

Quantitative Research in Education

Intermediate & Advanced Methods

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PREFACE

This book offers a comprehensive presentation of quantitative research design and statistical methods in the context of education and related fields. The text is intended primarily for use by students who take intermediate and advanced quantitative research courses as a part of their graduate degree program, but it can be a useful resource for researchers in education, counseling, rehabilitation, psychology, sociology, social work, and human development as well.

The main purpose of this book is to provide the readers with an in-depth conceptual and methodological understanding of intermediate and advanced quantitative research methods, as well as the skills necessary to apply such methods using SPSS and to interpret the results. This is achieved by building layers of context-based understanding of research concepts and methods, their statistical translation, methodological principles, computer-based data analysis, presentation of the results in APA style format, and contextual interpretations. The text allows people who experience difficulties with analytic representations of statistical concepts to capitalize on conceptual understanding and still be able to master the research tools necessary for their work on theses, dissertations, and professional research.

While there are many excellent introductory books on research design and statistics in education and the social sciences, most books at the intermediate and advanced levels tend to be either too technical and mathematical or too simplistic. Typically, claiming to have an "applied orientation," such books are dominated by presentations of SPSS dialog boxes and printouts at the expense of theoretical and methodological rigor. To bridge the gap between these extremes, this book attempts to provide a balance between conceptual meaning and its statistical translation by developing understanding and application skills in a spiral exposure to quantitative concepts and methods. For example, the comparison of groups on variables of interest is addressed in a sequence from univariate cases of *t*-tests, nonparametric methods, and analysis of variance (ANOVA) to scenarios illustrating the use of multivariate analysis of variance (MANOVA) and structural equation modeling (SEM). As another example, the concept of validity is addressed in the framework of measurement, research design, and structural equation modeling. Particular attention is devoted to potential problems associated with violation of assumptions, common misconceptions (e.g., conducting MANOVA versus separate ANOVAs), effect sizes, confidence intervals, and sample size. The book is organized in four parts comprising 24 chapters. Each chapter ends with a summary and study questions.

Part I [*Measurement in Educational Research*] consists of three chapters. Chapter 1 presents variables and measurement scales in the context of education. The focus is on the nature of measurement in education, types of variables, types of scales and their transformations, permissible arithmetic operations with scale values, summation symbols, and basic rules of summation. Chapter 2 introduces the classical model of reliability of scores, types of reliability, and reliability of composite scores. Chapter 3 deals with the concept of validity for measurement instruments (e.g., tests, questionnaires, or inventories) and types of validity (content-related validity, criterion-related validity, and construct-related validity).

Part II [*Research Design*] consists of two chapters. Chapter 4 deals with research problems, hypotheses, and types of quantitative research: nonexperimental research, experimental research, and threats to internal and external validity. Chapter 5 presents pre-experimental and true experimental research designs that involve quantitative methods of data analysis. The focus is primarily on conceptual understanding and methodological principles underlying the application of such designs in educational research.

Part III [*Univariate Statistics in Educational Research*] consists of fourteen chapters. The first five of these chapters (6, 7, 8, 9, and 10) cover introductory statistics and prepare the ground for understanding and practical applications of intermediate statistics in educational research. The next six chapters (11 through 16) provide intermediate treatment of correlation, regression, and analysis of variance (ANOVA) including some nonparametric methods. The last three chapters in this section (17, 18, and 19) provide more advanced treatment of multiple regression, analysis of variance, and the relations between them.

Part IV [*Multivariate Statistics in Educational Research*] consists of five chapters. This part covers the topics of logistic regression, multivariate analysis of variance (MANOVA), exploratory factor analysis, confirmatory factor analysis, and elements of structural equation modeling (SEM). The analytic framework of these topics is simplified and tailored to conceptual understanding, computer-aided applications, and interpretations in the context of educational research.

Supplements

Data sets for computer-based applications in examples using SPSS can be downloaded from the online supplement to this book [<http://cehd.gmu.edu/book/dimitrov>]. This supplement provides also (a) answers to the study questions for each chapter, (b) addendum to some topics discussed in the book, (c) syntax for confirmatory factor analysis, path analysis, and group comparison on latent variables in the framework of major computer programs — LISREL, AMOS, EQS, and *Mplus* [used for illustrations in Chapters 23 and 24], and (d) additional references (books, articles, and online products) related to the content of this book.

