Overview of Meta-Analysis

Definition of Meta-Analysis

- Meta-analysis is a term for a collection of techniques used to study quantitatively the direction and size of relationships between similar variables across studies, as well as to relate these results, called "effects," to characteristics of the research in which the results were found. (Schaffer)

Goal of Meta-Analysis

- The goal is to obtain statistically non-significant heterogeneity chi-squares -- that is, the possibility that the samples chosen to conduct the individual studies are not part of the same population
- Do they agree or disagree in terms of the direction of association and effect size? The meta-analyst is not averaging the findings but rather treating data from multiple studies as if they were all part of a single study (Schaffer)

Advantages

- meta-analysis examines both the direction and the magnitude of effects obtained in each study as well as the distribution of effects across studies. As a result, the meta-analyst can test explicitly the "groupwise" statistical significance of the set of study outcomes, a tactic not customarily employed in conventional reviews. (Durlak)
- Reduces likelihood of type ii error, failing to reject a false null hypothesis
- Quantitative coding of study characteristics permits a researcher to keep track of a large amount of potentially important information and then conduct a more detailed breakdown of this data than is easily managed using conventional review techniques (Durlak)
- by treating the review process itself as a type of research study, meta-analysis can make very explicit and visible the sample of studies selected, the aspects of the studies attended to, and the basis for the reviewer's claims about the outcomes and relations found (Durlak)

Disadvantages

- Not easy to understand or apply correctly to research questions, many research unfamiliar with technique
- Evolving research strategy, difficult to keep up with developments
- Regularly offer different findings and conclusions to typical reviews, sometimes different conclusions with similar meta-technique

Criticisms

- Inconsistencies in reporting research findings across studies, failing to provide enough detail on method and instrumentation to facilitate replication, and the multiplicity of different operational definitions or measures for the same concept all pose difficulties to successfully attempting any form of meta-analysis. (Saxton)
- Publication bias, studies with no or little significant findings not published
- Range restriction limits ability to compare results across studies
- Lack of noting missing cases effects significance level and effect size
- Lack of reliability in measurement and coding
- Different studies lumped together (apples and oranges)
- Little screening on the methodologies used in studies (poor methodologies weighted same as good)

Methodology

- Durlak laid out a comprehensive overview of the steps – other articles in close agreement
- Formulate Research Question
- Literature Search
- Coding Procedure
- Index of Effect
- Statistical Analysis
- Conclusion and Interpretation

Formulate Research Question

- (a) Are specific research questions, formal hypotheses or the major variables of importance made explicit? Do such formulations rest upon prior work in the area?
- (b) Is the literature to be reviewed fully defined? Does the definition capture the important literature in the field?

Literature Search

- (a) Is a representative and unbiased sample of studies identified?
- (b) Has potential publication bias been estimated by including a sample of unpublished
- studies?
- (c) Have several different methods of searching the literature been used?
- (d) Is the number of relevant but non-usable studies presented?
- (e) Is a fail-safe n calculated to assess the robustness of obtained findings vis-a-vis the likelihood that not all relevant studies have been obtained?
- (f) Are all the sampled studies listed or available from the author?

Coding Procedures

- (a) Are problems in coding procedures described?
- (b)Is the coding system available on request and does it contain criteria for coding
- potentially confusing study features?
- (c) Have proper estimations of interrater agreement been conducted and reported?
- Compare two independent groups on a outcome measure, assess degree of linear relationship between two variables, relationship between two dichotomies(Schafer)
- Two people code each to check for accuracy (Ankem)

Index of Effect

- (a) Has the pooled standard deviation been used to calculate individual effects in group difference meta-analyses?
- (b) Are all methods of calculating effect sizes described?
- (c) Is the procedure for dealing with "non-significant findings" made explicit? Is incidence of such findings made known? Are the implications of non-significant findings related to the conclusions and generalizations of the meta-analysis?
- (d) Are comparison groups described and coded, if appropriate?

Statistical Analysis

- (b) Are outliers identified and examined for their potential heuristic benefit?
- (c) Has an appropriate unit of analysis been used? Has one effect been calculated per construct per study per research question to avoid confounding important constructs in the analyses?
- (d) Are appropriate weighting procedures used throughout the analyses?
- (e) Has a systematic and defensible approach been taken toward analyzing differences in effect sizes?
- (f) Are *a priori* hypotheses used to explore obtained differences in effects across studies?
- (g) Is sufficient attention given to the potential influence of methodological features?
- (h) Has the meta-analyst proposed a statistical model that correctly specifies the obtained
- data?

