CHAPTER 1

Introduction

The only limit to our realization of tomorrow will be our doubts of today. Let us move forward with strong and active faith.

—Franklin D. Roosevelt
(undelivered address, April 13, 1945; quoted in Peters & Woolley, 1999–2018)

This book is for thesis students who are learning to conduct independent (but still supervised) research in the behavioral sciences, such as psychology, education, or other disciplines where empirical studies are conducted with humans or animals. Such students may be senior undergraduates who are completing an honors program or a specialization program with a thesis option, or they may be newly admitted graduate students at the master's level. I assume that readers (1) have already taken at least one introductory course in both statistics and research methods and (2) are considering careers in which the ability to understand or produce research is important. The main goal is to help thesis students develop the cognitive and applied skills to eventually become capable and effective researchers in their own right.

Transitions

Thesis students must navigate a few challenges as they complete their undergraduate-level studies or enter graduate school (Mumby, 2011; Pearson, 2011). They must transition from

1. Attending large classes in which students can be relatively anonymous and have little direct contact with professors to being a highly visible member in a smaller research group with closer relationships to faculty members and student peers.
2. Being evaluated by individual instructors on mainly in-class examinations that involve little or no writing (e.g., multiple-choice tests) to being evaluated by a research committee based on extensive writing (i.e., your thesis) and oral presentations, too.
3. Reading or listening about research produced by others with some understanding to doing so, with even stronger comprehension or conducting your own studies.
4. Being a relatively passive recipient of information from authority figures to someone who both takes in and disseminates knowledge through what you write and say (you become an authority figure, too).
5. Being aware of limitations with the way research is conducted or reported in the behavioral sciences to being capable of doing something about them (you learn to appreciate the need for reform and can act on it, too).

Not Yet Ready for Prime Time

Even after completing basic (introductory) courses in statistics and research methods, students are usually not yet ready to carry out independent research projects. This observation is something that instructors of research seminars and supervisors of thesis projects know only too well, and students often feel the same way, too. Part of the problem is that there are some critical gaps in the knowledge and skills of students who undertake thesis projects. For example, students' knowledge of basic concepts about statistics or research design is often rather poor, despite their previous coursework. Some possible reasons are outlined next:

1. Statistics and research methods are typically dealt with in separate courses and, consequently, their integration may not be emphasized. That is, analysis and design are presented outside the context of the other, but in real research projects they are integral parts of the same whole.

2. Too many statistics classes cover mainly the **old statistics,** or estimation based on null hypothesis significance testing, which has serious flaws. Emphasized in more modern courses are the **new statistics,** or estimation based on effect sizes, confidence intervals, and meta-analysis. The new statistics are an important part of **statistics reform,** in which routine significance testing is replaced by methods aimed at building a more cumulative research literature (Cumming, 2014; Kline, 2013).
3. Beginning in the 1980s, courses in measurement theory, or psychometrics, were dropped from many undergraduate and graduate programs in psychology (Aiken, West, Sechrest, & Reno, 1990). This development is unfortunate because strong knowledge of measurement is crucial for behavioral science researchers, especially if they analyze scores from psychological tests. Without a grasp of basic psychometrics, researchers may have trouble understanding whether those scores can be analyzed with reasonable precision (reliability) or support a particular interpretation (validity).

A consequence of these problems is that students often have difficulty when it comes time to analyze data in their own research projects. They may experience a lack of confidence in what they are doing, or, worse, they may wind up conducting analyses on results they do not really understand. That is, students too often carry out the analyses in a relatively blind way such that they lose sight of the connections between the hypotheses (research questions), study design and procedures, and interpretation of the results. Students also tend to become overly fixated on the analysis and thus pay less attention than they should to other issues, including those of methods and measurement. The problems just described occur more often among undergraduate students, but many junior graduate students evidence similar difficulties, too.

Write and Speak

Thesis students need to do a lot of writing, from a proposal before starting the project to the final version of the thesis. They may also be required to make presentations about their projects as part of research seminars or

thesis classes with students from other laboratories. Both of these forms of communication, written and oral, are critical skills for researchers. Many, if not most, scientists spend more time communicating about their work in the form of articles, grant applications, lectures, or as invited speakers than they do actually setting up experiments and collecting data. Indeed, communication is at the heart of science and a big part of a researcher's everyday life (Feliú-Mójer, 2015).

But thesis students are often unprepared to express themselves effectively in writing. This happens in part because few demands for writing may have been placed on them in earlier courses. For example, depending on the particular academic program and luck in course registration, it is possible to get a university degree without doing much, if any, serious writing. Thus, many students are simply unpracticed in writing before they enter a research seminar, thesis class, or graduate school. Even for students experienced in other types of writing, such as in the humanities or journalism, it is not easy to learn how to write research reports. This is because scientific writing has its own style and tenor that require extensive practice in order to master it.

