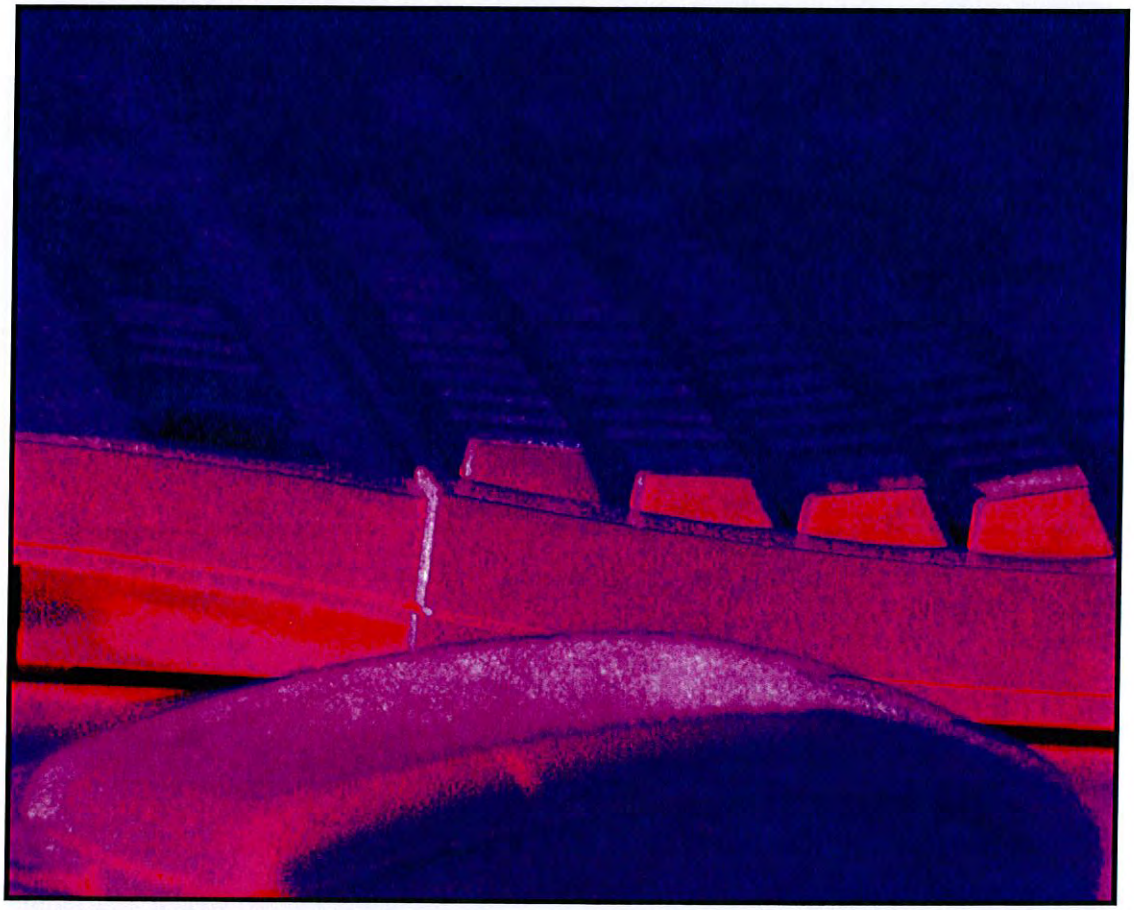
HANDBOOK OF RESEARCH ON

E-Learning Applications for Career and Technical Education

Technologies for Vocational Training



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Technologies for Vocational Training

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Chapter XLIV
Using Meta-Analysis as a Research Tool in Making Educational and Organizational Decisions

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ABSTRACT

This chapter explores the viability of meta-analysis as a research tool for helping career and technical educational and organizational professionals make decisions. Following many of the same steps involved in the basic research process, meta-analysis provides a means for reconciling contradictory quantitative results from multiple studies, thereby generating a conclusive answer. However, meta-analysis is subject to many forms of bias and can pose practical problems. Meta-analysis has been used to study many issues in administration and management. From this chapter, educational and organizational professionals can determine if it is an appropriate tool to help them make decisions about specific challenges that they face.

