundation of educational research before the turn of this century, Joseph Mayer Rice (1857-1934) has been commonly regarded as the father of educational research. Rice's major contribution was promoting the idea that some problems of education could be attacked by empirical means (Travers, 1983).

Rice spent two years investigating 1,200 teachers in 36 cities and published his observations in a book, *The Public School System of the United States* (1893). In 1902, Rice proposed that cities should appoint research assistants to superintendents of schools; and in 1903, together with 24 superintendents and others, he founded a Society of Educational Research (Travers, 1983).

Besag (1986) suggested that educational research has passed through three major phases based on the predominant methodology utilized. The first phase was called "deductive professional insight and folkways", which reached its nadir in the mid to late 19th century. Johann F. Herbert (1776-1841) exemplifies the professional insight research of the 19th century (Besag, 1986). His research in education was based on his own considerable intellectual abilities, not on data-based
inductive research that could be continued or replicated by other scholars. The second phase was called "inductive physical science experimentalism", which began in the late 19th century and continues today. Wilhelm M. Wundt (1832-1926) was a pioneer of the experimental method in psychology and education (Besag, 1986). The third phase, "a holistic research", can include deductive insight and folklore as well as inductive experimentalism. Inductive experimentalism has always been an accepted research approach but seems to be achieving renewed popularity. Joshus Price, at the turn of the century, attempted to use multiple methodologies in educational research (Besag, 1986).

In 1980, West and Robinson reported the results of a study designed to determine the progress which had been made in educational research. They studied a random sample of 78 empirical articles published in the American Educational Research Journal (AERJ), the Journal of Educational Psychology (JEP), and the Journal of Educational Research (JER) from their initial publication through 1974. Data were extracted from each article on type of explanation, type of study, focus, authorship, extended funding, affiliation of authors, number and type of subjects, and references. They concluded that "the major trend observed seems to be toward the use of empirical generalizations" (p. 275). "It is possible to characterize the period from 1910 through 1949 as a
descriptive era. The period since then may be termed the era of the empirical generalization" (p. 275).

One of the most important milestones in the development of educational research is the use of statistical techniques. The origin of this progress can be traced back to the beginning of this century. Edward L. Thorndike's Notes on Child Study (1901), Introduction to Mental and Social Measurements (1904), and subsequent works of his students established the statistical applications in educational research (Walker, 1956). Thorndike is considered to be the father of educational statistics (Besag, 1986).

Some Attributes of Research in Vocational Education

Vocational education research has a rich heritage. Since the American Vocational Education Research Association (AVERA) was established in 1965, it has been a viable and strong force in vocational education. The AVERA is affiliated with the American Vocational Association (AVA) as well as with the American Educational Research Association (AERA) through the Special Interest Group on Vocational and Technical Education. The major purposes of this organization are to: (a) Stimulate research and development activities related to vocational education; (b) promote the development of training programs designed to prepare persons for responsibilities in research in vocational education; (c) foster a cooperative effort in research and development activities within the total program of vocational education; and (d) facilitate the dissemination
of research findings and the diffusion of knowledge (Hjelm, 1983).

One characteristic of vocational education research is that it is greatly influenced by the legislative priorities for research programs. Hughes (1983) pointed out that "research in vocational education is all too often determined by who has the money and what they want to know; by the legislative priorities for program content (especially federal); and, to some extent, by whatever is 'in' at the moment" (p. 119).

Although vocational education research had been conducted several decades earlier, special authorization for such research did not occur until the Vocational Education Act of 1963. The first funds were not appropriated until fiscal year 1965 (Boerrigter, 1983). Since then, several major federal legislative acts have supported vocational education research: (a) the Vocational Education Amendments of 1968 which included three separate authorizations affecting research and related activities; (b) the Education Amendments of 1976 which continued to support research and authorized the establishment of the National Center for Research in Vocational Education; and (c) the Carl D. Perkins Vocational Education Act of 1984 which contained a special part on research under Title IV--National Programs.

Channels to communicate vocational education research findings have been available through numerous publications as
well as research conferences at the national and regional levels. Copa (1987) compiled a list of 45 professional journals across various vocational discipline areas. Among that list there were 24 refereed journals and four journals with some articles or sections refereed. Kotrlik (1991) identified 34 professional journals in vocational education, including 24 refereed journals.

A major research journal in vocational education is the Journal of Vocational Education Research (JVER), which purports to publish in both vocational education and associated service areas (Kelly, Sproles, Camp, Hauser, & Kopf, 1989). The JVER, established in 1976, is the official publication of the American Vocational Education Research Association (AVERA), which is refereed and serves as a communication vehicle for the vocational education research community (Oliver, 1983).

Research journals also are published within the various vocational education discipline areas. For example, in the area of agricultural education, the primary research journal is the Journal of Agricultural Education (JAE, formerly the Journal of American Association of Teacher Educators in Agriculture, or JAATEA). For the area of vocational home economics, the Journal of Vocational Home Economics Education (JVHEE) is the major research journal. The Journal of Industrial Teacher Education (JITE) is the primary research journal in the area of trade and industrial education.
Problem Areas of Study in Vocational Education

Problem Areas of Study in Vocational Education in the Past

The topics of concern for vocational education research have evolved over time. Further, priorities for research and development activities differ over time, often depending on availability of funds, legislative influence, and the extant literature (Schmidt, Lynch, & Frantz, 1988).

In 1976, the Assembly of Behavioral and Social Sciences of the National Academy of Science published the report of its Committee on Vocational Education Research and Development (COVERD). The purpose of the COVERD was to assess research and its administration and to provide suggestions for the improvement of legislative and administrative procedures (Evans, 1983). Based on outcomes of a study that took more than a year to complete, the Committee concluded that $250 million of federal funds had been used over the previous ten-year period for research which could be categorized into nine major topical areas: (a) career development and guidance; (b) students with special needs; (c) characteristics of students; (d) teacher education; (e) instructional techniques; (f) curriculum development; (g) labor market supply and demand information; (h) administration of vocational education; and (i) evaluation of vocational education programs (Committee on Vocational Education Research and Development, 1976).

Seidman (1985) studied the trends of vocational education research for the period 1963 to 1983. Research data were
collected from the following two major sources: (a) individual research and development efforts reported through dissertations and in research reports published in the *Journal of Vocational Education Research* (JVER) and in the *Journal of Industrial Teacher Education* (JITE), and (b) government research and development efforts at both the federal and state levels reported in various sources. For his initial content analysis, Seidman (1985) used the nine major research categories identified by the COVERD. As an outcome of a "geological" analysis procedure that focused on "level of effort", Seidman (1985) draw the following conclusion:

Within the 20 years studied (1963-1983), vocational education R & D comes across as a diffused and unfocused activity spread across so many areas that the advancement of vocational education as a discipline should be questioned. Any trends that did emerge were short-lived; the pattern of influence between the two fields--individual R & D and government R & D--were inconsistent and, therefore, inconclusive. (p. 57)

Several other studies also used professional research journals to analyze problem areas of research in vocational education (Schwandt, 1983; Kapes & Bartley, 1986; Schultz, 1988; Kelly, Sproles, Camp, Hauser, & Kopf, 1989). Schultz (1988) studied all of the 103 manuscripts submitted to the JVER during the period 1986 to 1987. She found that the subject matter areas being studied in descending frequency...
were: (a) teacher competency, certification, and evaluation; (b) program outcomes and evaluation; (c) student characteristics (needs, attitudes, and behaviors); (d) research directions, methods, and policy; (e) curriculum development, instructional design and methods; (f) special populations; (g) history and philosophy; (h) technology and computers; (i) instrument development; and (j) basic skills.

Kapes and Bartley (1986) reviewed research articles published in four vocational education research journals during the period 1982 to 1986. Two assumptions in the study were: (a) The best place to sample the research of a field is through its research journals; and (b) the Journal of Vocational Education Research (JVER), Journal of Industrial Teacher Education (JITE), Home Economics Research Journal (HERJ), and Journal of the American Association of Teacher Educators in Agriculture (JAATEA) represent a reasonable cross-section of the field of vocational education and its research. Based on data collected from a sample of 386 articles published in the four specified journals, they found that the problem areas studied in descending frequency order were: (a) perception, needs and attitudes; (b) student behaviors; (c) teacher behavior; (d) teacher evaluation; (e) curriculum; (f) technical knowledge; (g) special population; (h) teaching methods and materials; and (i) others.

Schwandt (1983) examined a total of 82 articles published in Volumes 16 and 17 of the JITE and Volumes IV and V of the
JVER to analyze the problem areas studied in vocational education research. A system proposed by Steiner (1978) was used to classify each article examined into one of the following problem areas: (a) teacher; (b) student; (c) curriculum; and (d) setting. The results of Schwandt's (1983) study showed that approximately equal numbers of studies in vocational education were conducted on the "teacher" and "setting" components (about 30% each). A smaller number of studies focused on the "student" and "curriculum" components (about 20% each).

**Suggested Areas of Research in Vocational Education**

Many researchers concentrated their studies on what kinds of problems should be addressed in vocational education research (David, Hjelm, & Harris, 1983; Oliver, 1983; Smith, 1983; Wallrodt, 1983; Phelps & Hughes, 1986; Lynch, Schmidt, & Asche, 1988; Schmidt, Lynch, & Frantz, 1988). A Colloquium on Vocational Education Research was sponsored in 1982 by the AVERA in cooperation with the Coordinating Committee on Research in Vocational Education (David, Hjelm, & Harris, 1983). Several participants of the Colloquium offered suggestions on future research areas in vocational education (Wallrodt, 1983; Smith, 1983; Oliver, 1983).

Wallrodt (1983) predicted that "pervasive change will be the most likely descriptor of the condition of vocational education over the next decade" (p. 35). He suggested that the following eight issues should be addressed in future
vocational educational research: (a) high technology; (b) "flex" skills; (c) science, math, communication skills; (c) relations with other programs; (d) equity issues; (e) motivation and attitudes; (f) cooperative ventures; and (g) standards of excellence.

Smith (1983) identified three topics that he thought had received insufficient attention and that bore on the future role in vocational education research. These topics were: (a) basic skills; (b) postsecondary outcomes for postsecondary vocational students; and (c) the financing for vocational education.

Oliver (1983) surveyed the members of the Editorial Board of the JVER to seek suggestions on topics of research and development for the 1980s. Major preferred areas of research among the surveyed members were identified as the following: (a) the role of various deliverers of vocational education; (b) alternative models for delivering vocational education instruction; (c) maximizing the marginal benefits of vocational training to the individual and to the society; (d) alternative approaches to preparing and updating vocational teachers and specialists such as administrators, researchers, curriculum developers, etc.; (e) managing vocational education at all levels; and (f) school/work transitions.

Based on 16 papers prepared by the Colloquium participants, David (1983) summed up suggestions for future research into six categories: (a) change; (b) students; (c)
Phelps and Hughes (1986) suggested that there were three broad categories of vocational education research: (a) educational research; (b) policy research; and (c) evaluation research. Based on recommendations and observations of the National Commission on Secondary Vocational Education (NCSVE), Phelps and Hughes (1986) identified general problem areas that needed to be studied in each of the research categories: (a) educational research—incorporation of basic skills; improvement of teacher education; work and family; (b) policy research—access; equity; field based learning; and (c) evaluation research—use of longitudinal surveys; local studies of students. They further detailed topics of study for each of the general problem areas.

Lynch, Schmidt, and Asche (1988) used the Nominal Group Technique to determine priorities for vocational education research. The participants of the Nominal Group consisted of 23 leaders selected from three broad backgrounds: (a) business and industry; (b) public agencies or research/policy institutes; and (c) universities. Based on suggestions generated from the participants, the researchers concluded that:
six broad categories of research may be used as a basis from which to design future research activities in vocational education: (a) competencies, content, and instructional methods; (b) equity and access; (c) vocational education data; (d) policy; (e) communications, marketing, and public relations; and (f) delivery systems and levels. (p 25-26)

Schmidt, Lynch and Frantz (1988) surveyed 49 organizations of major providers or sponsors of the research and development of vocational education. Each of those organizations was asked to list the prioritized areas of needed research for vocational education. Based on analyses of 122 statements generated by the key individuals, either directors or chief executive officers, of 31 responding organizations, the researchers grouped the statements into the following eight priority topics: (a) effectiveness (or evaluation) of vocational education; (b) vocational program development and improvement, including curriculum development; (c) basic skills development in vocational education; (d) policy studies in vocational education, including the impact of future workforce and societal changes in vocational education; (e) collaborative relationship development in vocational education; (f) vocational personnel development; (g) providing for students with special needs, including addressing issues of access and equity; and (h) clarifying the
roles of vocational education and the federal role in vocational education.