Students obliged to make oral presentations about their thesis projects are often given little guidance beyond specifying a time limit (e.g., 20 minutes), asking for coverage of particular content (e.g., project rationale, methods, and hypotheses), and maybe also showing them the basic workings of Microsoft PowerPoint or similar computer tools for creating and showing electronic slides. Yes, students see many PowerPoint presentations during course lectures, some of which may be experienced as pretty awful and trivial but others as more engaging and enlightening. For the reasons explained next, however, these experiences teach them little about how to prepare effective presentations.

Amid hundreds of hours of lecture time, it is difficult for students to identify and articulate specific principles for making effective PowerPoint presentations based on hit-or-miss experiences as audience members. Consequently, it is not surprising that many students find oral presentations to be intimidating. They worry both about dealing with anxiety related to public speaking and about how to organize and display their content in PowerPoint. A few students eventually develop by trial and error an effective presentation style, but many others do not. As we all know, not all instructors are effective public speakers; thus, this statement is not an indictment directed specifically against students. Perhaps the period of trial-and-error learning could be reduced if students were offered more

systematic instruction in how to make effective presentations, including both what to do and what not to do as a speaker, and in PowerPoint, too.

What Thesis Students Say They Need

In my sections of our thesis course for psychology honors students, I ask them at the beginning of the semester, "Who are you, what do you want, and where are you going?" The "what do you want" part of the question concerns what they want to learn in the course besides the mechanics of submitting their theses at the end of the school year. Most students, about 75% or so, say that they want to learn how to better conduct their statistical analyses and interpret the results. About the same proportion say that learning how to make effective oral presentations is a priority. A somewhat smaller proportion, but still the majority, respond that they want to learn how to write a research paper for an empirical study. So the "big three" items on the students' wish list concern the analysis and developing better communication skills (both written and oral).

Other kinds of responses are typically given by a minority of the students. These include receiving information about graduate school, how to manage the logistics of a research project, how to make effective posters for presentation in a poster session, research ethics, and technical details of American Psychological Association (APA) style. The last-named refers to specifications for formatting manuscripts according to the sixth edition of the *Publication Manual of the APA* (APA, 2010). I make no claim that these results are representative, but I bet that many senior undergraduate students—and junior graduate students, too—who conduct thesis projects would mention the same "big three" concerns as my students.

Career Paths for Behavioral Scientists

At first glance, it may seem that most behavioral scientists work strictly in academia—that is, as faculty members in universities. Some do, of course, but only a relatively small proportion of people with graduate degrees in psychology, education, or related areas go on to pursue academic careers. That's a good thing because it is increasingly difficult to secure a tenure-track faculty position, given the increasing numbers of graduates with doctoral degrees but shrinking numbers of such positions. Estimates vary

by discipline, but only about 20% of people with doctoral degrees in the behavioral sciences eventually get a tenure-track job, and the situation in engineering and the "hard" sciences is not all that different (Schillebeeckx & Maricque, 2013; Weissmann, 2013). Within psychology, the areas with the most favorable academic job markets include the neurosciences, quantitative, health, social–personality, and developmental psychology, while the areas with the worst prospects include industrial–organizational, clinical, and counseling psychology (Kurilla, 2015).

Overall, the academic job market is highly competitive in that there are typically many more applicants than available positions, especially for tenure-track slots. Those applicants face greater demands, too, than they did in the past. As noted by van Dalen and Klamer (2005) and others, universities now place more of a premium on research productivity and especially on the ability to secure funds from granting agencies than in the past. This emphasis works against "late bloomers" who did not discover a passion for research until later in their careers. In bygone days, some tenured professors did not really begin their academic careers until their early 40s. Starting at this age is quite rare now: the usual starting age of those with assistant-level tenure-track positions today is the late 20s or early 30s.

Given the shortfall of tenure-track faculty positions relative to the number of people who graduate with doctoral degrees, many qualified young scholars are forced to either abandon their aspiration for a full-time faculty position or accept work as an adjunct or part-time faculty member. Such positions allow one to remain in an academic setting, but they may offer high teaching loads with little time for research, relatively low pay, few or no benefits, and little if any job security (Kurilla, 2015). In many undergraduate programs, part-time instructors teach most of the classes, thus creating a new faculty majority that is quite separate and unequal relative to tenure-track faculty. About 30% of part-time faculty seek outside employment, such as teaching in multiple departments or schools, in order to make a living (Griffey, 2016). This situation has produced a kind of academic apartheid that is not likely to change in the near future because it saves universities money; that is, it costs less to pay part-time faculty than full-time, tenured faculty.