INTRODUCTION

Faced with numerous challenges on the job, career and technical educators (CTE) and administrators rarely have the luxury of having simple, straightforward decisions about what is the best course of action for addressing those challenges. Sorting through the various options for dealing with challenges can be more difficult than the challenges themselves. For example, consider job satisfaction of CTE. Although most educational and organizational professionals undoubtedly will agree that increasing job satisfaction is vital for organizational effectiveness, how to go about increasing job satisfaction is debatable. Should one focus on such organizational factors as reward

structure and promotion policies? Or, should one direct one's energy to recruitment and selection of employees? The answers to these questions can vary according to who is asked and what literature is consulted. Consequently, many professionals charged with addressing an issue such as job satisfaction can easily find themselves overwhelmed by a myriad of confusing and contradictory ideas. Therefore, it is essential that professionals know how to integrate and make sense of conflicting information.

The purpose of this chapter is to explore the viability of meta-analysis as a research tool in order to help professionals make decisions about complex challenges facing their organizations. Specifically, the author hopes to provide enough information about the definition, purpose, and process of conducting meta-analysis research, as well as the key issues and emerging trends associated with this type of research. In doing so, this information will allow educational and organizational professionals to determine if it is suitable for application in their situation so that they can become savvy consumers of meta-analytic results.

BACKGROUND

History of Meta-Analysis

Prior to the establishment of meta-analysis, researchers often summarized findings of various studies by grouping together similar aspects of the research. For example, if a researcher was reviewing literature regarding the effect of a reading program intervention, he or she may have stated that 15 of 25 studies showed that reading programs led to increases in student ACT scores. However, this method did not take into account the diverse designs and quality of the various research studies that were being summarized or the discrepancies in study results (Gay, Mills, & Airasian, 2009; Rubin & Babbie, 2008). Furthermore, the summarization approach resulted in subjective research, often varying from one researcher to the next due to inconsistent ways of selecting and analyzing such research (Gay, Mills, & Airasian). Introduced in the early 20th century (Moncrieff, 1998; Rosenthal & DiMatteo, 2001), meta-analysis initially was used primarily in clinical medical research (Nijkamp & Pepping, 1998). However, in the 1970's, Glass, McGaw, and Smith (1981) adapted this method of research for the social sciences, and over the past 30 years, it has been widely applied to quantitative research in education, psychology (personal and industrial), criminology, and other social sciences (Bangert-Drowns & Lawrence, 1991; Duvall & Tweedie, 2000; Mann, 1994; Robey & Dalebout, 1998).

Meta-Analysis Defined

During the past several decades, the literature associated with research studies has increased substantially. While many studies investigate similar subjects and phenomena, often the results are not the same. Meta-analysts seek to reconcile the differences amongst a multitude of research literature (Gay, Mills, & Airasian, 2009; Rubin & Babbie, 2008). In simple terms, meta-analysis is a quantitative technique for combining results of multiple studies with similar hypotheses to clarify findings (Creswell, 2008; Gay, Mills, & Airasian; Rubin & Babbie). When performed properly, it generates a conclusive answer to a complex issue from an inconsistent and disparate body of research. It can be particularly useful for reconciling contradictory results from studies on similar topics. Meta-analysis research also provides insight into the strengths and weaknesses of prior research studies using quantitative measures (Rubin & Babbie).

