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ABSTRACT

This paper highlights the relative strengths and weaknesses of the contemporary methods of research synthesis and proposes a multistage approach to research synthesis that draws on the strengths of each of these individual methods. In this approach, the decisions at every step of the synthesis process are guided by the nature of the data. The contemporary methods reviewed are: (1) narrative reviews of research; (2) meta-analysis; (3) best evidence synthesis; and (4) synthesis of qualitative research. A key assertion of this paper is that the process of synthesizing research should be inductive and interpretive rather than a rigid set of procedures and techniques. The proposed multistage approach begins with conceptual, rather than methodological, criteria for inclusion of individual studies. Open coding and the categorization of studies into sets and subsets follows, with the synthesis process remaining dialectical and hermeneutic at each stage. Whatever the techniques chosen for the qualitative synthesis, the process of research synthesis should be inductive, interpretive, dialectic, and hermeneutic. (Contains 31 references.) (SLD)

Revisiting Methods of Literature Synthesis

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Introduction

A single study can rarely provide a generalisable and definitive answer to a research question focussed within the social sciences (Cooper, 1989; Hunter, Schmidt & Jackson, 1982; McGaw, 1997). Results of a single study are frequently influenced by sampling characteristics such as the sample population, study setting, and timing. The research environment is often difficult to control and human behaviour complex to explain (Wolf, 1986). In many areas, particularly Education, economic constraints may restrict the scale of any single study (Draper et al., 1992). As a consequence, the comprehensive investigation of an area, such as internet-based courses, may require the combination of results from several individual studies.

More causal factors of a particular effect are likely to be detected by a research synthesis than by a single study (Cook et al., 1992). Often different individual studies provide conflicting results which can have confusing implications (Wolf, 1986). Knowledge in the social sciences, therefore, should progress by recognising the generalisable trends and underlying principles across a large body of empirical studies (Niemi, 1986). Synthesis of primary research is also important to transmit the accumulated knowledge to lay persons and to determine the direction of subsequent research, policies and practice (Cooper & Rosenthal, 1980; Sandelowski, Docherty & Emden, 1997).

Research review plays an important role in dissemination of knowledge and in shaping further research and practice. Therefore the methodology of research synthesis is crucial (Glass, McGaw & Smith, 1981; Dunkin, 1996). Contemporary methods of research synthesis include traditional narrative reviews, meta-analyses, best-evidence syntheses and methods of synthesising qualitative research. When rigidly followed, none of these contemporary methods can comprehensively review research in any specific area of interest. This paper will highlight the relative strengths and weaknesses of the contemporary methods of research synthesis and propose a multi-stage approach to research synthesis that draws on the strengths of each of these individual methods. In this approach, the decisions at every step of the synthesis process will be guided by the nature of the data.

A Critique of Contemporary Methods of Research Synthesis

Traditional Narrative Reviews of Research

Traditional literature reviews are often narrative reports of an intuitive aggregate of individual research findings (Johnson, 1989). Good traditional narrative reviews can synthesise individual research studies, both quantitative studies and qualitative studies, into a conceptually meaningful product. These reviews are flexible in their methodology and can be undertaken effectively by an experienced research reviewer. But this flexibility can be associated with a high level of subjectivity that may explain inconsistencies in the conclusions of different reviews on the same issue. The criteria for the inclusion of particular studies in a narrative review have not always been made sufficiently clear which makes it difficult for the reader to fully appreciate the effect of the reviewer's theoretical position on the review's findings. Different primary research studies may use different methodologies and precision levels, which in turn are handled differently by different reviewers (McGaw, 1997).

Traditional narrative reviews are often inconclusive, especially when the review includes several individual findings supporting conflicting hypotheses or contradictory narratives. Therefore, when compared to statistical procedures, traditional narrative reviews are more inclined to have type II errors (Cooper & Rosenthal, 1980). These reviews usually ignore unpublished research, which in turn, introduces a publication bias (Glass, McGaw & Smith, 1981). Thus, at times different traditional reviews may even consistently misrepresent the literature: by failing to diagnose a significant effect size or by being biased in favour of published research (Wolf, 1986). Sometimes these reviews use a "voting method" to determine if an effect exists. In a voting method, all the findings are divided into three categories: those with statistically significant results in one direction; those with statistically significant results in the opposite direction; and those with statistically insignificant results. This method tends to give equal weight to studies with different sample sizes and effect sizes at varying significance levels, resulting in misleading conclusions. No matter what conclusion is reached, a major problem remains to determine the size of the effect (Abrami, Chambers, Poulsen, De Simone, d'Apollonia & Howden, 1995; Hunter, Schmidt & Jackson, 1982). Further, these methods often fail to identify the variables, or study characteristics, that could moderate the effect (McGaw, 1997).