Conclusion and Interpertation

- (a) Does the meta-analyst relate the issue of power to statistical findings?
- (b) Are conclusions restricted to the literature reviewed?
- (c) Is a table presented describing the characteristics of reviewed studies so that missing information in the reporting of certain important study features is apparent?
- (d)Are appropriate qualifications offered in line with the state of the research being reviewed?

So what do it look like in Practice?

- Example from Trahan
- Step 1: Formulate Research Question
- Question: Comparative effectiveness of computerized versus paper-based information retrieval systems.
- Methodology: Code the individual studies on the basis of their features and compute an effect size for each dependent variable of each study.

Trahan – Step 2 – Lit Reserach

- Search: Six major Databases searched Educational Resources Information Center (ERIC), Library and Information Science Abstracts (LISA), Information Science Ab-stracts (ISA), National Technical Information Service (NTIS), Library Literature, Dissertation Abstracts, and the "Online Information Re-trieval Annual Bibliography," which is published in Online Review.

Trahan – Stated Limitations

- Limitations: The study pool was limited to those works in which comparisons were made between computerized catalogs and card catalogs or between computer-ized bibliographic retrieval and searching printed indexes.
- Each study was required to report information on at least one of the following dependent variables: the recall of relevant material, the precision of the retrieval set, the time necessary to identify each relevant hit, and the costs involved in identifying each relevant hit.
- Reject many studies for reporting insufficient data. In order to be included, studies had to report one of the following forms of numerical results: means and standard deviations; recall or precision ratios, with the total number of relevant citations also reported; F, t, or x2 statistics; or data from which any of these could be computed or estimated. Studies were not rejected on the basis of the meta-analyst's perception of the quality of the research design.
- 25 studies met criteria

Trahan – Step 3 - Coding

- Coding: Each of these studies was then analyzed and coded for the following features: the geographic location, the year and mode of publication, the library type, the outcome variables, the statistics used to produce and report these outcomes, and search complexity.

Trahan – Step 4 – Index of Effect

- Not covered in the study

Trahan – Step 5 - Analysis

- Analysis: Effect sizes were computed for each dependent variable of each study

Trahan Step 6 - Results

- Results: These results show that the overall mean effect size seemed to favor slightly the paper-based systems. However, this result was not statistically significant. The average effect sizes on two of the individual variables were significant. On average, for the studies analyzed, the paper-based systems were slightly superior at producing relevant citations, and they produced a much more precise set of citations. There were no appreciable differences between the two systems on the variables of time/relevant citation and cost/relevant citation.

Trahan – Step 6 - Conclusion

- The first is that there was no correlation between the study publication date and the study effect size. There was also no significant difference between the study effect sizes Thus, neither of these variables can be used to explain the variability in the individual study findings.
- Studies that were published in alternate formats tended to be somewhat more negative than the effect sizes of studies published in journals.
- insignificant difference was detected on the variable of search complexity because it was impossible to determine the degree of search complexity.
- Indication that inclusion of low-quality studies that prevented statistical significance in the original analysis.
- This advantage was most apparent when the dependent variables were the number of relevant citations recalled and the precision of the recalled citations. The differences between the two types of systems were most apparent when the searching was relatively simple and when the system analyzed was a library catalog rather than a periodical index.

Closing Thought on Using Meta-Analysis

- "The reasons for the lack of use of meta-analysis in LIS may be attributed to the difficulty in accumulating results involving variables related to the same research problem across studies and the lack of appropriately measured variables related to the same research problem across studies so that the results can be combined meaningfully" (Ankem)
- "The distinctive features of meta-analysis compared to other review strategies are the quantitative representation of key research findings in the studies reviewed and the statistical analysis of the distribution of findings across studies and the relationship" (Durlak)

Bibliography

- Ankem, K. (2005). Approaches to meta-analysis: A guide for LIS researchers. *Library & Information Science Research (07408188), 27*(2), 164-176. .
- Chambers, E. A. (2004). An introduction to meta-analysis with articles from the journal of educational research (1992-2002). *The Journal of Educational Research (Washington, D.C.), 98*(1), 35-44.
- Durlak, J. A., & Lipsey, M. W. (1991). A practitioner's guide to meta-analysis. *American Journal of Community Psychology, 19*, 291-332.
- Schafer, W. D. (1999). An overview of meta-analysis. *Measurement and Evaluation in Counseling and Development, 32*(1), 43-61.
- Trahan, E. (1993). Applying meta-analysis to library and information science research. *Library Quarterly, 63*(1), 73-91.