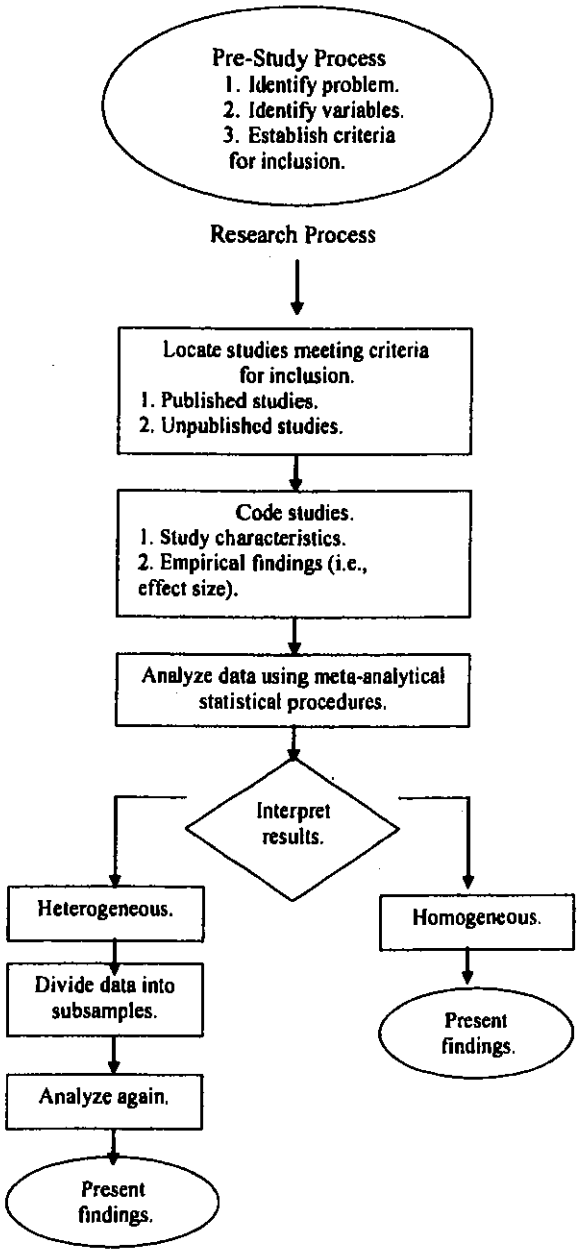
STEPS IN CONDUCTING A META-ANALYSIS

The basic process for conducting a meta-analysis is similar to that for other research methods (Bangert-Drowns & Lawrence, 1991; Robey & Dalebout, 1998; Rosenthal & DiMatteo, 2001). The following denotes the basic steps to conducting this form of research, although subtopics and titles may differ according to the preferences of the researcher:

1. Identify the problem to be studied, including the variables of interest
2. Establish criteria for inclusion of studies
3. Locate studies meeting criteria for inclusion
4. Code studies
5. Analyze data using meta-analytical statistical procedures
6. Interpret results from analysis
7. Present findings

Figure 1 displays the process of meta-analysis. Although the process outlined in the flowchart appears straightforward, it involves the researcher in numerous considerations. A discussion of the steps in the process and considerations relative to each step follows.

Figure 1. The process of meta-analysis



Identify Problem and Variables

Identify the problem to be studied, including the variables of interest. Glass (2006) maintains that there are no true guidelines for choosing a field of study when conducting meta-analysis research. Similar to other research methods, the first step in conducting a meta-analysis is to identify the problem to be studied, including the variables of interest. A good example would be "job burnout" with the variables being "age" and "years of experience" (Brewer & Shapard, 2004). Another example would be "dimensions for teacher burnout" with the variables being "demand" and "resources." For many educational and organizational professionals, identifying a problem may not be difficult; they merely have to specify one of the challenges facing their organization. In these cases, the focus shifts to determining whether or not a problem is appropriate for meta-analysis.

When selecting a problem, meta-analysts search for a subject matter that has been previously investigated through a variety of studies. An appropriate problem for meta-analysis successfully balances two extremes: enough has been written about it, but not too much. On one hand, enough studies must exist to be able to conduct meta-analytical procedures. However, if numerous studies have been conducted on the same problem with analogous results, then it would be more prudent to make decisions about how to address challenges based on those results than to conduct a meta-analysis. Therefore, an appropriate topic for meta-analysis is one that has been studied in depth, but not to the point of reaching definitive answers. For example, although there is an abundance of literature—including copious empirical findings—on job burnout, much of that research has been conducted without benefit of an overarching theoretical framework. Consequently, research on burnout has suffered from a lack of order and congruence (Brewer & McMahan, 2003a, 2003b; Brewer & McMahan-Landers, 2003; Maslach, 1999). To address this shortcoming, a meta-analysis—such as the one conducted by Lee and Ashforth (1996)—that studies the dimensions of burnout in relation to a specific theoretical construct could be performed.

Establish Criteria for Inclusion of Studies

After identifying a problem to be studied, the researcher must establish criteria for determining which studies will be used in the meta-analysis and which will not. Setting clear, straightforward criteria strengthens the meta-analysis. Lipsey and Wilson (2001) suggested several general categories for study eligibility criteria: (a) distinguishing features, (b) research respondents, (c) key variables, (d) research designs, (e) cultural and linguistic range, and (f) time frame. Specific criteria should be enumerated within each general category. For example, under the distinguishing features category, use of a particular instrument might be specified. In their meta-analysis of job burnout, Brewer and Shapard (2004) and Lee and Ashforth (1996) specified that they included only studies that used the Maslach Burnout Inventory (MBI) to measure burnout. Only studies that meet the established criteria should be included in the meta-analysis.