**Classifications of Vocational Education Research**

Vocational education research covers vast problem areas. "An organization scheme is needed to provide a way to think about innovations, and their potential uses, in the field" (Copa, 1984, p. 1). In turn, such organization could provide a basis for choosing appropriate focus and approaches to inquiry. "There is no single authoritative answer to the problem of how to organize knowledge about a professional field" (Copa, 1984, p. 2). Lewis (1990) stated that such a paradigm "is by nature a value-laden question, prone to subjective judgment, oft times reflecting parochial interests that may or may not have lessons of wide applicability" (p. 1).

Copa (1984) suggested three kinds of questions or types of knowledge which might serve as basic categories or starting points for organizing knowledge about vocational education. They are (a) questions of meaning, (b) questions of ends, and (c) questions of means. "One needs all three types of knowledge to solve problems raised in vocational education. They each serve a unique purpose in problem solving" (p. 5).

Concerning the first type of questions, a large number of ideas and concepts are used in vocational education, such as work, vocational education student, employer satisfaction, etc., which must be understood in their meanings among
vocational educators. The second type of questions has to do with the purpose and values of vocational education. The third type of questions is associated with the criterion for soundness, such as the effectiveness and efficiency of vocational education programs.

Miller (1989) introduced a model on interrelationships among philosophy, kinds of research, and kinds of knowledge in vocational education. The model was developed according to Johnson's (1986) proposition. Johnson (1986) addressed the following three primary philosophies used by social and behavioral scientists: positivism, normativism, and pragmatism. Miller pointed out that "different kinds of knowledge can be produced by any of the kinds of research from among any type of philosophical orientation" (p. 7). Three different kinds of knowledge may include: positivistic knowledge, knowledge of values, and prescriptive knowledge.

Miller (1989) categorized educational research into three broad types. In order of increasing complexity, these research types are: (a) disciplinary research; (b) subject matter research, and (c) problem solving. "In vocational education, disciplinary research might include research on improving the measurement of student laboratory performance, research on teaching/learning theories, or research about the parameters of the populations served" (Miller, 1989, p. 4). Such research might be of unknown relevance for the immediate, practical problems faced by decision makers. An example of
subject matter research might be "equity problem" which is not confined just within the area of vocational education. "The results of subject matter research are seldom specific enough to assist individual decision makers with individual problems" (Miller, 1989, p. 5). "Problem solving research is the most practical and most rapidly accepted by the vocational practitioners, as it has immediate relevancy for the decision maker. The long-term importance of the research may be lacking, unless problems are cyclic and reoccur" (Miller, 1989, p. 6).

Lewis (1990) defined vocational education as "education aimed at the preparation of people for working life" (p. 13). Based on a set of assumptions pertaining to the aim, purpose, and subject matter of vocational education, Lewis (1990) proposed a model for research in vocational education. The proposed model was anchored on nine concepts: (a) work; (b) occupations; (c) labor markets; (d) pedagogy; (e) curriculum; (f) context; (g) ecosystem; (h) clientele; and (i) management. According to this model, vocational education research should encompass problems of these concept areas.

Corresponding lines of inquiry to these nine concept areas were identified by Lewis (1990) to further clarify his position. These lines of inquiry included: (a) work--sociology of work, psychology of work, and economics of work; (b) occupations--comparisons, trends, case studies, and manpower requirements; (c) labor markets--segmentation,
secondary market, floundering; (d) curriculum—determination, organization, evaluation, content sequencing; (e) context—legislation, policy, history, sociology; (f) pedagogy—effective teaching/instruction and alternative teaching strategies; (g) clientele—cognitive, affective and psychomotor attributes and dispositions, needs, working life experiences, life experiences; (h) management—feasibility studies, recruitment, governance issues; and (i) ecosystem—action studies, ecological psychology, holistic ethnography, cognitive anthropology (p. 19). Lewis (1990) provided detailed explanations about the meanings of these fundamental concepts.

Lewis (1990) proposed a model which consisted of three broad kinds of inquiry toward problems in vocational education research. The first group includes studies concerning problem justification, philosophy, and design, which entail the concept areas of work, markets, occupations, context, and management. The second group is called "milieu" or "ethos" studies, which would be studies of curriculum, pedagogy, and ecosystem. The third group contains studies aimed at assessing impact, which would focus on the ability of clientele to find jobs, clientele working life experiences (job success, job satisfaction, etc.), and clientele life experiences (lifestyle, disposition, occupational status, educational status, taste, etc.).
**Steiner's Classification of Quantitative Educology**

Steiner (1978) pointed out that "to do educational research is to do research about the teaching-studenting process" (p. 1). "A teaching-studenting process is one in which someone is attempting to bring about learning in someone who is attempting to learn" (Steiner, 1978, p. 1). Three kinds of knowledge from educational research can be distinguished: (a) quantitative, which consists of adequate characterizations of general properties and their interrelations; (b) qualitative, which consists of adequate characterizations of unique properties and their interrelations, and (c) performative, which consists of adequate executions. Steiner used the term "educology" to denote the knowledge from educational research, "so that 'education' need not be used both for the teaching-studenting process and for knowledge of that process" (p. 2).

Steiner (1978) identified four kinds of quantitative educology: (a) teacher, (b) student, (c) curriculum, and (d) setting. Research on teacher includes those on teacher's needs, functions, characteristics, competencies, and education. Research on student consisted of those on student's characteristics, needs, and learning. Research on curriculum has to do with the efforts to understand anything used in the "teaching-studenting" process and the micro environment in which the process takes place. Steiner defined curriculum as "something to be taught, and the selected
culture to transmit" (1978, p. 2). Research on setting includes the efforts to study the macro environment which indirectly affect the "teaching-studenting" process. Steiner (1978) defined setting as "a context of objects (e.g. school building), persons (e.g. administrators such as principals and deans), and culture (e.g. middle class culture)" (p. 3).

Methodological Strategies in Educational Research

Educational Research Process

Research is a continuous process made up of highly interdependent activities. This process has directionality, but it is not a single direct path from start to end. It is more like a network of intersecting paths. Runkel and McGrath (1972) divided the empirical research process into eight phases. Each phase represents a bundle of choices or questions to be dealt with before subsequent phases can be undertaken. These eight phases in behavioral research were: (a) formulating the problem; (b) designing; (c) making an operational plan; (d) carrying out the operational plan; (e) mapping observations into data; (f) mapping data into variables; (g) exploring relations; and (h) drawing conclusions.

Fox (1969) proposed a model of the educational research process which "has been developed at three levels: the stage itself, the dynamic forces underlying the stage, and the outcomes of the stage" (p. 25). Fox divided the process into the following three parts: (a) designing the research plan;
(b) implementing the research plan; and (c) implementing the results.

Classifications of Methodological Strategies

A major step in behavioral research is the selection of an appropriate research strategy. "Behavioral research is carried out within a wide range of settings and with the use of a variety of strategies varying in control, precision of measurement, realms of situations, and a number of other characteristics" (Runkel & McGrath, 1972).

Van Dalen (1979) described three broad strategies used in educational research: (a) experimental research; (b) descriptive research; and (c) historical research. He pointed out that "the central idea behind experimental design is control" (p. 227). Designs in experimental research can be classified into subcategories based on the extent of control used. Van Dalen (1979) further stated:

Descriptive studies range from simple surveys that do little more than ask questions and report answers about the status quo to studies that present explicit statements about the relationship between variables which approach the level of the explanatory hypotheses one finds in experimental research. (p. 285)

Historical research may be used to ascertain the meaning and reliability of past facts encountered in the subject matter that is commonly referred to as history, and it may
also be used to appraise the past facts encountered in everyday life.

Gay (1979) discussed five broad research strategies. According to Gay, historical research involves studying, understanding, and explaining past events. Descriptive research involves collecting data in order to test hypotheses or answer questions concerning the current status of the subject of the study. Correlational research attempts to determine whether, and to what degree, a relationship exists between two or more quantifiable variables. In a causal-comparative study, the independent variable, or "cause", is not manipulated; it has already occurred. In an experimental study the researcher manipulates at least one independent variable and observes the effect on one or more dependent variables.

Other researchers (Smith, 1984; Ary, Jacobs, & Razavieh, 1985) proposed similar classifications as the one proposed by Gay (1979). Ary, Jacobs, and Razavieh (1985) stated that "none of the methods is necessarily superior to the others" (p. 27). They did believe, however, that there is a logical order in which one type of research will follow another.

Smith (1984) believed that there was a continuum ranging from subjective questions to objective hypotheses in the following sequence: historical research, descriptive research, relational research (including correlational, causal comparative, ex post facto, quasi-experimental), and
experimental research. "There appears to be no single empirical-analytic methodology which can be used for all research studies; rather, the selection of a particular methodology is an indication of the investigator's perception of the research problem..." (p. 27).

Kerlinger (1973) discussed five primary inquiry strategies in behavioral research: (a) laboratory experiments; (b) field experiments; (c) field studies; (d) ex post facto research; and (e) survey research. He believed that the strategies used are dictated by the nature of the problem and the kind of data required.

**Runkel and McGrath's Theory**

Runkel and McGrath (1972) defined methodological strategies as "generic classes of research settings for gaining knowledge about a research problem" (p. 182). There are (at least) eight readily distinguishable research strategies in educational research: sample surveys, formal theory, computer simulations, field studies, field experiments, experimental simulations, laboratory experiments, and judgment tasks. These eight intricate strategies also can be viewed as four quadrants, each with a related pair of strategies. Further classifications of these methods are made in two dimensions: (1) the use of obtrusiveness versus unobtrusiveness in operation; and (2) concern with universal behavior systems versus concern with particular systems. Within the two dimensional space there are three "maxima"
points at which each of three mutually conflicting desiderata is realized at the highest value. McGrath (1981) called this model a "three-horned dilemma" and claimed that not only is there no one strategy that will guarantee success, there is not even a best strategy for a given problem.

According to Runkel and McGrath (1972), field studies and field experiments are typically conducted in natural settings. Field studies rely on systematic observation of phenomena with real-world behavior systems. When deliberate modification of some important property of the behavior system is included in a field study, the type of study is called a field experiment.

Experimental simulations and laboratory experiments are conducted in contrived and created settings. "An experimental simulation not only requires intrusion by measurement and by manipulation of a major property of the system, but it also involves the deliberate attempt to construct a behavior setting--one that will mirror or typify some particular class of naturally occurring system" (Runkel & McGrath, 1972, p. 96). On the other hand, some studies deal with behavior within settings that are deliberately created for the research itself. These often are called laboratory experiments.

Both sample surveys and judgment tasks are strategies for gathering observations in situations where the behavior observed is not intrinsically connected to the setting. However, there are two major differences between these strategies. First, they differ in the way stimulus
presentations are organized and in the nature of the response alternatives permitted. The judgment task is more intrusive than the sample survey because it involves more rigorous control and manipulation of properties of the stimulus conditions and of the behavior. A second difference is that sample surveys generally are concerned with generalizability over respondents and focus on sound sampling of respondents from the populations to whom results are intended to be generalized. In contrast, the judgment task strategy is concerned with generalizability over stimuli and focuses on sound selection of stimuli in terms of the set of stimulus properties that are of concern.

Formal theory and computer simulations are two nonempirical strategies for systematically processing information and extrapolating it. Formal theory is used to construct an abstract, logical model of a behavior system and to perform logical manipulations to adduce new insights. Computer simulation creates an imitation of some concrete, real system which is artificially complete and closed.

Runkel and McGrath (1972) asserted that field experiments, experimental simulations, laboratory experiments, and judgment tasks comprise the subset of relatively more obtrusive operations, whereas sample surveys, formal theory, computer simulations, and field studies comprise another subset of relatively more unobtrusive operations. Laboratory experiments, judgment tasks, sample surveys, and formal theory
represent a subset of strategies dealing with universal
generic behavior systems, and the rest of the strategies
represent a subset of strategies dealing with particular or
concrete behavior systems.

Regarding the concern with generalizability over
respondents, an order of strategies from maximum to minimum
is: sample surveys and formal theory, judgment task and
computer simulations, laboratory experiments and field
studies, and experimental simulations and field experiments.
In regard to the concern with precision of measurement of
behavior, an order of strategies from maximum to minimum is:
laboratory experiments, experimental simulations and judgment
tasks, field experiments and sample surveys, field studies and
formal theory, and computer simulations. Regarding the
concern with system character of context, an order of
strategies from maximum to minimum is: field studies, field
experiments and computer simulations, experimental simulations
and formal theory, sample surveys and laboratory experiments,
and judgment tasks.

McGrath (1981) concluded that "the research process teems
with dilemmas involving the need to maximize, simultaneously,
two or, in some cases, three conflicting desiderata" (p. 208).
He believed that "no strategy, design or method used alone is
worth a damn" (p. 209). Thus, he urged the use of multiple
approaches, because this would allow compensation for the
inherent limitations that any one strategy would have if used alone.

**Empirical Studies on Strategies Used in Educational Research**

Eason and Daniel (1989) investigated the trends and methodological practices in 100 education dissertations completed over a nine-year period at an urban university during the 1980s. They found that 61% of these dissertations were classified as survey research. Mailed questionnaires (41%) and questionnaires administered personally (37.7%) were the two major alternatives for data collection. No major changes were found in research methodology during the specified time span.