Meta-analysis

Glass (1976) argued that variability and uncertainty of data in research synthesis are as evident as in the data analysis of primary research. Hence research synthesis requires the same statistical rigour as is demanded in the data analysis of an empirical study. With these views in mind, he proposed a statistical method of research integration that he called "meta-analysis". Meta-analysis is the quantitative integration and analysis of the findings from all the empirical studies relevant to an issue and amenable to quantitative aggregation. It not only quantifies the effect of a treatment, but also identifies potential moderator variables of the effect. In a meta-analysis, findings from different studies are expressed in terms of a common metric called the effect size. In general, the effect size is the difference between the means of the experimental and control conditions divided by the standard deviation (Glass, 1976; Wolf, 1986).

Meta-analysis has several advantages over traditional narrative review. It not only shows the direction of the effect of a treatment, but also quantifies the effect and identifies the moderator variables. It includes all the quantitative empirical studies relevant to the research question and should be free from the subjectivity introduced by selective sampling. The criteria used for selecting the findings included in the synthesis are explicitly stated to remove any unstated ambiguity (Hunter, Schmidt & Jackson, 1982). Meta-analysis can provide a general conclusive answer to a question (Glass, McGaw & Smith, 1981). It is sufficiently robust to deal with a large number of empirical studies (McGaw, 1997).

However, meta-analyses are not free from criticisms. They can overgeneralise, include results from poorly designed studies, be biased in favour of published research in comparison to unpublished research, give more weight to studies with multiple results and ignore studies for which the effect size cannot be computed. In particular, qualitative studies are inevitably excluded from such research syntheses (Slavin, 1986).

Best-evidence Synthesis

To overcome the limitations of the methods of traditional narrative review and meta-analysis Slavin (1986) proposed the method of "best-evidence synthesis" which, in theory, draws on the strengths of the methods of traditional narrative review as well as meta-analysis. According to Slavin, best-evidence syntheses incorporate the statistical rigour of meta-analyses to synthesise quantitative findings together with the flexibility of traditional narrative reviews. The method is

freed from unacknowledged subjectivity by including well-justified and well-described inclusion criteria for empirical studies (Slavin, 1986).

The method of best-evidence synthesis does not prescribe a rigid set of criteria for selecting the empirical studies. Like traditional narrative reviews, best-evidence syntheses allow for the individual differences in priorities from review to review. Like meta-analyses, best-evidence syntheses explicitly state the criteria for including or excluding the individual research reports. Best-evidence syntheses do not exclude all the studies for which computation of the effect size is not possible. Unlike meta-analyses, best-evidence syntheses are not limited to statistical aggregation and analysis of only quantitative findings from individual studies. In this method, statistical analysis is supplemented with a rich literature review which explains any discrepancies observed and summarises the results which cannot be quantified (Slavin, 1986).

A closer inspection of best-evidence syntheses reveals some major differences in the meta-analytic aspect of Slavin's method and the contemporarily acceptable meta-analytic procedures. For instance, unlike meta-analyses, best-evidence syntheses take the median effect size rather than the appropriately weighted mean effect size as the pooled effect size (Slavin, 1986; Veenman, 1995). While Slavin's modifications are rarely referenced in the meta-analytic literature, contemporary meta-analytic procedures have undergone rigorous criticisms and modifications, as evident in the vast literature on different aspects of meta-analysis. Slavin's method also fails to provide guidelines for systematic and rigorous methods of synthesising qualitative research.

Synthesis of Qualitative Research

Qualitative researchers argue that synthesis of qualitative research should be interpretive rather than aggregative. While preserving the integrity and holism of individual studies, inductive and interpretive techniques should be used to sufficiently summarise the findings of individual studies into a product of practical value (Jensen & Allen, 1996; Noblit & Hare, 1988; Sandelowski, 1997; Sandelowski, Docherty, & Emden, 1997).

According to Jensen and Allen (1996), an interpretive synthesis is essentially a reciprocal translation of key metaphors of each study in terms of the key metaphors of other studies (described in next section). Hence, they argue that an interpretive synthesis should include studies that use similar methodologies only. However, reciprocal translational synthesis is only one of the possible types of interpretive synthesis. "Refutational" synthesis and "lines of argument" synthesis are two other forms of interpretive synthesis advocated by Noblit & Hare (1988) (described in next section). The criteria for inclusion of individual studies should be based on conceptual considerations rather than only methodological considerations (Noblit & Hare, 1988; Sandelowski, Docherty & Emden, 1997).