Locate Studies Meeting Criteria for Inclusion

The next procedural step in a meta-analysis is to conduct a literature search to identify studies meeting criteria for inclusion. Given the volumes of literature available on certain subjects, it may be nearly impossible to include all of the studies that meet the criteria. However, having that literature search be as exhaustive as possible is key to a high-quality meta-analysis (Gay & Airasian, 2002; Glass, 2006). The researcher must determine if he or she has included a sufficient amount of studies to effectively conduct the meta-analysis.

A good starting point for the literature search is to consult a computerized bibliographic database (Glass, 2006). As in other types of research, it is advantageous to search for the most current studies when possible, and Glass suggests using the "forward tracking" (p. 431) function in the databases to locate the most current studies available on topics. Researchers should take care to consult more than one database as well as more than one kind of database. For example, suppose a researcher wanted to conduct a meta-analysis on the relationship between leadership style and managerial performance. In addition to searching such databases as *ABI Complete* and *LexisNexis* for studies on managerial performance, the researcher should also search such databases as *PsycINFO* for studies relative to leadership.

Other sources for studies also should be consulted. Lipsey and Wilson (2001) pointed out that such sources as (a) bibliographic reference volumes, (b) relevant journals, and (c) reference

lists from relevant studies, books, and review articles can be valuable for locating studies. In their meta-analysis of the correlates of the dimensions of job burnout, Lee and Ashforth (1996) examined the reference lists of several key review articles on burnout for additional studies not identified through their database searches.

Another issue related to conducting a literature search for a meta-analysis involves the decision of whether or not to include both published and unpublished studies (Brewer & Shapard, 2004; Duval & Tweedie, 2000; Gay, Mills, & Airasian, 2009; Glass, 2006; Hedges, 1990; Ioannidis, Cappelleri, & Lau, 1998; Lipsey & Wilson, 2001; Moncrieff, 1998; Rubin & Babbie, 2008; Sutton, Duval, Tweedie, Abrams, & Jones, 2000; Wolf, 1986). While some researchers have advocated excluding unpublished studies from a meta-analysis on the grounds that their quality could not be ensured because they had not gone through the peer review process, other researchers have cited publication bias as an argument for including unpublished studies. Because studies with significant results tend to be published more often than studies without significant results (Begg, 1994; Egger & Smith, 1998; Stern & Simes, 1997), including only published studies can result in an inaccurate representation of research conducted on a topic chosen for a meta-analysis. Another argument for including unpublished studies is lack of publishing does not always mean lack of quality in the study (Gay, Mills, & Airasian, 2009) Of course, including unpublished studies can pose difficulties relative to identification and availability of studies, but meta-analysts who decide to include unpublished studies can get a good start by consulting the *Dissertation Abstracts* database.

Code Studies

After collecting all appropriate studies, the next step in conducting a meta-analysis is to code the studies. Studies should be coded according to their characteristics and their empirical findings. Study characteristics are descriptors of the study and may include such factors as demographic characteristics of the population studied and the sampling method. Thus, data may be nominal, ordinal, or ratio. When identifying characteristics to be coded, a researcher should include factors that might have had possible moderating effects on the study's results (Glass, 2006). For example, if the literature indicates that a factor such as time with organization has an effect on the variable of interest to the researcher, time with organization should be one of the coded study characteristics. However, if the literature consistently indicates that time with organization does not have an effect on the variable of interest, then time with organization should not be coded. The study characteristics can be thought of as the independent variables in a meta-analysis (Lipsey & Wilson, 2001).

The dependent variables in a meta-analysis are a study's empirical findings (Lipsey & Wilson, 2001). When coding a study, a researcher converts that study's empirical findings to an effect size (ES). An ES is "a numerical way of expressing the strength or magnitude of a reported relationship, be it causal or not" (Gay, Mills, & Airasian, 2009, p. 96). Gay, Mills, and Airasian explain that an ES near .00 demonstrates homogenous results from control and experimental groups, while a high ES reveals an effective intervention. If the ES is below .00, the intervention had a negative, or reverse effect, i.e. "the control group did better" than the experimental group (p. 96).