Jarrell, Johnson, Chisom, and Hughes (1989) selected a random sample of 75 Ed.D. dissertations out of a population of 209 from 1984 to 1988 at a major university to study the research methodologies used. The researchers found that 95% of the dissertations had a quantitative component and 43% of them were classified as survey research.

Schwandt (1983) reviewed a total of 82 articles published in Volumes 16 and 17 of the JITE and Volumes IV and V of the JVER to determine the inquiry strategies used in vocational education research. Based on McGrath's (1981) theory, Schwandt (1983) classified inquiry strategies into four categories: (a) laboratory experiments, which can maximize precision in measurement, but are very low on generalizability and realism of context; (b) field experiments, which are
moderately high on precision in measurement and realism, but are very low on generalizability; (c) field study and other forms of ex post facto research, which can maximize realism of context, but are very low on generalizability and realism in measurement; and (d) population and sample surveys, which can maximize generalizability, but are low on precision of measurement and realism of context.

Schwandt (1983) found that population and sample surveys, which accounted for about 60% of all the articles examined, were the most frequently used methodological strategy. Approximately 24% of the examined articles were classified as "field study and ex post facto research", whereas another 16% of the articles were classified as "field experiment". None of the articles examined were classified as "laboratory experiment". Regarding the methodological strategies used for each of the problem areas studied, Schwandt (1983) found that "none of the components of teacher, student, curriculum, or setting were investigated with a program of multiple strategies that compensated for the weakness inherent in any one inquiry strategy" (p. 54).

Mannebach and Mckenna (1984) analyzed research methodology used in agricultural education studies completed and reported in the annual national Summaries of Research and Development Activities in Agricultural Education during the period from 1974 to 1982. They used Van Dalen's (1979) classification of research methodology, and found that
descriptive research accounted for 90% of the studies, while the rest of the studies were classified as either historical research (0.7%) or experimental research (9.3%). Further analysis of the descriptive studies revealed that 45% of them were survey studies, 13% were interrelationships studies, 4.4% were developmental studies, and 27.6% were not classified as any of the above listed categories.

Schultz (1988) conducted a content analysis on all of the manuscripts submitted to the JVER during 1986 and 1987, and found that correlational and causal comparative studies accounted for approximately one-fourth of all the manuscripts received. She concluded that "heavy reliance on descriptive studies in vocational education research appears to be decreasing" (p. 13).

Kelly, Sproles, Camp, Hauser, and Kopf (1989) studied all articles (N=31) appearing in the first three volumes of the Journal of Vocational and Technical Education, except presidents' messages, editors' notes, commentaries and book reviews. They found that 58% of the articles were classified as either descriptive (N=4), evaluation/feasibility (N=2), implications (N=1), or research/technical (N=11). Further, research designs used in all the 11 research/technical reports were descriptive studies.
Statistical Sophistication in Behavioral Research

Use of Statistics in Educational Research

Moore (1989) studied the citations used in the *Journal of American Association of Teacher Educators in Agriculture* (JAATEA) from 1978 to 1988 and found that two of the 10 most cited references within the ten-year period were two statistics textbooks. Mannebach and Mckenna (1984) found that as high as 32.9% of all the studies in agricultural education from 1974 to 1982 used statistical techniques. These findings suggested the important roles that statistics played in vocational education research.

Use of statistical techniques in research has been extensively studied by researchers in general education (Emmons, Stallings, & Layne, 1990; Eason & Daniel, 1989; Jarrell, Johnson, Chisom, & Hughes, 1989; Elmore & Woehlke, 1988; Goodwin & Goodwin, 1985a; West, Carmody, & Stallings, 1983; Willson, 1980;), in psychology (Edginton, 1964; Edginton, 1974, Goodwin & Goodwin, 1985b), in sociology (Cartney, 1970), and in other areas (Teleni & Baldauf, 1989; Rudolph, McDermott, & Gold, 1985). Virtually all of these studies tabulated the frequencies of the use of specific statistical techniques. A few studies (West, Carmody, and Stallings, 1983; Goodwin & Goodwin, 1985a, 1985b; Eason & Daniel, 1989; Teleni & Baldauf, 1989; Emmons, Stallings, & Layne, 1990) further examined the sophistication levels of
various statistics used in educational research within a certain period of time.

**The Concept of Statistical Sophistication**

The concept of statistical sophistication was mentioned or implied in several studies (Goodwin & Goodwin, 1985a, 1985b; Teleni & Baldauf 1989; Eason & Daniel, 1989; West, Carmody, & Stallings, 1983; Emmons, Stallings, & Layne, 1990). Studies conducted by Goodwin and Goodwin (1985a, 1985b) and Teleni and Baldauf (1989) grouped various statistical techniques into different levels of sophistication. Another group of studies classified statistics into univariate and multivariate techniques and implied that multivariate techniques were higher in the sophistication level (Eason & Daniel, 1989; West, Carmody, & Stallings, 1983; Emmons, Stallings, & Layne, 1990).

The classification system developed by Goodwin and Goodwin (1985a) divided statistical techniques into three sophistication levels: basic, intermediate, and advanced. The statistical techniques listed at the basic level were: descriptive statistics, Pearson correlation, $X^2$, independent and dependent t-tests, and one-way ANOVA (Analysis of Variance). The techniques listed at the intermediate level were: factorial ANOVA, planned orthogonal comparisons, post-hoc multiple comparisons, trend analysis, one-way and factorial ANCOVAs (Analysis of Covariance), part/partial correlation, and multiple regression. The techniques listed
at the advanced level were: discriminant analysis, path analysis, canonical correlation, factor analysis, cluster analysis, one-way and factorial MANOVA/MANCOVAs (Multiple Analysis of Variance/ Multiple Analysis of Covariance). Statistical techniques not listed within the three levels were classified as others, which included other correlational techniques, other nonparametric techniques, etc..

The rationale for this classification system was that it corresponded to a course progression of studying applied statistics in current practice. The more training needed to understand or apply the technique, the more sophisticated that technique tend to be. Teleni and Baldauf (1989) also used such a three-level classification of statistical sophistication in their study.

Use of Multivariate Techniques in Educational Research

Hinkle, Wiersma, and Jurs (1979) stated that "it is becoming increasingly important for behavioral scientists to understand multiple procedures even if they do not use them in their own research" (p. 415). Hopkins (1980) also concurred that "multivariate methods allow understanding of relationships among several variables not possible with univariate analysis" (p. 374).

Thompson (1988) identified the following two major advantages of using multivariate methods: (a) these methods control the inflation of type I "experimentwise" error rates,
and (b) these methods best honor the reality to which the researcher is purporting to try to generalize.

One possible source of misusing statistics in educational research is to use multiple univariate statistics where a single multivariate analysis can be more appropriate (Moore, 1983). The study by Goodwin and Goodwin (1985a) found some cases of misuse of this type. In vocational education, Miller (1987) advised researchers to avoid making mistakes in selecting the most appropriate statistics.

One reason some researchers had hesitated to use multivariate statistical techniques was noted by McMillan and Schumacher (1984). They observed that "the statistics for analyzing many variables at the same time have been available for many years, but it has only been since the computer age that researchers have been able to utilize these procedures. There is thus a lag in the training of researchers that has militated against the use of these more sophisticated procedures" (p. 270).

**Empirical Research on the Use of Statistical Techniques in Social Science Research**

Early studies on the use of statistical techniques in behavioral research can be dated in the 1960s. Two of the major studies in this area were reported by Edginton in 1964 and 1973. Edginton's first study (1964) examined the use of inferential statistical techniques in articles published in APA journals in the even numbered years from 1948 to 1962,
inclusive. He divided statistical techniques into six broad categories: analysis of variance (ANOVA), t-test, correlation, chi-square ($X^2$), factor analysis, and new nonparametric techniques. He listed the total number of statistical inference articles and the percentages for the six types of statistical techniques, and found that ANOVA techniques were the most frequently used category, and use of correlation techniques showed a definite decline. However, there were no definite trends on the use of the techniques during that time span.

Edginton's second study (1974) brought the tabulation up to date for the same journals or their successors. Articles in the seven APA Journals for the even numbered years from 1964 to 1972 were examined to see what kinds of inferential statistics were used. His findings indicated some trends over a 25-year period from 1948 to 1972. For example, the use of ANOVA increased dramatically from 11% of the 1948 articles to 71% of the 1972 articles; further, 88% of the 1972 ANOVAs involved more than one independent variable. The use of t-tests decreased concomitantly, from 51% in 1948 to 12% in 1972.

Goodwin and Goodwin (1985b) studied a stratified random sample of one-third of each volume's articles of the Journal of Educational Psychology (JEP) from 1979 to 1983 ($n=150$). They coded every statistical technique mentioned and categorized the major techniques into three levels: basic,
intermediate, and advanced. The inter-rater reliability estimate of the study was 92%. Factorial ANOVA was found to be the most frequently used statistical technique (15.6%), followed by Pearson correlation (14.9%), post-hoc multiple comparisons (10.8%), and multiple regression (8.0%). The least frequently used techniques—those used less than 1% of the time—were descriptive statistics, trend analysis, canonical correlation, and other nonparametric techniques. Aggregating percentages by level, it was found that 35.3% of the techniques were basic, 43.1% intermediate, and 11.7% advanced. The researchers concluded that major changes in the usage of statistical techniques did not occur during the 1979-1983 period.

A series of studies was conducted on analyzing the statistical techniques used in the articles published in the *American Educational Research journal* (AERJ). Willson (1980) surveyed the research techniques in AERJ articles from 1969 to 1978. His coding scheme included a number of methodological variables in addition to the major research technique(s) used, such as characteristics of subjects, sample size, and use of randomization. Using a discipline-based classification scheme, he found that the biology-based techniques (correlation, multiple regression, discriminate analysis, multivariate analysis of variance (MANOVA), and intraclass correlation) comprised the largest category of techniques used (41%). The agriculture-based techniques of ANOVA and ANCOVA
accounted for 34% of the techniques used. Techniques grounded in psychology, economics, sociology and miscellaneous others (such as secondary analysis, Jackknife, etc.) together represented the reminder used during the ten-year period. Moreover, he found that "there appears to be no broadening of the pool of research techniques used in educational research as represented by AERJ" (p. 9).

Goodwin and Goodwin (1985a) also used AERJ research articles between 1979 and 1983 to tabulate the statistical techniques employed. Their coding was based on the following two variables: (a) types of techniques; and (b) "major" or "minor" importance for comprehending the research findings. "Techniques were considered major if they were used to directly answer the key research question(s) posed in the article, and/or if understanding of their meaning was viewed as integral to completely interpreting the main results or findings" (p. 7). Twenty-seven types of techniques were identified and further classified as being at the "basic", "intermediate", or "advanced" level, in terms of typical statistics course progression. The researchers found that of the "major" techniques, 33%, 37%, and 17% were basic, intermediate, and advanced, respectively. This result suggested that "students with both a basic and intermediate level knowledge of statistics would understand most of the techniques encountered in AERJ" (p. 5). The researchers
concluded that major changes in the usage of statistical techniques did not occur during the 1979-1983 period.

Elmore and Woehlke (1988) reviewed the literature published in the American Educational Research Journal (AERJ), the Educational Researcher (ER), and the Review of Educational Research (RER) for the ten-year period ending in 1987. They found that the most frequently used methods in the AERJ in rank order were ANOVA/ANCOVA, multiple correlation/regression, multivariate, bivariate correlation, nonparametric, and t-test. They found that descriptive was the most frequently used method in the ER, and meta-analysis was the most frequently used method in the RER for the specified time period.

Emmons, Stallings, and Layne (1990) studied the use of particular statistical methods in articles published in the American Educational Research Journal (AERJ), the Journal of Educational Psychology (JEP), and the Sociology of Education (SOE) from 1972 to 1987. A total of 221 issues of the three publications (2,674 articles) was reviewed by using the coding system reported by Goodwin and Goodwin (1985a). A total of 41 different statistical techniques were found to be used in the articles published in the three journals. The two most frequently used techniques were identified as ANOVA (37%) and regression (13%). In addition, decreases in frequency of use were found for descriptive statistics, $X^2$, other non-parametric statistics, factor analysis, and ANOVA over the 16-
year period. Increases of frequency were found in the use of MANOVA, MANCOVA, multiple regression, and multiple correlation during the same period. The researchers observed that, across the three journals, increases in the use of logit, probit, and log-linear methods. These were signs of trends toward adjusting methodology to account for the multiplicative and curvilinear nature of most social science research data.