The purpose of an interpretive synthesis of qualitative research is not to generate predictive theories, but to facilitate a fuller understanding of the phenomenon, context or culture under consideration (Jensen & Allen, 1996; Sandelowski, 1997). It is our contention that policy making should be informed not only by quantitative research findings, but also qualitative research findings.

Principal Argument of This Paper

Traditional narrative reviews, meta-analyses, best-evidence syntheses, and qualitative research syntheses have their own strengths and weaknesses. This paper argues that a comprehensive research synthesis should include quantitative as well as qualitative research findings. A key assertion of this paper is that the process of synthesising research should be inductive and interpretive rather than a rigid set of procedures and techniques.

A Multi-Stage Approach of Synthesising Quantitative and Qualitative Findings

Several criticisms of each of the above mentioned methods of synthesis are not specific to traditional narrative reviews, meta-analyses, best-evidence syntheses or interpretive syntheses per se, but can be generalised to every research synthesis method (McGaw, 1997; Sandelowski, 1997). Likewise, issues of rigour at various stages of synthesis are often similar across different methods of research synthesis. Instead of arbitrarily excluding any body of literature because of its methodological paradigm, a good research synthesis should comprehensively include qualitative as well as quantitative findings. The quantitative and qualitative approaches should be complementary rather than adversarial.

In educational research, the researcher often does not have control over all the variables. Leinhardt and Leinhardt (1997), therefore, emphasise the importance of exploratory data analysis. They urge educational researchers to immerse themselves in their data and let the procedures for analysis be guided by the nature of the data, before performing inferential statistics.

This paper argues that a similar inductive approach is required not only in the preliminary data analysis of primary research, but also in the synthesis of results from individual primary research studies. The notion of inductive analysis is not exclusive to the synthesis of qualitative findings. The approach is equally applicable in the meta-analytic synthesis of quantitative findings where the selection of particular statistical techniques for data analysis should be determined by the nature of the data, rather than any rigidly prescribed rules. For example, the spread of individual effect sizes should be examined before deciding whether to use parametric or non-parametric tests for statistical analyses (McGaw, 1997). Consistent with the spirit of exploratory data analysis, the preliminary data analysis may also be enriched through the use of graphs and visual displays of data (Light & Pillemer, 1984). *Figure 1* illustrates a schematic diagram of the multi-stage approach of research synthesis as proposed in this paper.

Inclusion Criteria

The criteria for inclusion of individual studies should be conceptual. Good research studies should not be excluded just because they do not follow a particular methodological paradigm. All the individual primary research studies relevant to the particular context, concept, culture, or strategy under examination should be included in the synthesis.

Open Coding and Categorisation of Studies into Sets and Subsets

Each selected report should first be coded using an open coding scheme for substantive variables, the nature of reported data, and the findings relevant to the purpose of research synthesis. These reports should then be categorised into sets with similar research focuses. Studies within each set should further be categorised into subsets using similar methodological paradigms. Findings within each subset should be synthesised using meta-analytic, aggregative, or reciprocal translational methods of synthesis. Synthesis results of each subset should be synthesised across the subsets within each set. Synthesis results of each set should then be synthesised across the sets using an inductive and interpretive approach. At every level the relationship between the studies within a group should decide the nature of the synthesis process and the synthesis product at that level.

Dialectical and Hermeneutic Approach

At each stage, the synthesis process should be dialectical and hermeneutic (Jensen & Allen, 1996) as illustrated in *Figure 2*. Let Set 1 be a collection of studies that investigates the relative preferences of students enrolled in online courses for teacher control versus student control. Within this set, let there be three subsets. Subset 1.1 is a collection of quantitative findings that can be synthesised using meta-analytic procedures, Subset 1.2 includes qualitative findings from