The type of ES must be the same for all studies included in a meta-analysis and depends on the type of studies included in a meta-analysis. Therefore, the ES size used for a meta-analysis involving correlational studies would differ from the ES used for a meta-analysis involving experimental studies. For example, whereas the ES for a meta-analysis of correlational studies could be the Pearson product-moment correlation (Hunter & Schmidt, 1990), the ES for a meta-analysis of

experimental studies could be derived by subtracting the mean of the treatment group from the mean of the control group and then dividing that answer by the standard deviation of the control group (Glass, McGaw, & Smith, 1981).

Analyze Data Using Meta-Analytical Statistical Procedures

After the studies have been coded, the researcher can proceed to analyzing the data. This generally involves moving the coded data from an electronic spreadsheet into an appropriate statistical software program. Although meta-analytical statistical techniques generally have been viewed as a method for averaging results across studies (Glass et al., 1981; Wolf, 1986), they are actually much more complicated than just averaging results. In many cases, conducting a meta-analysis involves correcting for artifacts (i.e., errors or imperfections in a study that might have altered the value of its outcomes). For example, Hunter and Schmidt (1990) have designed procedures to correct for such artifacts as sampling error, range variation, dichotomization of continuous variables, and error of measurement.

We will not attempt an in-depth discussion of the statistical procedures involved in conducting a meta-analysis. For details related to meta-analytical statistical procedures, we refer you to Glass (2006), Glass et al. (1981), Hedges and Olkin (1985), Hunter and Schmidt (1990), and Rosenthal (1984). Which of these meta-analytical procedures a researcher chooses to use depends on (a) the type of studies included in a meta-analysis, (b) the level of correction the research wants to achieve, and (c) the research domain (Hunter & Schmidt; Lipsey & Wilson, 2001). However, it is important to note that researchers have debated over the use of inferential statistics in meta-analysis. Glass asserts that inferential statistics is inappropriate because of the lack of random assignment, random sampling, and experimentation. Opponents to this viewpoint believe that results from meta-analyses can be generalized based on the fact that the studies have already been conducted using experimental methods (Glass).

Interpret Results from Analysis

The next step in conducting a meta-analysis involves interpreting the results from the analysis. In interpreting meta-analytical results, it is critical to test for homogeneity to determine if the results have been affected by moderating variables. It is important to note that—relative to meta-analysis—homogeneity indicates an approximation rather than uniformity (Hunter & Schmidt, 1990). Meta-analytical homogeneity tests include the Q statistic, credibility intervals, and chi-square tests for homogeneity (Hunter & Schmidt). If the test indicates homogeneity, then the researcher can accept the results and proceed to presenting them to concerned parties. However, if the test indicates heterogeneity, then the researcher would need to divide the data into subsamples and analyze it again to identify moderating variables before presenting findings.

Present Findings

As with other research methods, the final step in conducting a meta-analysis is to present the findings. To whom the findings are presented may vary. In cases where the researcher plans to apply the findings to a specific situation, the intended audience may be limited to an individual or a committee who has final approval—financial or executive—for making decisions regarding that situation. However, we encourage meta-analysts to consider an expanded audience. Numerous scholarly and professional publications are eager to publish meta-analytical results. Reflecting upon his experience as editor for a top-tier journal, Dalton (1995) noted, "Any attempt to formally review a literature without benefit of a meta-analytical approach is largely futile" (p. 613).

KEY ISSUES SURROUNDING META-ANALYSIS RESEARCH

Advantages of Meta-Analysis Research

Conducting a meta-analysis offers several advantages over other research methods. Fischer asserts that "meta-analysis gives us benchmarks that are useful in considering the relative strengths of effectiveness of various interventions" (cited in Rubin & Babbie; 2008; p. 529). He further stated that this type of research can "identify relationships across studies." One advantage is that meta-analysis can provide improved statistical power. When several studies demonstrate that an intervention has a large effect on the experimental groups, this strengthens the hypothesis for all studies involved (Rubin & Babbie). Well-conducted meta-analyses add to scientific knowledge by improving estimates of ES, thereby resolving questions about small primary studies with small ESs (Wolf, 1986). Consequently, there is increased conclusive evidence on which to base decisions.

Another advantage of meta-analysis is the capacity to synthesize results from individual studies. As noted earlier, meta-analysis brings together disparate research findings from primary studies and reconciles them, thus providing a means to generate definitive answers to complex issues (Gay, Mills, & Airasian, 2009; Rubin & Babbie, 2008). These answers can provide sound direction for making decisions regarding these issues, which is particularly important when limited funds exist to implement policies. Meta-analytical results can point to the best direction for allocating those funds.