Several studies of the use of statistical techniques obtained data from sources other than AERJ (West, Carmody, & Stallings, 1983; Eason & Daniel, 1989; Jarrell, Johnson, Chisom, & Hughes, 1989). West, Carmody, and Stallings (1983) studied the quality of (empirical) research articles in the Journal of Educational Research (JER) over a ten-year period from 1970 to 1980 by selecting articles from 1970 and 1980 only. The researchers compared the differences in quality between the articles published in the two years, and considered the statistics used as one of the quality indicators. Their study indicated that the most frequently used techniques in the articles published in 1970 were ANOVA, Pearson correlation, t-tests, $X^2$, and multiple regression/correlation, whereas those in the 1980s were ANOVA, multivariate techniques, multiple regression/correlation, and t-tests. Based on these results, they concluded that there were increases for the use of more sophisticated and robust statistical techniques from 1970 to 1980.
Eason and Daniel (1989) examined 100 education dissertations completed over a nine-year period at an urban university during the 1980s. They found that 90% of these dissertations used only univariate techniques, whereas 10% reported use of multivariate techniques. Their results indicated that the instances of using specific statistical techniques had changed little during the nine-year period.

Jarrell, Johnson, Chisom, and Hughes (1989) studied the use of statistics in a sample of 75 Ed.D. dissertations. The sample was randomly selected from a population of 209 Ed.D. dissertations completed at a major university from 1984 to 1988. They found that $X^2$ was the most frequently used statistical technique, and observed that more complex multivariate analyses were rarely used. Thus, they concluded that there was a relative lack of sophistication in the use of statistical procedures in educational research.

In linguistics, Teleni and Baldauf (1989) studied statistical techniques used in three applied linguistics journals from 1980 to 1986. They found that 47% of the published articles in these journals used some sort of statistical technique. In those articles, 63%, 28%, and 9% of the techniques employed could be described as basic, intermediate, and advanced, respectively. Descriptive statistics accounted for 32% of the total range of techniques while analysis of variance techniques accounted for another
16%. There was a ratio of about three different techniques used per quantitative study.

Rudolph, McDermott, and Gold (1985) reviewed articles published in all issues of the *Journal of School Health* (JOSH) from 1979 to 1983 (N=504). They identified the four most frequently used statistical techniques were descriptive statistics, contingency tables, ANOVA, and t-tests among the 210 "research/evaluation-original data" studies. These four most frequently used techniques composed more than two-thirds of all the techniques reported, and the multivariate techniques only accounted for 4.7% of all the techniques used. However, the use of multivariate techniques had increased steadily in each of the years during that period (1979-1983).

Only one study on the use of statistical techniques in vocational education was reported. Kelly, Sproles, Camp, Hauser, and Kopf (1989) reviewed publications (N=31) in Volumes one through three of the *Journal of Vocational and Technical Education* (JVTE). They used a modified code system based on the one proposed by Goodwin and Goodwin (1985b). The researchers found that among the 13 quantitative research studies over 60% used only descriptive techniques.

**Summary**

The research literature reviewed showed that previous studies were conducted on the use of statistics, the problem areas of study, and the use of methodological strategies in
educational research. The use of statistics is an important aspect of empirical research in vocational education.

The studies on the problem areas of research indicated that vocational education research covered a wide range of problem areas, ranging from "career development and guidance" to "evaluation of vocational education programs" (COVERD Report, 1976), or ranging from "teacher competency" to "basic skills" (Schultz, 1988). Various researchers used different classification systems in their studies. Three studies in this area obtained research data by examining research journal articles (Schwandt, 1983; Kapes & Bartley, 1986; Schultz, 1988), whereas data collected in another two studies used different sources (COVERD, 1976; Seidman, 1985). A classification system proposed by Steiner (1978) was used by Schwandt (1983) in his study. Schwandt (1983) found that more studies were conducted on the problem areas of "teacher" and "settings" than those on "student" and "curriculum". In addition, Seidman (1985) found that the trends were short-lived on how the problem area of study changed.

All reported studies of the methodological strategies used concluded that vocational education research heavily relied on survey strategy. In these studies, journal articles, dissertations, and reports of other kinds were selected as samples. A recent trend of decreased use of descriptive studies in vocational education research was observed (Schultz, 1988).
Past studies of the use of statistics in educational research showed that ANOVA, correlations, t-tests, regression, and Chi-square tests were among the most frequently used techniques. Most studies found that significant changes did not occur in statistical techniques used within a period of 10 years. However, two other studies indicated that changes in the statistical techniques used did happen within a 10 to 15 year period.

The concept of statistical sophistication was mentioned by Goodwin and Goodwin (1985a, 1985b) and Teleni and Baldauf (1989). Most statistical techniques were classified at the following three levels: basic, intermediate, and advanced. The classification systems used in these two studies were based on the proposition that different levels of preparation were needed for readers to understand various statistical techniques; and the more preparation needed to understand the statistical technique, the higher the sophistication level it should be. Previous research suggested only a small proportion of the statistical techniques used in educational research were at the advanced level.
CHAPTER III

RESEARCH METHODOLOGY

The purpose of the study was to determine the status of, and changes in, the statistical sophistication of research in vocational education in the 1980s. The study also sought to explore relationships among the statistical sophistication level, the problem area studied, and the methodological strategy used in vocational education research. There were six specific objectives of the study. These objectives were to:

1. describe the statistical techniques used and determine the statistical sophistication of vocational education research reported in the 1980s;

2. describe the problem areas studied in vocational education research reported in the 1980s;

3. determine if a relationship existed between the statistical sophistication of research and the problem areas studied in vocational education reported in the 1980s;

4. describe methodological strategies used in vocational education research reported in the 1980s;

5. determine if a relationship existed between the statistical sophistication levels and methodological strategies used in vocational education research reported in the 1980s;
6. determine changes over time in the statistical techniques employed, the statistical sophistication levels, the types of problems studied, and the types of methodological strategies used in vocational education research reported in the 1980s.

To accomplish the above objectives, a sampling plan was developed, and the data collection instrument was developed. The research procedures are described in the following sections.

**Population and Sample**

The target population of this study was defined as the quantitative research articles published in the *Journal of Vocational Education Research* (JVER), the *Journal of Agricultural Education* (JAE, formerly the *Journal of American Association of Teacher Educators in Agriculture*, or JAATEA), the *Journal of Industrial Teacher Education* (JITE), and the *Journal of Vocational Home Economics Education* (JVHEE) in the 1980s. The JVER is the official publication of the American Vocational Education Research Association. The JAE, JITE and JVHEE are the primary research journals in agricultural education, trade and industrial education, and vocational home economics education, respectively. These four journals were chosen because they are all established journals with track records so that a sufficient quantity of articles could be sampled.
The sampling plan of the study included the following steps:

1. Articles in the population were stratified by three time periods: (a) 1980-83; (b) 1984-85; and (c) 1986-89;
2. Articles in the population also were stratified by the four journals;
3. Stratified random samples were drawn from two of the three periods, 1980-83 (period I), and 1986-89 (period III) from all the four journals. The sample size was proportional to the number of articles published for each journal during the two periods.

The decision on stratifying articles by the three specified time periods was based on the consideration that articles from all the four journals were included in each time period. Due to the fact that the JVHEE did not start to publish until 1983, the period 1980-83 was chosen. As a result, the JVHEE articles published in 1983 was selected into the sample of period I.

The decision to use 1980-83 (period I) and 1986-89 (period III) was based on Kerlinger's (1973) max-min-con principal. Considerations were given to 'maximize systematic variance' on the time variable, because one purpose of this study was to determine the change over time on the statistical sophistication of research. The most appropriate way to accomplish this was to maximize the distance between time periods used.
A total of 467 quantitative research articles were published in the four specified journals during the two time periods (1980-1983 and 1986-1989). This included 109 articles in the JVER, 197 in the JAE (or JAATEA), 103 in the JITE, and 58 in the JVHEE.

Cochran's sample size determination formula was used to calculate the needed sample size for this study (Cochran, 1977). With an 8% margin of error and a .05 alpha level, a needed sample size of 114 quantitative research articles was calculated. According to the sampling plan, the decision was made to select a total of 118 quantitative research articles for this study, including 28 articles selected from JVER, 50 from JAE, 26 from JITE, and 14 from JVHEE. In order to make fair comparisons of the research characteristics between the two periods, half of the articles from each journal were selected from each of the two time periods. Therefore, there were 59 articles selected from each time period, including 14 from the JVER, 25 from the JAE, 13 from the JITE, and 7 from the JVHEE.

Pilot Study

A pilot study was conducted before the formal data collection stage. The purpose of a pilot study was to "assess the appropriateness and practicality of the data collection instruments" (Ary, Jacobs, & Razavieh, 1985). A sample of 24 articles was randomly selected for analysis at this stage (from other than those being selected as part of the sample
for the study). This sample included three articles from each journal for each period. Data from each selected article was coded. Based on the experience gained from this stage, the list of statistical techniques in the instrument was revised. The classification system proposed by Steiner (1978) was chosen for the component "problem areas studied" of the instrument. The classification system employed by Schwandt (1983) was chosen to be used in the component "methodological strategy used" of the instrument.

Instrument Development

Components of the Instrument

The instrument used in data collection was developed by the researcher. It consisted of four components: (a) background information of the article; (b) statistical techniques and sophistication; (c) problem areas studied; and (d) methodological strategies used (Appendix A).

The component of "background information" contained the following variables: (a) the source of the article (journal, volume, number, year, and time period); and (b) the title and authors of the article. The above information was needed to calculate the reliability of the instrument.

The component of "statistical techniques and sophistication" contained information on the following variables: (a) whether or not a descriptive statistic was used; (b) each inferential statistic used; (c) the number of inferential statistics; and (d) the level of statistical
sophistication of the article. The instrument used by Goodwin and Goodwin (1985a) was utilized as the basis for identifying statistical techniques. Two commonly cited statistics textbooks and two major educational research textbooks in vocational education research identified by Moore (1989) also were utilized for the same purpose. A panel of experts was used to validate the statistical sophistication level of each technique in the list.

The component designed to identify "problem areas studied" was developed by using Steiner's (1978) classification system. Each article in the sample was classified into one of the following categories according to the purpose of the study: (a) teacher; (b) student; (c) curriculum; and (d) setting. The definitions and indicators suggested by Steiner (1978) served as the sole basis for decisions in the classification.

The component of "methodological strategies used" was developed following a system used by Schwandt (1983). Each article in the sample was classified into one of the following four strategies: (a) laboratory experiment; (b) field experiment; (c) field study and ex post facto research; and (d) population and sample surveys. Definitions and guidelines written by Schwandt (1983) and Runkel and McGrath (1972) were used as the sole basis of categorization.
Validation of Statistical Sophistication Levels

After an extensive list of statistical techniques was developed, a system of defining sophistication level of each technique was needed. The primary source of validating the statistical sophistication level of each technique was a panel of experts. Panel members were selected based on their expertise in statistics and/or vocational education research. Three specific criteria were used in the selection of panel members from vocational education areas: (a) the individual's direct involvement in publishing data based research articles; (b) the individual's experience as a research journal editor; and (c) recommendations from the vocational education faculty at LSU. A total of 18 panel members was selected from 12 different institutions across the United States. The panel members consisted of three statisticians and 15 vocational education researchers. The 15 vocational education researchers were selected from the following areas: general vocational education (n=8); agricultural education (n=3); industrial education (n=1); home economic education (n=2); and business education (n=1).

Each panel member received a mailed questionnaire and a cover letter (Appendix B). The cover letter explained the purpose of this study and the need for his/her contribution. The questionnaire included the list of statistical techniques and instructions concerning the criteria used to rank the sophistication level of each technique. Each statistical
technique listed could be ranked as one of the three levels of sophistication: (a) basic (Level 1); (b) intermediate (Level 2); and (c) advanced (Level 3). If an expert was not familiar with the technique listed, that technique could be labeled as "unfamiliar" and was rated as level 4. In addition, each expert was asked to list statistical techniques and the corresponding levels of sophistication on the questionnaire, if they identified techniques not on the instrument. Additional statistical techniques listed by the panel of experts are listed in Appendix C.

In order to establish consistency among the panel members, the three levels of sophistication were operationally defined by the researcher as the following: (a) Statistical techniques at the "basic" level should be those which can be understood by average readers who have completed one typical graduate level course in statistics; (b) statistical techniques listed in the "intermediate" level should be those which should be understood by average readers who have completed two typical graduate level courses in statistics; and (c) statistical techniques at the "advanced" level should be those which can be understood by average readers who have passed two typical graduate courses in statistics and at least one advanced course in statistics.

Seventeen of the 18 panel members responded. Upon receiving the responses from the panel members, the median sophistication level for each statistical technique was
calculated based on ratings of panel members. That calculated median score then was used as the sophistication level of each technique. The reason for using median instead of mean was that the statistical sophistication level of research as measured by this instrument was defined as an ordered measure and the most appropriate measure of central tendency for ordinal data is the median. For the convenience of data coding, this list of statistical techniques was reorganized based on levels of statistical sophistication as assessed by the panel.

When this validation procedure was completed, the four components of the instrument were combined. Thus, the instrument was developed and used for this study.