Figure 1: Schematic diagram of the multi-stage approach proposed in this paper

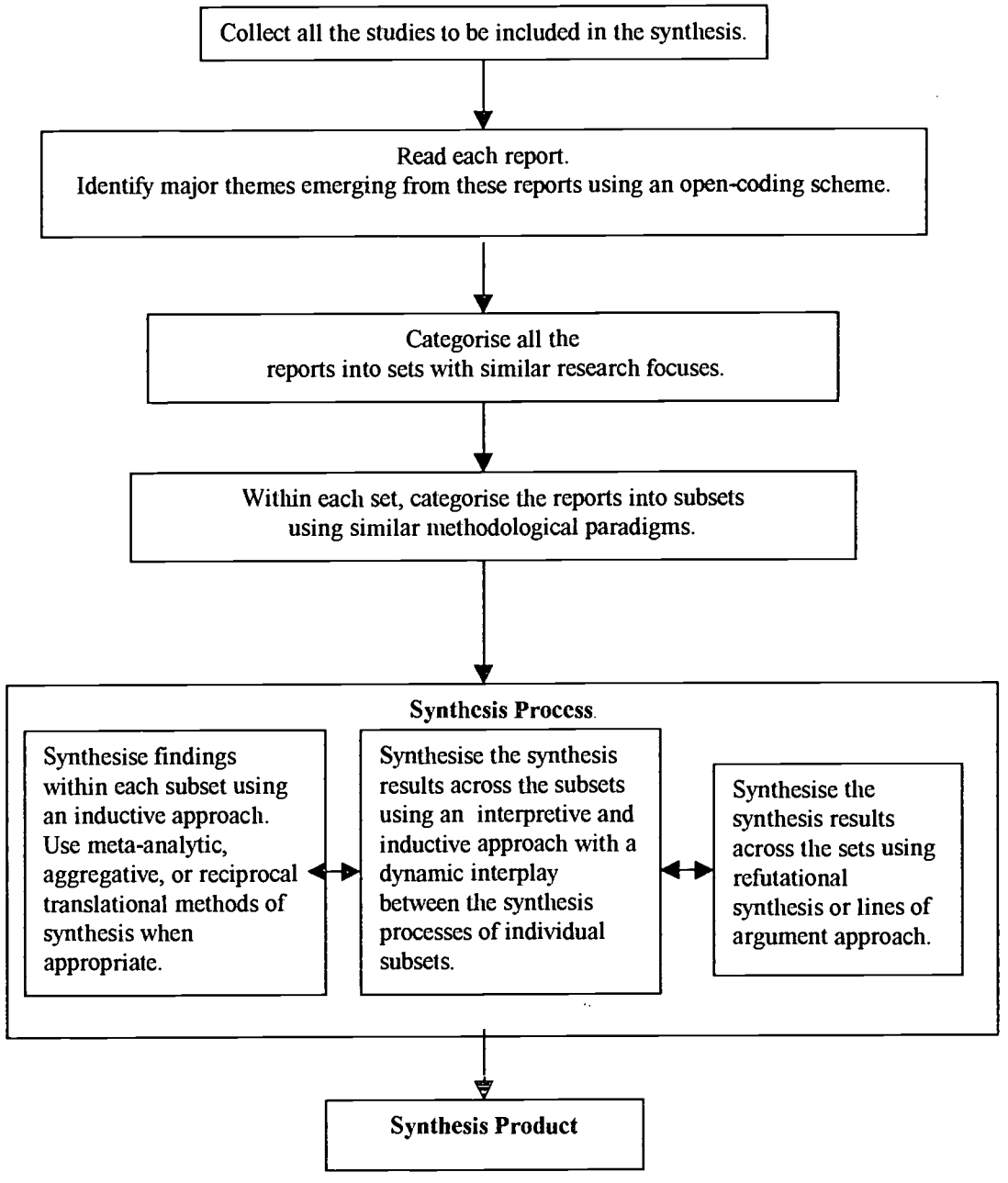
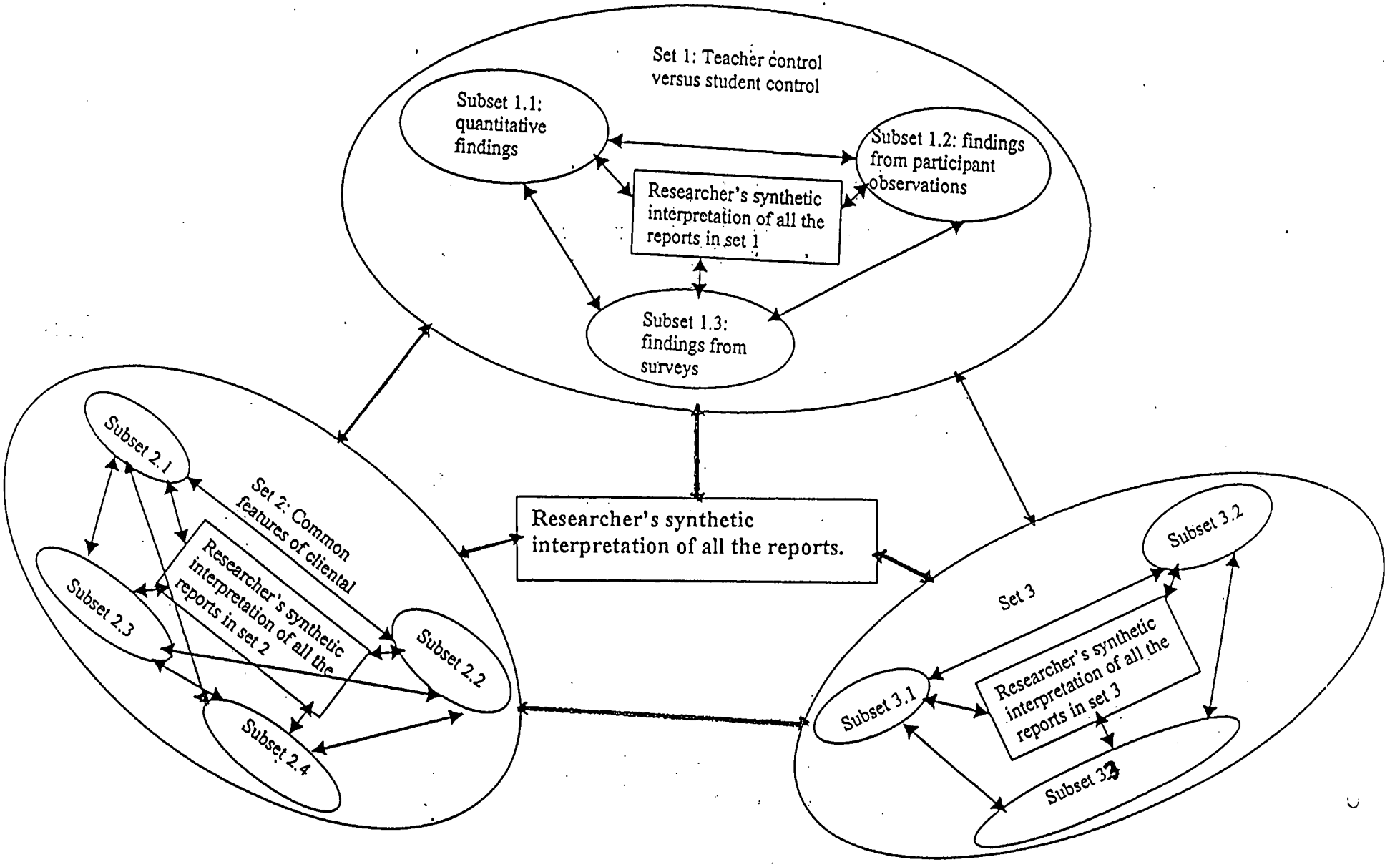