Meta-analysis also can provide a means for identifying moderator variables. For example, suppose a researcher wants to examine the effectiveness of a particular training method. If the primary studies on that method have been conducted with different types of employees, the type of employee may have an effect on the results gained from that training method (e.g., administrative workers may benefit more from the training method than engineers do). A meta-analytical test for homogeneity can identify such moderating effects, thereby allowing the researcher to take moderating variables into consideration. Identifying moderator variables can suggest causal relationships in research findings and thus can enrich professionals' understanding of the literature (Rosenthal & DiMatteo, 2001). Also, in cases in which studies testing similar hypotheses have generated contradictory results, meta-analytical procedures can detect whether or not the differences in results are due to study artifacts (Hunter & Schmidt, 1990).

Disadvantages of Meta-Analysis Research

One of the disadvantages of meta-analysis is inherent in the meta-analytical process. That is, meta-analysis can only be used to synthesize quantitative results; qualitative findings cannot be included in a meta-analytical study. To address this limitation, *meta-ethnography*, a process that modifies both data collection and research standards to accommodate qualitative studies, has been proposed as an evolution of meta-analysis (Pielstick, 1998). However, meta-ethnography is not widely used, and the seminal texts (see Glass et al., 1981; Hunter & Schmidt, 1990; Rosenthal, 1984) that describe meta-analytical procedures do not address inclusion of qualitative studies.

Other major disadvantages and limitations of meta-analysis involve various forms of bias in addition to publication bias discussed earlier. For example, just as a researcher writing a traditional literature review can inflict bias through his or her choices of studies to include in the review, a meta-analyst can inflict bias by his or her choices of primary studies to be included in the meta-analysis (Rubin & Babbie, 2008). To combat this

form of sampling bias, it is important to have unambiguous criteria for inclusion and to include all studies meeting those criteria. However, including all studies that meet criteria can lead to further complications, such as magnification of study bias and practical problems related to the availability of primary studies (Gay, Mills, & Airasian, 2009).

Magnification of study bias occurs as a result of the improved statistical power associated with meta-analysis. Whereas ES in individual studies can be modest, the combined ESs generated by meta-analysis can be very powerful; any bias present in an individual study is magnified through meta-analytical procedures. Consequently, one should report any known potential biases, and strongly positive findings should be viewed conservatively to avoid an inflated sense of their significance (Moncrieff, 1998). Another option is to conduct a study effect meta-analysis. With this variation, the researcher uses strict standards for inclusion of studies, thereby excluding studies that do not meet acceptable research standards. Also, the effect size of each study receives the same weight in a study effect meta-analysis. These modifications can improve the reliability of findings, provided that the aforementioned problem of researcher bias in selection of studies does not surface (Bangert-Drowns & Rudner, 1991).

In addition to magnification of study bias, including all primary studies meeting inclusion criteria poses practical problems related to the availability of identified studies. One simply may not have access to all studies identified through a literature search, or obtaining all identified studies may prove to be too expensive. In cases in which not enough studies are available to conduct a meta-analysis, researchers may choose to use a variation of meta-analysis, such as expert opinion (Nijkamp & Pepping, 1998). Rather than gathering data from primary studies, researchers can gather data from field experts. Then, the data can be pooled, and a meta-analysis can be conducted.

Other practical problems involved in conducting a meta-analysis relate to technical capabilities. To conduct a meta-analysis, one will need an appropriate software program as well as the ability to run it. A person whose statistical experience consists of a single class in college most likely will not be able to conduct meta-analytical statistical procedures without further study, although he or she probably has a foundation. Thus, before conducting a meta-analysis, one should be willing to commit either to devoting time to learning how to run a meta-analytical statistical program or to locating an individual who can do so.

Criticisms of Meta-Analysis Research

Despite the inherent benefits to synthesizing literature on a research subject, many have criticized the process of meta-analysis research. Because the meta-analyst's goal is to include as many studies as possible, often strong research designs are combined with weaker research designs, yet results may be treated the same (Rubin & Babbie, 2008; Gay, Mills, & Airasian, 2009). To combat this, it is possible for the meta-analyst to statistically weight the results so that stronger studies receive higher ES than the weaker studies (Glass, 2006; Rubin & Babbie). However, again the question arises regarding researcher subjectivity when determining the strength of the studies.