**Reliability of the instrument**

An important characteristic of a measuring instrument is reliability or consistency. To assure the reliability of the instrument used in this study, the test-retest procedure was utilized. A stratified subsample of 24 articles used in the study were randomly selected. Three articles were selected from each of the four journals for each of the two time periods. Measurements on each selected article was collected for a second time in the same format as used initially. This second data collection was conducted 15 to 17 days after the initial data collection. The purpose of such a time lag was to allow the researcher's judgment to be independent of the
previous analysis. The following formula was applied to calculate the test-retest reliability estimate:

\[
\frac{\text{(Number of Coding Agreements)} - \text{(Number of Coding Disagreements)}}{\text{(Number of Total Coding)}}
\]

It was found that the overall reliability coefficient of the instrument was .90; the reliability coefficients were .92, .83, and .92 for the components of "statistical techniques and sophistication", "problem areas studied", and "inquiry strategies used", respectively.

**Data Collection**

The researcher-developed instrument was used in recording data collected from each article in the sample. Articles in the sample were analyzed and coded upon their availability to the researcher. Data collection was completed over a period of one month.

During the data collection stage, the researcher read each of the articles in its entirety. Special attention was given to the sections of "data collection", "data analysis", and "results" of each article when recording statistical techniques used. If the same technique was cited or used more than once in a single article, it was coded only once for that article. Operationally, the highest level among all techniques reported in an article was defined as the statistical sophistication level of that article.

Special attention was given to the "purpose", "objectives", and "discussions" of each article in identifying its problem areas. When more than one problem area was
studied in one article, the problem area of that study was
determined by the primary dependent variable investigated.

To determine the methodological strategy used, special
attention was given to "methodology", "procedures", and "data
collection" in each article. If more than one strategy was
used by a study, the dominant strategy used to gain knowledge
about the major problem area was determined as the
methodological strategy used by that study.

Two types of data were coded for each article, the
primary data and the secondary data. The primary data were
defined to be those which could be coded directly from reading
an article, such as the background information, statistical
techniques used, problem areas studied, and methodological
strategies used. Coding of the secondary data required the
knowledge of the primary data. The secondary data coded in
this study included the number of correlational/inferential
statistics used per article and the statistical sophistication
level of the article examined.

Data Analysis

Descriptive statistics, Spearman rho correlation, t-
tests, and chi-square tests were used in data analysis.
Frequencies, percentages, and ranks were used to report the
statistical techniques used, problem areas studied, and
methodological strategies used among the samples. Means and
standard deviations were used to report the numbers of
inferential statistics used per article and the statistical sophistication levels among the samples.

Spearman rho correlation was used to explore the relationship of the type of statistical techniques used between the early 1980s and the late 1980s. A t-test was used to determine whether the average number of statistical techniques used per article was significantly different between the two time periods.

Chi-square tests were used to examine any relationships between the statistical sophistication levels, problem areas, methodological strategies, and time periods. An alpha value of .05 was used in inferential statistics to analyze data of this study.

In summary, a random sample of 118 quantitative research articles published in the early and late 1980s was drawn for analysis from four vocational education research journals. Stratified proportional sampling was used to draw samples from these four journals at the two time periods. A pilot study was conducted to assess the practicality of the researcher-developed data collection instrument. The overall test-retest reliability of this instrument was .90. The four components of the instrument were: (a) background information; (b) statistical techniques and sophistication; (c) problem area studied; and (d) methodological strategy used. The test-retest reliability coefficients of .92, .83, and .92 were found in the above four components, respectively. A panel of
experts was used to validate the statistical sophistication component of the instrument. Steiner's (1978) classification system was used in the component of problem areas studied in vocational education research. A classification system employed by Schwandt (1983) was utilized in the component of methodological strategies used.
CHAPTER IV

FINDINGS OF THE STUDY

The purpose of the study was to determine the status of, and changes in, the statistical sophistication of research in vocational education in the 1980s. The study also sought to explore relationships among the statistical sophistication level, the problem area studied, and the methodological strategy used in vocational education research. There were six specific objectives of the study. The results are presented in the following sections based on objectives of the study:

The Use of Statistical Techniques and Level of Sophistication

The first objective of this study was to describe the statistical techniques used and determine the statistical sophistication of vocational education research reported in the 1980s.

A total of 30 different statistical techniques was used in the articles examined, ranging from simple descriptive statistics to multivariate techniques. The frequencies and ranks of the reported techniques are listed in Table 1.

For the purpose of summarizing the reported techniques, statistics were divided into two large groups, descriptive and correlational/inferential. The techniques listed as "descriptive" included frequencies, percentages, central
tendency, and variability. About 91% of the examined articles (n=111) reported at least one type of descriptive statistic, whereas 88.1% of these articles used at least one correlative/inferential statistical techniques.

The mean number of correlative/inferential statistical techniques used per article was 1.66 (SD=1.22). This number ranged from 0 to 5 with a median of 2. The most frequently used correlative/inferential statistical techniques were identified as t-tests (n=33), Pearson correlation (n=32), one-way ANOVA (n=30), chi-square (n=18), multiple linear regression (n=12), factor analysis (n=12), and post-hoc multiple comparisons (n=11).

To further summarize in a more interpretable form and to avoid excessive inflation of experimentwise error in subsequent data analysis, the reported techniques were grouped into eight clusters and are listed in Table 2. The techniques listed under the cluster "ANOVA's" included one-way ANOVA, factorial ANOVA, one-way ANCOVA. Pearson r, Spearman rho, Kendall's tau, Kendall coefficient of concordance, part/partial correlation, and other correlations were grouped together under "Correlations". "Multivariate" techniques included factor analysis, MANOVA/MANCOVA's, discriminant analysis, path analysis, canonical correlation, cluster analysis, and LISREL. The techniques listed under the cluster "Other Nonparametric" included Kolmogorov-Smirnov tests,
Table 1

Frequencies and Ranks of the Statistical Techniques Used

<table>
<thead>
<tr>
<th>Statistical Techniques</th>
<th>Frequency</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Level 1: Basic</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Descriptive(^a)</td>
<td>111</td>
<td>1</td>
</tr>
<tr>
<td>t-tests</td>
<td>33</td>
<td>2</td>
</tr>
<tr>
<td>Pearson Correlation</td>
<td>32</td>
<td>3</td>
</tr>
<tr>
<td>One-Way ANOVA</td>
<td>30</td>
<td>4</td>
</tr>
<tr>
<td>Chi-Square</td>
<td>18</td>
<td>5</td>
</tr>
<tr>
<td>Spearman rho Correlation</td>
<td>4</td>
<td>12.5</td>
</tr>
<tr>
<td>Kendall's Tau Correlation</td>
<td>2</td>
<td>17</td>
</tr>
<tr>
<td>Simple Linear Regression</td>
<td>1</td>
<td>25</td>
</tr>
<tr>
<td><strong>Level 2: Intermediate</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Multiple Linear Regression</td>
<td>12</td>
<td>6.5</td>
</tr>
<tr>
<td>Post-hoc Multiple Comparisons</td>
<td>11</td>
<td>8</td>
</tr>
<tr>
<td>One-Way ANCOVA</td>
<td>7</td>
<td>9</td>
</tr>
<tr>
<td>Factorial ANOVA</td>
<td>6</td>
<td>10.5</td>
</tr>
<tr>
<td>Part/Partial Correlations</td>
<td>4</td>
<td>12.5</td>
</tr>
<tr>
<td>Kendall Concordance Coefficient</td>
<td>2</td>
<td>17</td>
</tr>
<tr>
<td>Kruskal-Wallis One-Way ANOVA</td>
<td>2</td>
<td>17</td>
</tr>
<tr>
<td>Omega-Square</td>
<td>2</td>
<td>17</td>
</tr>
<tr>
<td>Other Correlations(^b)</td>
<td>1</td>
<td>25</td>
</tr>
<tr>
<td>Planned Orthogonal Comparisons</td>
<td>1</td>
<td>25</td>
</tr>
<tr>
<td>Fisher's Exact Test</td>
<td>1</td>
<td>25</td>
</tr>
<tr>
<td>Wilcoxon Rank Sum Test</td>
<td>1</td>
<td>25</td>
</tr>
<tr>
<td>Kolmogorov-Smirnov Tests</td>
<td>1</td>
<td>25</td>
</tr>
<tr>
<td><strong>Level 3: Advanced</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Factor Analysis</td>
<td>12</td>
<td>6.5</td>
</tr>
<tr>
<td>One-Way MANOVA/MANCOVA</td>
<td>6</td>
<td>10.5</td>
</tr>
<tr>
<td>Path Analysis</td>
<td>3</td>
<td>14</td>
</tr>
</tbody>
</table>

(table continues)
Table 1 (continued)

<table>
<thead>
<tr>
<th>Statistical Techniques</th>
<th>Frequency</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Level 3 Advanced</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Factorial MANOVA/MANCOVA</td>
<td>2</td>
<td>17</td>
</tr>
<tr>
<td>Discriminant Analysis</td>
<td>1</td>
<td>25</td>
</tr>
<tr>
<td>Canonical Analysis</td>
<td>1</td>
<td>25</td>
</tr>
<tr>
<td>Cluster Analysis</td>
<td>1</td>
<td>25</td>
</tr>
<tr>
<td>Log-Linear Analysis</td>
<td>1</td>
<td>25</td>
</tr>
<tr>
<td>LISREL</td>
<td>1</td>
<td>25</td>
</tr>
</tbody>
</table>

*Descriptive statistics included measure of central tendency, measures of variability, frequency, and percentage;

Other Correlations included phi, rank biserial, point biserial, tetrachoric, biserial.

Kruskal-Wallis one-way ANOVA, Wilcoxon rank sum test, Fisher's exact test, log-linear analysis, and omega-squared. Simple linear regression, and multiple linear regression were grouped under the cluster "Regressions". However, planned orthogonal comparisons and post-hoc multiple comparisons were not included in any above categories because their use required the presence of ANOVAs.

The most frequently used techniques by clusters were found in "Descriptive", "Correlations", and "ANOVAs", whereas the least frequently used techniques by clusters were found in "Regressions" and "Other Nonparametric".

Three levels of statistical sophistication were operationally defined and used to classify the research examined. The level of statistical sophistication of an
Table 2

Statistical Techniques Used by Clusters

<table>
<thead>
<tr>
<th>Clusters</th>
<th>Frequency</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Descriptive</td>
<td>111</td>
<td>1</td>
</tr>
<tr>
<td>Correlations</td>
<td>45</td>
<td>2</td>
</tr>
<tr>
<td>ANOVAs</td>
<td>43</td>
<td>3</td>
</tr>
<tr>
<td>t-tests</td>
<td>33</td>
<td>4</td>
</tr>
<tr>
<td>Multivariate</td>
<td>27</td>
<td>5</td>
</tr>
<tr>
<td>Chi-square</td>
<td>18</td>
<td>6</td>
</tr>
<tr>
<td>Regressions</td>
<td>13</td>
<td>7</td>
</tr>
<tr>
<td>Other Nonparametric</td>
<td>8</td>
<td>8</td>
</tr>
</tbody>
</table>

The problem areas studied

The second objective of the study was to describe the problem areas studied in vocational education research reported in the 1980s.

Each article examined was classified into one (and only one) of the four following problem areas based on the stated purpose of that study: (a) teacher; (b) student; (c) curriculum; and (d) setting (Steiner, 1978). When more than one problem area was studied in one article, the problem area of that study was determined by the primary dependent variable.
investigated. The results of this study showed that the largest group of articles was focused primarily on the problem area of "curriculum", which accounted for 38.1% ($n=45$) of the total articles examined. "Student" was the least studied problem area, which only accounted for 13.6% ($n=16$) of all the reports. Another 25.4% ($n=30$) of the studies in the sample were primarily focused on the problem area of "teacher", and 22.9% ($n=27$) were on "setting".

**The Relationship between the Statistical Sophistication Level and the Problem Areas Studied**

The third objective of the study was to determine if a relationship existed between the statistical sophistication of research and the problem areas studied in vocational education reported in the 1980s.

A chi-square test of independence was used to test the null hypothesis ($H_0$): The statistical sophistication level of research in vocational education is independent of the problem area studied. The test result is presented in Table 3.

An obtained $X^2$ ($6, n=118$) = 20.59, $p = .02$, was significant, indicating that statistical sophistication level of research and problem area studied were not independent. The nature of the association was that research on "student" tended to have a higher proportion classified as advanced statistical sophistication; research on "curriculum" tended to have a higher proportion classified as intermediate statistical sophistication; and research on "setting" tended
to have a higher proportion classified as basic statistical sophistication.

Table 3

Cross Classification of Statistical Sophistication Levels by Problem Area Studied

<table>
<thead>
<tr>
<th>Problem</th>
<th>Statistical Sophistication Level (n/%)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Basic</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Teacher</td>
<td>18/60.0</td>
<td>4/13.3</td>
</tr>
<tr>
<td>Student</td>
<td>5/31.3</td>
<td>4/25.0</td>
</tr>
<tr>
<td>Curriculum</td>
<td>23/51.1</td>
<td>16/35.6</td>
</tr>
<tr>
<td>Setting</td>
<td>21/77.8</td>
<td>6/22.2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>67</td>
<td>30</td>
</tr>
</tbody>
</table>

Note. $X^2 (6, n=118) = 20.59. p = 0.02$

a Row percentage.