Figure 2: Dialectical and Hermeneutic Synthetic Process



participant observations and Subset 1.3 includes findings from open-ended surveys conducted on students. In this case, synthesis of findings within individual subsets could be influenced by the synthesis results of other subsets. For instance, synthesis results from participant observations of Subset 1.2 could explain the contradictions in the quantitative findings from individual studies in Subset 1.1. Synthesis results of survey findings from Subset 1.3 may facilitate the synthesis process of findings from participant observations of Subset 1.2 by providing possible explanations for differences in key findings from different narratives. Researcher's synthetic interpretation of all the reports in Set 1 is the synthesis product of the synthesis products of individual Subsets within the Set 1. This synthetic interpretation may further modify the synthesis products of individual subsets, which in turn, may influence the synthesis product of the set. Thus, the synthesis process at this stage is dialectical rather than sequential.

This dialectical approach should be followed even when synthesising the findings across individual sets. For example, let Set 2 be a collection of studies that examine common features of the students enrolled in online courses. Synthesis product of Set 1 may indicate that online students prefer more student control, rather than teacher control, in their online learning experiences. A closer examination of the demographic features of the online learners from the findings of Set 2 may further suggest that a majority of online learners are mature-age individuals who are working full-time and have to constantly meet the demands made by their professional lives. This could provide a possible explanation to the synthesis results of the Set 1. Researcher's synthetic interpretation of all the reports is the synthesis product of the synthesis products of findings within individual sets. The synthesis process at this stage should also be dialectic and hermeneutic.