It is a reality that one needs to plan for an academic position early in graduate school by (1) seeking out a supervisor who is a prolific researcher, (2) participating in research above and beyond one's particular thesis project, (3) presenting papers or posters at scientific conferences, and

(4) publishing research articles while still a student, not just after graduation. It also does not hurt to pick up some teaching experience while in graduate school, but not at the expense of getting your research done. Academia is a tough business, but it is better to consider a faculty position with your eyes wide open. But the potential rewards are great for those who believe they will thrive in academia, especially for energetic, creative, and self-motivated people who love ideas and question conventional wisdom.

Besides universities, behavioral scientists work in a wide range of governmental agencies or ministries, including those involved in health, education, transportation, engineering, criminal justice, statistics and standards, finance, and social services. Others work for nongovernmental organizations, such as those involved in human service delivery or public policy, or work in the private sector, including hospitals, marketing research firms, pharmaceutical companies, software development groups, manufacturing facilities, financial service organizations, and insurance companies. Some work as consultants, either as freelancers or as members of consultancy firms. The main clients of such firms are governments and businesses.

Research training leaves graduates of behavioral science programs with marketable skills in a variety of careers outside universities. And, of course, work directly related to research is only part of what behavioral scientists do in these positions. Such responsibilities could involve actually carrying out research projects from start to finish. If so, then skills other than those directly related to design, analysis, and measurement are needed, including the ability to convey study rationale to nonresearchers (i.e., write a proposal for those who control project funds) and to work out project budget and personnel needs. University faculty members deal with the same issues whenever they write grant proposals.

Another possibility includes working to evaluate research results generated by others but then conveying your recommendations, possibly to colleagues with no formal training in research but who count on your judgment. So, once again, the ability to communicate research findings in terms that are meaningful to nonresearchers or multidisciplinary audiences is crucial, both inside and outside universities. It helps that you really understand what your own results mean; otherwise, how can you explain them to others if you cannot first do so to yourself? This is why this book places so much emphasis on correct interpretations of statistical results and on statistics reform, too.

The ability to think critically about how evidence is collected and evaluated is especially important for those who work in human service fields, such as mental health, where there are unsubstantiated beliefs about associations between variables or the effectiveness of certain types of practices (Dawes, 1994):

1. Even well-intentioned efforts at intervention can produce unexpected negative consequences later on—for example, the history of medicine has many instances where some treatment is later found to do more harm than good. A skeptical attitude about a proposed treatment may help to prevent such problems.
2. An empirically based, "show-me" perspective may also constrain otherwise less cautious practitioners from making extreme claims without evidence. It may also prevent fads from dominating professional practice.
3. It is relatively easy for professionals to believe, based on their experience, that they have special insight about the causes and mitigation of human problems. Such beliefs may be incorrect, however, and it could take longer to make discoveries if one does not value the role of evidence.
4. There is growing appreciation for the need to base practice on evidence-based techniques in medicine, professional psychology, and education (APA Presidential Task Force on Evidence-Based Practice, 2006; Shernoff, Bearman, & Kratochwill, 2017). Strong research skills are obviously relevant here.

Plan of the Book

The organization of this book and the contents of its three parts are intended to address the issues just outlined about preparing thesis students for research-based careers. We begin in the next chapter with review of fundamental principles that integrate research design with measurement and statistical analysis. Also elaborated is the association between each of the three areas just mentioned, with a particular type of validity concerning the accuracy of inferences.

Considered in Chapter 3 are various problems and crises that beset the psychology research literature, including:

1. The aforementioned **measurement crisis,** including the widespread failure of researchers to estimate and report the reliabilities of scores analyzed.
2. The **reporting crisis,** or the realization that critical information supporting replication, results synthesis (i.e., meta-analysis), and scientific transparency is omitted in too many journal articles.
3. The **replication crisis,** or the apparent inability to replicate findings from many classical studies and the dearth of studies in the literature explicitly devoted to replication.
4. The **significance testing crisis,** or the ongoing controversy, now occurring in many disciplines, about the proper role of statistical significance testing, if any, in data analysis.