The Methodological Strategies Used

The fourth objective of the study was to describe the methodological strategies used in vocational education research reported in the 1980s.

Each article in the sample was examined on its methodological strategies used, or "generic classes of research settings for gaining knowledge about a research problem" (McGrath, 1981, p. 182). Each of these articles was classified as one (and only one) of the following four strategies: (a) laboratory experiment; (b) field experiment;
(c) field study and ex post facto research; and (d) survey. If more than one strategy was used by one study, the dominant strategy used to gain knowledge about the major problem area was determined as the methodological strategy used by that study.

The results indicated that the largest group of articles used the "survey" strategy, which accounted for 56.8% \((n=67)\) of all the articles examined. Very few articles, only 1.2% \((n=2)\), used the "laboratory experiment" strategy. About 12.7% \((n=15)\) of the articles examined were classified as "field experiment", and 28.8% \((n=34)\) were classified as "field study and ex post facto research".

The Relationship between Statistical Sophistication Level of Research and Methodological Strategies Used

The fifth objective of the study was to determine if a relationship existed between the statistical sophistication levels and methodological strategies used in vocational education research reported in the 1980s;

A chi-square test of independence was used to test the null hypothesis \((H_0)\): The statistical sophistication level of research in vocational education is independent of the research strategy used. Since there were only two cases in the sample using "laboratory experiment" strategies, a category "experiment" was used in performing the chi-square test which combined both strategies of "laboratory experiment"
and "field experiment". The result of the chi-square test is listed in Table 4.

The obtained $X^2 (4, \ n=118) = 14.11, \ p = .007,$ was significant, indicating that the statistical sophistication level and methodological strategy used were not independent. The nature of the association was that research using the "survey" or "experiment" strategies tended to have higher proportions classified as basic statistical sophistication; research that used "field study and ex post facto research" tended to have equal proportions classified at the three levels of statistical sophistication.

Table 4
Cross Classification of Statistical Sophistication Levels by Methodological Strategies Used

<table>
<thead>
<tr>
<th>Strategies</th>
<th>Statistical Sophistication Level (n/%$^a$)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Basic</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Experiment</td>
<td>9/52.9</td>
<td>6/35.3</td>
</tr>
<tr>
<td>Field Study$^b$</td>
<td>12/35.3</td>
<td>10/29.4</td>
</tr>
<tr>
<td>Survey</td>
<td>46/68.7</td>
<td>14/20.9</td>
</tr>
<tr>
<td>Total</td>
<td>67</td>
<td>30</td>
</tr>
</tbody>
</table>

Note. $X^2 (4, \ n=118) = 14.11. \ p = .007$

$^a$Row percentage

$^b$Field study and ex post facto research
The Change over Time of the Statistical Sophistication Level, Problem Areas Studied, and Methodological Strategies Used

The sixth objective of the study was to determine changes over time in the statistical techniques employed, the statistical sophistication levels, the types of problems studied, and the types of methodological strategies used in vocational education research reported in the 1980s.

The changes in statistical techniques used between the early 1980s (1980-83) and the late 1980s (1986-89) were examined in three aspects: (a) the technique used; (b) the level of sophistication; and (c) the mean number of correlational/inferential techniques used per study.

Statistical techniques were grouped into the eight clusters as previously described, then broken down by time periods (see Table 5). There was a slight increase in the use of descriptive, t-tests, and regression techniques and a slight decrease in the use of ANOVAs, correlations, multivariate, chi-square and other nonparametric techniques from the first time period (1980-83) to the second time period (1986-89). A Spearman rank-order correlation coefficient (rho) was calculated between the ranks of technique clusters in the early 1980s and the late 1980s according to the data listed in Table 5. A correlation coefficient of .96 was found, which indicated that a very strong relationship existed between the ranks of the frequencies in the techniques used
between the two time periods. This result indicated a very high degree of consistency in the relative frequencies of techniques used in the two time periods.

Table 5
Comparisons of the Use of Statistical Techniques by Clusters Between the Early 1980s (1980-83) and the Late 1980s (1986-89)

<table>
<thead>
<tr>
<th>Clusters</th>
<th>Early 80s (1980-83)</th>
<th>Late 80s (1986-89)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Frequency</td>
<td>Rank</td>
</tr>
<tr>
<td>Descriptive</td>
<td>55</td>
<td>1</td>
</tr>
<tr>
<td>Correlations</td>
<td>23</td>
<td>2</td>
</tr>
<tr>
<td>ANOVAs</td>
<td>22</td>
<td>3</td>
</tr>
<tr>
<td>t-tests</td>
<td>16</td>
<td>4</td>
</tr>
<tr>
<td>Multivariate</td>
<td>15</td>
<td>5</td>
</tr>
<tr>
<td>Chi-square</td>
<td>11</td>
<td>6</td>
</tr>
<tr>
<td>Regression</td>
<td>5</td>
<td>7.5</td>
</tr>
<tr>
<td>Nonparametric</td>
<td>5</td>
<td>7.5</td>
</tr>
</tbody>
</table>

In order to determine the change in statistical sophistication level of research, a chi-square test of homogeneity was used to test the null hypothesis (H₀): The statistical sophistication levels of research in vocational education are not different between the two time periods. The results of the test are listed in Table 6. The obtained $X^2 (2, n=118) = 0.063, p = .97$, was not significant, which indicated that no significant change occurred in the
statistical sophistication level of research in vocational education between the two time periods.

Table 6

Cross Classification of Statistical Sophistication Levels by the Two Time Periods

<table>
<thead>
<tr>
<th>Period</th>
<th>Basic</th>
<th>Intermediate</th>
<th>Advanced</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1980-83</td>
<td>33/55.9</td>
<td>15/25.4</td>
<td>11/18.6</td>
<td>59/100</td>
</tr>
<tr>
<td>1986-89</td>
<td>34/57.6</td>
<td>15/25.4</td>
<td>10/16.9</td>
<td>59/100</td>
</tr>
<tr>
<td>Total</td>
<td>67</td>
<td>30</td>
<td>21</td>
<td>118/100</td>
</tr>
</tbody>
</table>

Note. \( X^2 (2, n=118) = .063. \) \( p = .97 \)

*The row percentage.

In addition, a comparison was made between the mean numbers of correlational/inferential statistical techniques used per article in the two time periods. An independent t-test was used to test the significance of the difference. The result is listed in Table 7. The calculated statistic, \( t(116) = .90, \) \( p = .37, \) was not significant, which indicated that there was not a significant difference in the mean number of "correlational/inferential" techniques used per report between the early 1980s (1980-83) and the late 1980s (1986-89).

Changes in the problem areas studied and the methodological strategies used between the two time periods also were examined. A chi-square test of homogeneity was used
to test the null hypothesis ($H_0$): The problem areas studied in vocational education research does not differ between the two

time periods. The obtained $X^2 (3, n=118) = 2.02$, $p = .57$, was not significant, which indicated that no significant difference was found in problem areas studied between the early 1980s (1980-83) and the late 1980s (1986-89) (see Table 8).

The frequencies of methodological strategies used in the two time periods are listed in Table 9. A chi-square test of homogeneity was used to test the null hypothesis ($H_0$): The methodological strategy used in vocational education research does not differ between the two time periods. The obtained $X^2 (2, n=118) = .662$, $p = .72$, was not significant, which indicated that methodological strategies used in vocational education research did not differ between the early 1980s (1980-83) and the late 1980s (1986-89).
Table 8
Cross Classification of Problem Areas Studied by the Two Time Periods

<table>
<thead>
<tr>
<th>Period</th>
<th>Problem Areas (n/%)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Teacher</td>
<td>Student</td>
</tr>
<tr>
<td>1980-83</td>
<td>14/11.9</td>
<td>10/8.5</td>
</tr>
<tr>
<td>1986-89</td>
<td>16/13.6</td>
<td>6/5.1</td>
</tr>
<tr>
<td>Total</td>
<td>30</td>
<td>16</td>
</tr>
</tbody>
</table>

Note. $X^2(3, n=118) = 2.02$. $p = .568$

*Row percentage.

Table 9
Cross Classification of Methodological Strategies Used by the Two Time Periods

<table>
<thead>
<tr>
<th>Period</th>
<th>Methodological Strategies (n/%)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Experiment</td>
<td>Field Study</td>
</tr>
<tr>
<td>1980-83</td>
<td>7/5.4</td>
<td>17/14.4</td>
</tr>
<tr>
<td>1986-89</td>
<td>10/8.5</td>
<td>17/14.4</td>
</tr>
<tr>
<td>Total</td>
<td>17</td>
<td>34</td>
</tr>
</tbody>
</table>

Note. $X^2(2, n=118) = .66$. $p = .718$

*Row percentage
CHAPTER V

SUMMARY, CONCLUSIONS, DISCUSSIONS, AND RECOMMENDATIONS

Summary

The purpose of the study was to determine the status of, and changes in, the statistical sophistication of research in vocational education in the 1980s. The study also sought to explore relationships among the statistical sophistication level, the problem area studied, and the methodological strategy used in vocational education research. Objectives of the study were to:

1. describe the statistical techniques used and determine the statistical sophistication of vocational education research reported in the 1980s;

2. describe the problem areas studied in vocational education research reported in the 1980s;

3. determine if a relationship existed between the statistical sophistication of research and the problem areas studied in vocational education reported in the 1980s;

4. describe the methodological strategies used in vocational education research reported in the 1980s;

5. determine if a relationship existed between the statistical sophistication levels and methodological strategies used in vocational education research reported in the 1980s;
6. determine changes over time in the statistical techniques employed, the statistical sophistication levels, the types of problems studied, and the types of methodological strategies used in vocational education research reported in the 1980s.

To accomplish the objectives of this study, a random sample of 118 quantitative research articles published in the 1980s was drawn for analysis from the following four vocational education research journals: the Journal of Vocational Education Research, the Journal of Agricultural Education, the Journal of Industrial Teacher Education, and the Journal of Vocational Home Economics Education. Stratified proportional sampling was used to draw samples from the four journals independently. Half of the samples were from the early 1980s (1980-1983) and another half from the late 1980s (1986-89). A pilot study was used to assess the practicality of the data collection instrument.

The researcher-developed instrument used in data collection of the study consisted of four components: (a) background information; (b) statistical techniques and sophistication; (c) problem area studied; and (d) methodological strategy used. The overall test-retest reliability of this instrument was .90. A panel of experts was used to validate the statistical sophistication component of the instrument. A test-retest reliability of .92 was found for this component of the instrument. Steiner's (1978)
A classification system was used in the component of problem area studied in vocational education research. A test-retest reliability of .83 was found for this component. A classification system employed by Schwandt (1983) was utilized in the component of methodological strategy used. A test-retest reliability of .92 was found for this component.

The results of this study indicated that 30 different statistical techniques were used in the articles examined. The most frequently used statistical techniques were: descriptive, t-tests, Pearson correlation, one-way ANOVA, chi-square, multiple linear regression, and factor analysis. Descriptive techniques were used in 94.1% of the research reported. Approximately two correlational/inferential statistical techniques were used per article. The majority of research reports were classified as either basic (56.7%) or intermediate (25.4%) in their levels of statistical sophistication.

The statistical sophistication of research was related to the problem areas studied. The problem area most frequently studied in the research examined was "curriculum" (38.1%), followed by "teacher" (25.4%) and "setting" (22.9%), whereas "student" was the least studied problem area (13.6%). Research on the problem area of "student" tended to have a higher proportion classified as advanced statistical sophistication.
The statistical sophistication of research was related also to the methodological strategies used. "Survey" was found to be the most frequently identified strategy used in the research examined (56.8%). Very few research reports examined used the "laboratory experiment" strategy (1.7%). Studies which used "field study and ex post facto study" tended to have a larger proportion classified as advanced sophistication than those which used "experiment" or "survey" strategies.

In addition, no significant changes occurred from the early 1980s (1980-83) to the late 1980s (1986-89) in the statistical sophistication of research, the mean number of correlational/inferential statistical techniques used per article, the problem areas studied, and the methodological strategies used in the research reports examined. A very strong correlation (Spearman rho = .96) was found between the ranking of the frequency of use of the statistical techniques in the two time periods.

Conclusions, Discussions, and Recommendations

Based on the findings of this study, the following conclusions were developed:

1. The statistical sophistication level of the majority of research in vocational education reported in the 1980s was less than advanced.

This conclusion is based on the findings that the statistical sophistication level of 56.8% of the articles
examined was classified at the "basic" level, 25.4% of the articles were classified as being at the "intermediate" level, and 17.8% were at the "advanced" sophistication level.