Some critics also believe that meta-analysts should not compare studies that are too dissimilar. Glass (2006) refutes this "apples and oranges" argument, stating that "if two things are the same, they cannot be recognized as two things; they are one thing and there is no necessity to compare them" (p. 430). In essence, there would be no point in comparing studies that were identical, as the results would be exactly the same. Instead, as Glass further discusses, it is the job of meta-analysts to openly discuss the differences between and amongst studies "in quantitative ways that permit the statistical analysis of relationships,

central tendencies, and other interesting quantitative features" (p. 430).

CURRENT AND FUTURE TRENDS

Since its inception, meta-analysis has enjoyed increasing support from the educational and social science field. Despite its inherent disadvantages, it is an effective way of synthesizing a tremendous amount of research studies. Currently, as described by Glass (2006), the "Campbell Collaboration" has taken on the project of conducting "systematic reviews of research concerning the effects of social and educational policies and practices" using meta-analysis research (p. 437). These meta-analytical studies are published on the internet for public viewing, which shows signs of continuing to "serve as a model for research synthesis and dissemination in education and the social sciences for some time to come" (p. 437). Glass further discusses meta-analysis the only method currently available to understand the varying multitudes of research available on similar subjects. However, Glass notes that meta-analysis may hopefully one day be replaced by "archives of raw data that permit the construction of complex data landscapes that depict the relations among independent, dependent, and moderator variables" (p. 437). Until then, meta-analysis is the best format for fusing together the many complex research studies available, and as noted by Rubin and Babbie (2006), readers must interpret findings with care given the disadvantages and criticisms of this type of research.

CONCLUSION

Meta-analysis provides a means for synthesizing quantitative results from many studies. In doing so, it can help to make sense out of vastly different findings, thus enabling one to gain a clear direction for making decisions about complex issues. Although similar to other research methods in many ways, meta-analysis differs from other research methods in regard to the statistical procedures that are used (Brewer & Shapard, 2002). These procedures result in improved statistical power and can allow the researcher to detect moderator variables that have influenced results. However, meta-analytical results are subject to various forms of bias and can pose certain practical problems.

Meta-analysis has been used to study many issues in the administrator's scope of managing people. As examples, meta-analyses have been conducted on such topics as the relationship between participative decision making and job performance (Sagie, 1994), the effectiveness of realistic job previews (RJPs) for reducing job turnover (Meglino, Ravlin, & DeNisi, 2000), the effectiveness of RJPs in maximizing positive hiring outcomes and decreasing negative outcomes (Phillips, 1998), interrater and internal consistency reliability of selection interviews (Conway, Jako, & Goodman, 1995), correlations between supervisor and peer ratings for different dimensions of job performance (Viswesvaran, Schmidt, & Ones, 2002), the relationship between job performance and absenteeism (Bycio, 1992), and the relationship between job satisfaction and absenteeism (Scott & Taylor, 1985). From these meta-analytic results, HR professionals have gained knowledge and foresight for dealing with such issues as decision making processes, employee turnover, hiring decisions, interview procedures, performance reviews, job performance, absenteeism, and job satisfaction.

Other topics of interest to educational and organizational professionals undoubtedly would be appropriate for meta-analysis as well. I hope that this chapter will help administrators determine if meta-analysis is an appropriate tool for helping them to make decisions about challenges that they face. Even if they decide that meta-analysis is not appropriate for their particular situations, we believe—given the increasingly prevalent use of this research technique—that it will be crucial for

HR professionals to know how to interpret and to apply meta-analytical results if they are to survive on the forefront of change and innovation.

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KEY TERMS

Coding: A researcher includes factors that have had possible moderating effects on the study's results.

Criteria for Inclusion of Studies: General categories for study eligibility criteria include distinguishing features, research respondents, key variables, research designs, or time frame.

Effect Size (ES): A numerical way of expressing the strength or magnitude of a reported relationship.

Meta-Analysis: A quantitative technique for combining results of multiple studies with similar hypotheses to clarify findings.

Meta-Analysis Dependent Variables: Dependant variables are a study's empirical findings.

Meta-Analysis Independent Variables: Study characteristics can be thought of as the independent variable.

Problem Selection: An appropriate problem for meta-analysis balances the two extremes of enough has been written about it, but not too much.

Test For Homogeneity: Meta-analytical homogeneity tests include the Q statistic, credibility intervals, and chi-square tests for homogeneity.