The five chapters of Part II (Chapters 4–8) concern potential remedies for the various crises just described. Specifically, Chapter 4 deals with revised or new journal article reporting standards by the APA for quantitative research, qualitative research, and mixed methods research. The basic aim of such standards is to improve the quality, trustworthiness, and transparency of reporting on results from empirical studies. The difference between quantitative research and qualitative or mixed methods research is explained in this chapter, with greater emphasis on quantitative research. This is because most student research projects in the behavioral sciences are of the quantitative type, but this has been changing in some disciplines, such as education, where increasing numbers of students are using qualitative or mixed methods. Readers with little or no backgrounds in qualitative methods are thus introduced to them in Chapter 4.

Enhanced transparency of scientific research is part of the open-science movement, described in Chapter 5. Also emphasized in open science is making research data and related resources, including scientific articles, more accessible to both professional and public audiences. The practice of open science may also reduce the likelihood of scientific fraud, an obnoxious reality in basically all research areas.[1]

Chapters 6 and 7 deal with aspects of statistics reform, including the controversy about significance testing and suggested alternatives and the importance of routinely describing the magnitudes of results, or effect

[1]https://www.the-scientist.com/tag/research-integrity/

size. Many journals, especially those in health-related areas of research, and some journal article reporting standards now require the reporting of effect sizes when it is possible to do so (and it usually is). The basics of psychometrics are covered in Chapter 8, with emphasis on how to assess the precision or interpretation of scores from psychological tests and also on what to report in theses or journal articles about psychometrics. For too many thesis students, the material covered in this chapter may be the only substantial presentation about measurement theory they have encountered so far. Accordingly, the main goal of this chapter is to help you to make better choices about measurement in your own project, given this reality.

Part III is devoted to skills, including data analysis and communication. As mentioned, theoretical issues are covered in many introductory statistics courses, but relatively little is said about how to manage a real analysis. This is why Chapter 9 deals with many practical issues in data analysis, such as the need to develop a clear analysis plan in which the simplest statistical technique that will get the job done is applied. That is, students are encouraged to resist the need to conduct too many analyses or analyses that are unnecessarily complicated, and thus not understood. There is also discussion on data screening, or how to prepare the data for analysis by checking for problems that, if undetected, could invalidate the interpretation of any results based on those data. Proper data screening is too often neglected by even established researchers, and many reporting standards call for complete disclosure of alterations made to the data that could have affected the results.

How to write a manuscript-length summary of an empirical study (including your thesis) is the subject of Chapter 10. Also discussed in this chapter are principles of good writing in general and more specific requirements for good scientific writing. Examples of common writing mistakes to avoid are offered. Considered in Chapter 11 are suggestions for making effective oral presentations while using PowerPoint or other computer tools for showing digital slides. How to plan and organize the presentation is discussed, and how to avoid mistakes in many, if not most, PowerPoint presentations is reviewed. Examples of more effective visual styles for slides are offered. How to deal with "stage fright," or nervousness about public speaking, is also reviewed.

Exercises with answers are presented in Chapters 2, 4, and 6–11 that involve analysis, measurement, or communication. Exercises that concern statistics or measurement have suggested answers, but you should first

try to work out the solution before consulting the answers. Exercises for Chapters 4, 10, and 11 about, respectively, reporting, writing, and presentations concern your particular thesis project. These exercises are intended to assist you to write a proposal or make an oral presentation with slides about your research.

Summary

The fact that many students who are about to conduct supervised research projects are not yet ready in terms of their conceptual knowledge and practical skills was discussed in this chapter. Specifically, thesis students need help with (1) developing a more complete sense of how design, analysis, and measurement complement one another; (2) conducting their statistical analysis and correctly interpreting the results; and (3) communicating to others in written and spoken form about their findings. It was also noted that there are many career tracks for those who become behavioral scientists. Some of these paths involve working in academia, but many others do not; indeed, the range of employment prospects outside universities is wide and includes governmental, commercial, educational, and other kinds of settings. Do you want to see if one of these paths might be in your future? Then let us begin by getting you ready. We do so in the next chapter with a review of essential concepts about research design, measurement, and analysis.

RECOMMENDED READINGS

Kuther and Morgan (2012) and Sternberg (2017) described various careers for students in psychology, while Carlson and Carlson (2016) did so for education majors. Vick, Furlong, and Lurie (2016) offered helpful suggestions for conducting an academic job search.

Carlson, J., & Carlson, R. (2016). *101 careers in education*. New York: Springer.

Kuther, T., & Morgan, R. (2012). *Careers in psychology: Opportunities in a changing world* (4th ed.). Belmont, CA: Wadsworth.

Sternberg, R. J. (2017). *Career paths in psychology: Where your degree can take you* (3rd ed.). Washington, DC: American Psychological Association.

Vick, J. M., Furlong, J. S., & Lurie, R. (2016). *The academic job search handbook* (5th ed.). Philadelphia: University of Pennsylvania Press.