This study focused on the statistical sophistication level of research in vocational education in the 1980s. The determination of such sophistication levels was through examining the statistical techniques used. All the related previous studies focused on examining the usage percentages of statistical techniques at certain sophistication levels (West, Carmody, & Stallings, 1983; Goodwin & Goodwin, 1985a, 1985b; Eason & Daniel, 1989; Teleni & Baldauf, 1989; Emmons, Stallings, & Layne, 1990). Due to such a conceptual difference between this study and the previous ones on the level of statistical sophistication, it is difficult to compare the findings of this study with those previously reported.

Results from all the previous studies tended to agree that the most sophisticated statistical techniques available were not the most frequently used ones in educational research. Goodwin and Goodwin (1985a) found that 33%, 37% and 17% of the statistical techniques used were at "basic", "intermediate", and "advanced" levels, respectively, in the American Educational Research Journal from 1979 to 1983. Another study by Goodwin and Goodwin (1985b) indicated that 35.3%, 43.1%, and 11.7% of the statistical techniques used were at "basic", "intermediate", and "advanced" levels,
respectively, in the research articles published in the *Journal of Educational Psychology* during 1979-1983. Teleni and Baldauf's (1989) study showed that 63%, 28%, and 9% of the statistical techniques used in articles published in three linguistics journals during the period 1980 to 1986 were "basic", "intermediate", and "advanced", respectively. Eason and Daniel (1989) found that only 10% of a sample of dissertations used multivariate techniques. Rudolph, McDermott, and Gold (1985) also reported that multivariate techniques only accounted for 4.7% of all the techniques used.

The researcher recommends to university curriculum planners to review their current graduate program requirements in vocational education and to ensure the inclusion of those statistical techniques listed as basic and intermediate levels. Such preparation in statistics should enable graduates from the programs to understand the statistical aspect of most research literature in vocational education. On the other hand, those preparing to be active researchers in the future should consider additional preparation in more of the statistical techniques listed at the advanced level in this study. This would allow them to be more competent and to understand the statistics of over one-sixth of the most sophisticated literature in current vocational education research.

This study brought up the concept of statistical sophistication of research which is only one aspect of the use
of statistics. Another aspect of the use of statistics is the appropriateness, which should be the ultimate concern in the selection of specific techniques. No previous studies were found regarding the relationships between the statistical sophistication of research and the appropriateness of the statistical techniques used. The researcher recommends further research to determine the relationships between the statistical sophistication of research and the appropriateness in the selection of statistical techniques.

No assumption was made in this study that a high level of statistical sophistication equated appropriateness of the use of statistical techniques. Selections of statistical techniques for a study should be based on consideration of several factors. These factors include the research objectives, the types and number of variables investigated and their relationships, the research design, and assumptions for the use of each statistical technique. As a matter of fact, ease of interpretation of results may be included as a practicality factor in making selection of statistical techniques. Assuming there are two equally appropriate statistical techniques available, one technique lower in sophistication level, the technique with lower sophistication level might be preferable to be selected in this case if its results could be more easily interpreted. However, selection of the most appropriate statistical techniques only can be warranted when a researcher is knowledgeable of a variety of
the techniques available. The choice of a specific technique by a researcher involves his/her judgment based on comparisons among the many techniques available. The statistical competency of a researcher may affect the appropriateness in the use of techniques; but it is not clear if a researcher's statistical competency will affect the statistical sophistication level of his/her research.

2. **Curriculum was the most frequently studied problem area.**

This conclusion is based on the findings that the largest group of reports was focused primarily on the problem area of "curriculum", which accounted for 38.1% (n=45) of the total reports examined. "Student" was the least studied problem area, which only accounted for 13.6% (n=16) of all the reports. Another 25.4% (n=30) of the studies in the sample primarily were focused on the problem area of "teachers", and 22.9% (n=27) were on "settings".

This conclusion does not totally agree with the findings by Schwandt (1983), who used the same classification system as in this study. He reported that approximately equal numbers of studies were conducted on "teacher" and "setting" (about 30% each), and a smaller number of studies focused on "student" and "curriculum" (about 20% each) in a sample of 87 JVER and JITE articles in the early 1980s.

The similarity in the results between the current study and Schwandt's (1983) is that both studies indicated that "student" was the least studied problem area in vocational
education. The difference between the results from Schwandt's (1983) study and the current one is that "curriculum" was found to be the most frequently studied area in this study, whereas it was found to be one of the least studied areas in Schwandt's (1983) report. It seems that the component of "student" in vocational education research did not receive as much attention as those of "teacher", or "setting". The differences in the two studies might be explained by the sample differences. Schwandt's (1983) results were based on a sample of 82 articles published in two primary vocational education research journals within a two-year period in the early 1980s. The sample used in the current study consisted of 118 articles selected from four primary vocational education research journals in the early and late 1980s. Other related studies by Evans (1983), and Kapes and Bartley (1986) used very different classification systems and therefore are not comparable with the results of the current study.

To some extent, this conclusion agrees with the suggestions on what should be studied in current vocational education research as reported by Lynch, Schmidt, and Asche (1988). By using the Nominal Group Technique, they identified six broad research categories which future vocational educational research activities should emphasize. The first category of their list was "competencies, content, and instructional methods". The research on curriculum as defined
in this study is related to this category. According to Steiner (1978), research on curriculum includes that of "something to be taught, the selected culture to transmit" (p. 2). However, this conclusion does not coincide with many other suggestions on what should be studied in vocational education research in the 1980s (David, 1983; Smith, 1983; Wallrodt, 1983; Oliver, 1983).

Vocational education research in the 1980s was marked as having the greatest concern with curriculum. The researcher recommends that further research be conducted to identify the problem areas of study of vocational education in past decades. With such knowledge on larger scope, the nature of vocational education research can be better understood.

3. The problem areas studied in vocational education did not change in the 1980s.

This conclusion is based on the finding that no significant difference was found in problem areas studied between the early 1980s (1980-83) and the late 1980s (1986-89).

The conclusion may confirm what Seidman (1985) pointed out regarding changing patterns in vocational education research that "any trends that did emerge were short-lived" (p. 57). Vocational education research in the 1980s was a steady endeavor in solving problems faced by the profession.

The researcher recommends further study of the trends in problems areas focused upon in vocational education research
over a greater time period. Patterns or cycles of change in vocational education research may be identified as a result of these studies. Vocational education research should be consistent in the subjects of study for a scientific approach. On the other hand, vocational education research should promptly respond to the changing world. If vocational educational research should be claimed as truly scientific, its research subjects must not only be consistent in the long term but be sensitive to the changing world as well.

4. Statistical sophistication of research was related to the problem area studied.

This conclusion is based on the research finding that the statistical sophistication levels and problem areas studied were not independent \( (X^2 (6, n=118) = 20.59, p = .02) \).

The current study found that research on "students" tended to have a higher proportion classified as advanced statistical sophistication; research on "curricula" tended to have a higher proportion classified as intermediate statistical sophistication; and research on "settings" tended to have a higher proportion classified as basic statistical sophistication.

No previous studies were found to have examined such a relationship. Only speculations might be given to explain the nature of such a relationship. In practice, research on the "student" is probably the most manipulable among the four problem areas. As a result, more variables might be
investigated in a single study. Research on the "setting" might rely largely on sources other than the school system to obtain necessary information. The limited access to useful information means fewer variables can be investigated in a study of "setting". This difference in the number of variables investigated in a study may explain the relationship between the problem of study and statistical sophistication of research, since one consideration in selecting statistical techniques is the number of research variables. Statistical techniques involving more variables tend to be more sophisticated than those involving fewer variables. The researcher recommends further studies to support or deny such speculations.

5. Survey was a dominant strategy used in current vocational education research.

This conclusion is based on the finding that the largest group of reports examined used the "survey" strategy, which accounted for 56.8% (n=67) of all the articles. Very few reports, only 1.2% (n=2), used the "laboratory experiment" strategy. About 12.7% (n=15) of the reports examined were classified as "field experiment", and 28.8% (n=34) were classified as "field study and ex post facto research".

This conclusion confirmed findings of previous studies (Schwandt, 1983; Mannebach & Mckenna, 1984; Jarrell, Johnson, Chisom, & Hughes, 1989; Kelly, Sproles, Camp, Hauser, & Kopf, 1989) that "survey" has been the dominant strategy in
(vocational) education research. Schwandt (1983) found that 60% of the articles published in the JVER and JITE in the early 1980s were classified as survey; 24% were classified as "field study and ex post facto research"; 16% were classified as "field experiment"; none were "laboratory experiment". Mannebach and Mckenna (1984) studied the annual national Summaries of Research and Development Activities in Agricultural Education during the period 1974 to 1982, and found 90% of the reports were descriptive research. Further analysis of the descriptive studies revealed that 45% of them were survey studies. Kelly, Sproles, Camp, Hauser, and Kopf (1989) found all the research reports published in the first three volumes of the Journal of Vocational and Technical Education were descriptive studies. Jarrell, Johnson, Chisom, and Hughes (1989) studied 75 Ed.D. dissertations from a major university from 1984 to 1988, and found that 45% of them used survey as the primary methodological strategy.

Strong emphasis on a single research strategy--"survey"--can be viewed against McGrath's (1981, p. 184) notion of the "three-horned dilemma". McGrath (1981) believed that no single research strategy can simultaneously maximize generalizability, precision in measurement, and the realism of context. In this case, the survey research strategy may maximize generalizability, yet it also tends to minimize precision in measurement and realism of context. A way out of this dilemma is to have more research using methodological
strategies in addition to surveys across a given problem area in vocational education.

Since so much research effort in vocational education uses the survey strategy, a question of whether or not the survey strategy was used appropriately must be answered. Did the nature of vocational education research call for using the survey strategy? Was the survey strategy used repeatedly in research within a given problem area? Further studies are needed to answer the above questions. These studies can provide more evidence useful in assessing the criticism that vocational education research relied too heavily on survey.

6. The methodological strategies used in vocational education did not change in the 1980s.

This conclusion is based on the findings that the methodological strategies used in vocational education research did not differ from the early 1980s (1980-83) to the late 1980s (1986-89) ($X^2 (4, n=118) = 14.11, p = .007$).

The conclusion confirms the results reported by Eason and Daniel (1989) but does not agree with the observations made by Schultz (1988). Eason and Daniel (1989) examined 100 education dissertations completed over a nine-year period and found that no major changes occurred during the nine-year time span. On the other hand, Schultz (1988) analyzed all the manuscripts submitted to the JVER during 1986-1987, and observed that "heavy reliance on descriptive studies in
vocational education research appears to be decreasing" (p. 13).

Changes in the research strategy may be an evolutionary process. A ten-year evolution may have been too short to lead to significant changes in the research strategies used. A drastic change in research strategy may well take place by efforts of a generation or generations of researchers across several decades. The researcher recommends that further studies be conducted to characterize the process of change in the use of research strategies and to identify the different stages if there were any.

7. Statistical sophistication of research is related to the methodological strategy used.

This conclusion is based on the finding that the statistical sophistication level and methodological strategy used were not independent \( (X^2(4, n=118) = 14.11, p = .007) \).

The low use of advanced statistical techniques in experimental research might be explained by the fact that experimental studies are those with rigorous control by the design itself. Therefore, since the design controls most of the threats to internal validity, statistical controls are typically not needed. In survey research, the purpose of the study is usually descriptive in nature and therefore, no attempts are made to establish causal relationships among variables. Again, in this situation, statistical controls are typically not needed. However, in field studies and ex post
facto research, attempts might often be made to establish causal relations among variables. Threats to internal validity cannot normally be controlled by the research design in this situation. Therefore, statistical controls may be used to control threats to internal validity.

In order to accept or to deny the above speculation, further studies are needed to determine the differences in ways to control threats to internal validity among studies relying on various research strategies.

8. Use of statistical techniques and the statistical sophistication of research used in vocational education did not change from the early 1980s to the late 1980s

This conclusion is based on the following three findings: (a) A very strong correlation (Spearman rho = .96) existed between the ranking of frequency of use of the statistical techniques in the two time periods; (b) there was no change in the average number of statistical techniques used per article from the early 1980s (1980-83) to the late 1980s (1986-89); and (c) no significant changes occurred in the statistical sophistication level of research in vocational education between the two time periods.

This conclusion seems similar to the findings of previous studies (Willson, 1980; Goodwin & Goodwin, 1985a, 1985b; Eason & Daniel, 1989). Willson (1980) surveyed the statistical techniques used in articles published in the American Educational Research Journal (AERJ) from 1969 to 1978, and
concluded that "there appears to be no broadening of the pool of research techniques used in educational research as represented by AERJ" (p. 9). Goodwin and Goodwin (1985a, 1985b) reported two studies on the use of statistical techniques. One of their studies (Goodwin & Goodwin, 1985b) was conducted by using a sample of AERJ research articles between 1979 and 1983, whereas another study (Goodwin & Goodwin, 1985a) was conducted by using a sample of articles published in the Journal of Educational Psychology (JEP) from 1979 through 1983. Both of these studies concluded that no major changes in the use of statistical techniques had occurred during the period from 1979 to 1983. Eason and Daniel (1989) examined 100 education dissertations completed over a nine-year period at an urban university during the 1980s, and found that the instances of use of specific statistical techniques had changed little during the nine-year time.