Acknowledgments

I would like to acknowledge the assistance of my graduate research assistant, Jill Lammert, who provided valuable editorial comments and suggestions throughout the writing of this book. I also appreciate the feedback and encouragement of colleagues from different universities as well as graduate students who used draft chapters of this book in quantitative research courses that they took with me in the Graduate School of Education at George Mason University.

Dimiter M. Dimitrov

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Research methods in education (and the other social sciences) are often divided into two main types: quantitative and qualitative methods. This book will discuss one of these two main strands: "quantitative methods", and what distinguishes quantitative from qualitative methods. When you think of quantitative methods, you will probably have specific things in mind. You will probably be thinking of statistics, numbers, and many of you may be feeling somewhat apprehensive because you think quantitative methods are difficult. Apart from the last one, all these thoughts capture some of the essence of Quantitative research is empirical research where the data are in the form of numbers. Qualitative research is empirical research where the data are not in the form of numbers. (Punch, 1998: 4).

5. Qualitative and quantitative approaches. Christina Hughes (University of Warwick). p Quantitative research: key characteristics. p CONTROL: This is the most important element because it enables the scientist. causes. Control is necessary in order to provide unambiguous answers to such questions. To answer questions in education and social science we have to eliminate the simultaneous influence of many variables to isolate the cause of an effect. Research in science education is to discover the truth which involves the combination of reasoning and experiences. In order to find out appropriate teaching methods that are necessary for teaching science students problem-solving skills, different research approaches are used by educational researchers based on the data collection and analysis used at a given time. Though qualitative and quantitative research methods lies on separate continuum, they all aimed at identifying educational problems using different approach. This study critically examined the usefulness of both qualitative and quantitative research methods. Researchers often have issues choosing which research method to go with: quantitative or qualitative research methods? Many incorrectly think the two terms can be used interchangeably. Qualitative research is regarded as exploratory and is used to uncover trends in thoughts and opinions, while quantitative research is used to quantify the problem by way of generating numerical data or data that can be transformed into usable statistics. We shall look at five types of qualitative research that are widely used in business, education and government organizational models. Narrative Research. This method occurs over extended periods of time and gathers information as it happens.

Quantitative research is a research strategy that focuses on quantifying the collection and analysis of data. It is formed from a deductive approach where emphasis is placed on the testing of theory, shaped by empiricist and positivist philosophies. Associated with the natural, applied, formal, and social sciences this research strategy promotes the objective empirical investigation of observable phenomena to test and understand relationships. This is done through a range of quantifying methods and Researchers often have issues choosing which research method to go with: quantitative or qualitative research methods? Many incorrectly think the two terms can be used interchangeably. Qualitative research is regarded as exploratory and is used to uncover trends in thoughts and opinions, while quantitative research is used to quantify the problem by way of generating numerical data or data that can be transformed into usable statistics. We shall look at five types of qualitative research that are widely used in business, education and government organizational models. Narrative Research. This method occurs over extended periods of time and garners information as it happens. Engineering education¹ as a developing field shares many characteristics of a discipline undergoing a scientific revolution as described by Thomas Kuhn (1962, 1970). As Kuhn describes the transition associated with change, he asserts that negotiation over the path and endpoint are inevitable. While engineering education is not undergoing a purely scientific revolution in Kuhnian terms, which occurs when established disciplines experience a paradigm. ¹By Engineering Education, we refer to the field of engineering education research, not the practice of educating engineers. In order to establish itself as a research field, engineering education is negotiating input from both qualitative and quantitative methods advocates, both with strong investment in the field. 4 – Doing Quantitative Research in Education. This idea is linked to what are seen as the different underlying philosophies and worldviews of researchers in the two “paradigms” (also called “epistemologies”). According to this view, two fundamentally different worldviews underlie quantitative and qualitative research. To label all quantitative researchers positivists is equally inaccurate. Quantitative researchers have taken up many criticisms of positivist views, and there are now a variety of epistemologies underlying theory and practice in quantitative research. I think it is true to say that very few quantitative researchers nowadays are radical positivists. Post-positivism, experiential realism and pragmatism. Those wanting just to be able to understand quantitative research as well as the statistically unsure wanting to use it are unlikely to be disappointed. There is a growing need for Daniel Muijs’s text also in order to respond to the burgeoning interest in mixed methodology – Professor Liz Todd, Newcastle University. About the Author. Professor Daniel Muijs is Chair of Education. Previously he worked at the University of Manchester as Chair of Pedagogy and Teacher Development at the University of Manchester, School of Education, as Chair of School Leadership and Management at the University