However, some previous studies suggested that use of statistics did change in a period of 10 to 15 years (West, Carmody, & Stallings, 1983; Emmons, Stallings, & Layne, 1990). West, Carmody, and Stallings (1983) compared the statistical techniques used in the articles published in the Journal of Educational Research (JER) in 1970 and 1980, and observed some increases for use of more sophisticated and robust statistical techniques from 1970 to 1980. Emmons, Stallings, and Layne (1990) studied published research articles in three research
journals in education during the time period from 1972 to 1987. They observed increases in the use of logit, probit, and log linear methods, and thus concluded that there were trends toward adjusting methodology to account for the multiplicative and curvilinear nature of most social research data.

One possible explanation for this conclusion could be that the process of change in the use of statistics was slow. A ten-year time period was too short to allow significant changes to occur in practice, yet a longer period of time saw evidence of change. Another more pessimistic explanation could be that little progress was made in research practice of vocational education in the 1980s. Vocational education researchers may be insensitive to the vast changes in the world and do not take the opportunity to use more sophisticated research tools which were not available before. One another possibility is that the statistics training received by vocational education researchers has not significantly changed in the last 10 to 20 years.

The researcher recommends that studies be conducted to examine the status of, and changes in, the statistical competency level of vocational education researchers in the last three decades. The change in the researcher's statistical competency is a prerequisite for any change to happen in the practice of statistical analysis. Since the beginning of federal support for vocational education research
in the early 1960s, research activity has become an increasing important responsibility of many vocational educators. Changes in training of prospective or practicing vocational education researchers may have been reflected by addressing a stronger competency to conduct educational research including the area of statistics.

One of the major changes in the 1980s was the rapid popularization of computers and their applications. With the assistance of powerful statistical analysis software, performance of sophisticated techniques, especially multivariate techniques, became much easier. One potential side-effect caused by this computer revolution is the abusive use of "fancy" statistical techniques. In the early 1980s, Knapp (1983) noted "an unfortunate tendency on the part of many social scientists to 'overstatisticize' their data analysis" (p. 112). Knapp (1983) characterized this type of misuse as "underdesign and overanalysis". The stability in use of statistical techniques in vocational education research may signify a likelihood that less of such abuse had occurred in the field.

Stability is the most appropriate descriptor of vocational education research in the 1980s. Use of statistical techniques in vocational education research is not an isolated step in the entire process. A pragmatic approach in designing current vocational education graduate programs is to include two graduate level courses in statistics.
Vocational education researchers should be create and not be afraid to incorporate new developments in other areas such as statistics into future practice.
REFERENCES


APPENDICES
INSTRUMENT USED IN THE STUDY

Background Information

Source of the Article:
1. JAE 2. JVER 3. JITE 3.JVHEE

Year and Period:
Year: ___ Period 1 (80-83) Period 2 (86-89)

Title:

Author(s):

Statistical Techniques and Sophistication level

Level 1: Basic
1. Descriptive Statistics (Central Tendency, Variability, Frequencies, Percentages, etc.)
2. Pearson Correlation
3. Spearman Rho Correlation
4. Kendall's Tau Correlation
5. Simple Linear Regression
6. Chi Square
7. Independent & Dependent t-Tests
8. One-Way ANOVA

Level 2: Intermediate
9. Kendall Coefficient of Concordance
10. Part/Partial Correlations
11. Multiple Correlations
12. Other Correlations (Phi, Rank Biserial, Point Biserial, Tetrachoric, Biserial)
13. Multiple Linear Regression
14. Factorial ANOVA
15. Planned Orthogonal Comparisons
16. Post-hoc Multiple Comparisons
17. One-Way ANCOVA
18. Factorial ANCOVA
19. Median Test
20. Wilcoxon-Mann-Whitney U-test
21. McNemar Change Test
22. Kolmogorov-Smirnov One/Two Sample(s) Test
23. Friedman Two-Way ANOVA
24. Kruskal-Wallis One-Way ANOVA
25. Wilcoxon Rank Sum Test
26. Fisher's Exact Test
27. Power Calculation
28. Omega-Squared

Level 2: Advanced

29. Trend Analysis
30. Discriminant Analysis
31. Path Analysis
32. Canonical Correlation
33. Factor Analysis
34. Cluster Analysis
35. One-Way MANOVA/MANCOVA
36. Factorial MANOVA/MANCOVA
37. Log-Linear Analysis
38. Logistic analysis
39. LISREL

Other Statistical Techniques:

40. ______________________
41. ______________________
42. ______________________
43. ______________________

Reported Use of Descriptive Statistics:

1. Yes 2. No

Number of Inferential Statistics Per Paper: ___

Level of Statistical Sophistication:

1. Basic
2. Intermediate
3. Advanced

Problem Areas

1. Teacher
2. Student
3. Curriculum
4. Settings

Methodological Strategies

1. Laboratory Experiment
2. Field Experiment
3. Field Study and Ex Post Facto Research
4. Population and Sample Survey
APPENDIX B
COVER LETTER TO THE PANEL OF EXPERTS

May 17, 1991

|address |

|name |

The use of statistical techniques is an integral part of most vocational education research. It provides a way to report results in an efficient and effective format. With the increased availability of user friendly computer packages in recent years, the use of more sophisticated statistical techniques, such as multivariate analysis, has become more accessible. Few studies, however, have been reported on the use of statistics in vocational education research. Without such knowledge on how are statistical techniques used, it would be difficult to set appropriate statistics proficiency levels needed by practitioners and consumers of vocational education research.

A study currently underway at Louisiana State University is attempting to determine the status of and changes in statistical sophistication of vocational education research. To do this the first step necessary is to classify the various statistical techniques regarding their sophistication levels. You have been identified as having expertise in applied statistics. The rating from your response will be served as a valid classification system for various statistical techniques. Therefore, your expertise in this area will be crucial to the outcomes of this study.

Please respond to the questionnaire enclosed and return to the above address by X date. We appreciate your help.

Thank you very much.

Sincerely,

Chi Zhang Michael Burnett
Graduate Student Professor

Enclosure
Directions:

The following is a list of statistical techniques used in reporting research results. Please indicate for each statistical technique what you perceive to be the level of sophistication for that procedure. Possible responses include "1" = Basic, "2" = Intermediate, "3" = Advanced. If you are not familiar with the technique listed, indicate so by marking "4" on the response scale.

Please use the following definitions in making your decisions: Statistical techniques at the "basic" level should be those which can be understood by average readers who have completed one typical graduate level course in statistics. Statistical techniques listed in the "intermediate" level should be those which should be understood by average readers who have completed two typical graduate level courses in statistics. Statistical techniques at the "advanced" level should be those which can be understood by average readers who have passed two typical graduate courses and at least one advanced course in statistics.

<table>
<thead>
<tr>
<th>Statistical Techniques:</th>
<th>Level of Sophistication</th>
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</thead>
<tbody>
<tr>
<td>1. Central Tendency, Variability</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>2. Frequencies, Percentages</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>3. Pearson Correlation</td>
<td>1 2 3 4</td>
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<tr>
<td>4. Spearman Rho Correlation</td>
<td>1 2 3 4</td>
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<tr>
<td>5. Kendall's Tau Correlation</td>
<td>1 2 3 4</td>
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<tr>
<td>6. Kendall Coefficient of Concordance</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>7. Other Correlations (Phi, Rank Biserial, Point Biserial, Tetrachoric, Biserial)</td>
<td>1 2 3 4</td>
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<tr>
<td>8. Part/Partial Correlations</td>
<td>1 2 3 4</td>
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<td>9. Multiple Correlations</td>
<td>1 2 3 4</td>
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<tr>
<td>10. Simple Linear Regression</td>
<td>1 2 3 4</td>
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<tr>
<td>11. Ordinary Multiple Linear Regression</td>
<td>1 2 3 4</td>
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<tr>
<td>12. Weighted Multiple Linear Regression</td>
<td>1 2 3 4</td>
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<tr>
<td>13. Chi Square</td>
<td>1 2 3 4</td>
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<td>Method</td>
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<td>14</td>
<td>Independent t-Test</td>
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<td>15</td>
<td>Dependent t-Test</td>
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<tr>
<td>16</td>
<td>One-Way ANOVA</td>
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<td>17</td>
<td>Factorial ANOVA</td>
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<td>18</td>
<td>Factorial ANOVA with Advanced Designs (e.g., Latin Square, Split Plot, etc.)</td>
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<td>19</td>
<td>Planned Orthogonal Comparisons</td>
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<tr>
<td>20</td>
<td>Post-hoc Multiple Comparisons</td>
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<tr>
<td>21</td>
<td>One-Way ANCOVA</td>
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<td>22</td>
<td>Factorial ANCOVA</td>
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<td>23</td>
<td>Trend Analysis</td>
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<td>24</td>
<td>Discriminant Analysis</td>
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<td>Path Analysis</td>
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<td>Canonical Correlation</td>
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<td>Cluster Analysis</td>
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<td>29</td>
<td>One-Way MANOVA/MANCOVA</td>
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<td>Factorial MANOVA/MANCOVA</td>
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<td>Log-Linear Analysis</td>
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<td>32</td>
<td>Logistic analysis</td>
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<td>33</td>
<td>Median Test</td>
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<td>34</td>
<td>Wilcoxon-Mann-Whitney U-test</td>
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<td>35</td>
<td>McNemar Change Test</td>
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<td>36</td>
<td>Kolmogorov-Smirnov One/Two Sample(s) Test</td>
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<td>37</td>
<td>Friedman Two-Way ANOVA</td>
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<td>38</td>
<td>Kruskal-Wallis One-Way ANOVA</td>
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<td>Wilcoxon Rank Sum Test</td>
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<td>Fisher's Exact Test</td>
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If you can think of any statistical techniques not listed in the above, please list them in the following section and rate the sophistication of each:

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APPENDIX C
### List of Additional Statistical Techniques Identified by the Panel of Experts

<table>
<thead>
<tr>
<th>Statistical Techniques</th>
<th>Level of Sophistication</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Reliability Measures</td>
<td>1</td>
</tr>
<tr>
<td>2. Effect Size</td>
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</tr>
<tr>
<td>3. Contingency Coefficient</td>
<td>1</td>
</tr>
<tr>
<td>4. Exploratory Data Analysis</td>
<td>2</td>
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<tr>
<td>5. Ration Estimation</td>
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<tr>
<td>6. Cross-lagged Correlation</td>
<td>2</td>
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<tr>
<td>7. Birnbaum-Hall Test</td>
<td>2</td>
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<tr>
<td>8. Runs Test</td>
<td>2</td>
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<tr>
<td>9. Mann-Whitney U Test</td>
<td>2</td>
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<tr>
<td>10. ANOVA for Repeated Measures</td>
<td>2</td>
</tr>
<tr>
<td>11. Wilcoxon Matched Pair Squared Rank Test</td>
<td>2</td>
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<tr>
<td>12. Probit Analysis</td>
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<td>13. Tobit</td>
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<tr>
<td>14. Markov Chain</td>
<td>3</td>
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<tr>
<td>15. Survival Analysis</td>
<td>3</td>
</tr>
<tr>
<td>16. Multidimensional Scaling</td>
<td>3</td>
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<tr>
<td>17. Principal Components Analysis</td>
<td>3</td>
</tr>
<tr>
<td>18. Conjoint Analysis</td>
<td>3</td>
</tr>
<tr>
<td>19. LISREL</td>
<td>3</td>
</tr>
<tr>
<td>20. Latent Partition Analysis</td>
<td>3</td>
</tr>
<tr>
<td>21. Multiple Discriminant Analysis</td>
<td>3</td>
</tr>
<tr>
<td>22. Mixed Models</td>
<td>3</td>
</tr>
<tr>
<td>23. Stepwise Regression</td>
<td>3</td>
</tr>
</tbody>
</table>
24. Residual Analysis 3
25. Sampling Schemes 3
26. Non-linear Regression 3
Chi Zhang is a native of Jiaxing, Zhejiang Province, China. He is the son of Shizheng Zhang and Yayu Tao. He received his Bachelor of Science in Psychology from Hangzhou University, China in 1984 and Master of Science in Vocational Education from Louisiana State University, Baton Rouge, Louisiana in 1989.

For four years he was employed as a Research Assistant in the School of Vocational Education at Louisiana State University. He was previously employed as an Instructor of Psychology in the Department of Agricultural Education and Extension at Zhejiang Agricultural University, China.

Chi lives in Baton Rouge, Louisiana with his wife, Dongmei Han.
Candidate: Chi Zhang

Major Field: Vocational Education

Title of Dissertation: Statistical Sophistication of Research in Vocational Education

Approved:

Michael J. Burnett
Major Professor and Chairman

Dean of the Graduate School

EXAMINING COMMITTEE:

Date of Examination:

July 10, 1991