Qualitative Synthesis

The challenge in synthesising qualitative research lies in summarising the reports in a usable format, while preserving the integrity and holism of individual reports (Jensen & Allen, 1996; Noblit & Hare, 1988; Sandelowski, 1997; Sandelowski, Docherty, & Emden, 1997). The synthesis of qualitative findings should be inductive, hermeneutic and eclectic process at every stage where the nature of the synthesis product should be guided by the question under consideration and the relationships between the findings and methodological positioning of individual reports. The following sub-sections illustrate some of the techniques that could be used in the synthesis process.

Content Analysis of themes

Content analysis of themes could be used to identify the major questions that have been addressed in the research literature available on a particular field of interest. Content analysis is a technique for systematic and quantitative analysis of the manifest content of communication to make valid and replicable inferences. In this method, first of all a decision is made about the unit of analysis. This unit can be a string of text or a theme (Anderson, 1997; Tesch, 1990). As the purpose of a research synthesis is unlikely to be a semiotic investigation, the unit of analysis could be key themes or findings emerging from the data. Various categories, major themes in case of a research synthesis, should be identified as they emerge from the data. These categories should then be operationally defined such that they are mutually exclusive. Using frequency counts of the occurrences of individual categories, the research synthesist can identify the areas of research that have been thoroughly examined and those areas that need further examination.

Phenomenography

Phenomenography is a systematic method of examining the various ways in which people perceive, understand, experience, or conceptualise a particular phenomenon (Marton & Chaiklin, 1994; Marton, 1997). The main assumptions underlying a phenomenographic study are that:

* There are a limited number of qualitatively different ways in which any phenomenon is conceptualised by different individuals. The conceptions of different individuals about the same phenomenon can therefore be classified into a finite number of "categories of description".
* The categories thus formed can frequently be logically related in a hierarchical structure referred to as "outcome space".

Although most phenomenographic studies use interview data, sometimes other forms of data, such as documents, observations, written responses, can also lend themselves to a phenomenographic study. In a research synthesis, sections of research papers that address the conceptions of a particular phenomenon among the informants could be treated as responses to open-ended questions and could be subjected to a phenomenographic analysis.

The analysis of data in a phenomenographic study begins with decontextualisation. The boundaries of individual responses are removed and the entire data set is classified into categories by looking for similarities and contrasts. This data is then put back into context to identify the relation between various responses within the same category. These categories are further examined to find the logical relationships between individual categories and study continuous variations across categories.

Reciprocal Translational Synthesis

To synthesise reports within a subset of similar findings and methodological paradigms, "reciprocal translational synthesis" (Noblit & Hare, 1988) could be used. This method assumes that the individual reports are addressing similar issues and can be integrated. To begin with, the key metaphors, themes, perspectives, or concepts emerging from individual reports that can capture the essence of that report in a reduced form are identified. The findings of each report are then tested for their abilities to translate the findings of other reports. Thus we select those terms or findings that can more succinctly describe the findings of all the reports within the subset. At times, the terms employed in individual reports may not be suitable to portray concisely all the reports. In those cases, new terms could be introduced that adequately describe the major findings from all the reports.

Refutational Synthesis

When individual reports give conflicting representations of the same phenomenon, they are not amenable to a reciprocal translational synthesis. These reports lend themselves to a "refutational synthesis" (Noblit & Hare, 1988) where the relationship between individual studies and the refutations become the focus of synthesis process. This process begins with the identification of key findings of individual reports followed by an examination of the relationships between individual reports. The contradictions between individual reports may be explicit or implicit. The implicit refutations are made explicit using an interpretive approach. New metaphors are created to explain the key refutations. These metaphors are then used to explain the contradictions between other reports.

Lines-of-argument Synthesis

At some level, if the individual reports examine different aspects of the same phenomenon, "lines-of-argument" synthesis method (Noblit & Hare, 1988) could be used. The main purpose of a "lines-of-argument" synthesis is to make inferences. In this method, findings from individual reports are used as pixels to get a fuller picture of the phenomenon at hand. The method involves a grounded theory approach for open-coding and identifying the categories emerging from the data. The key categories that are more powerful in representing the entire data-set are identified by constant comparisons between individual accounts. These categories are then linked interpretively to create a holistic account of the whole phenomenon.

Quantitative Synthesis

The quantitative findings could be synthesised using meta-analytic procedures. The methods of meta-analytic synthesis have been well established. *The Handbook of Research Synthesis* (Cooper & Hedges, 1994) is a particularly good collection of contributions from experts in the field of meta-analysis that comprehensively deals with different aspects of meta-analysis. Following are the main stages of the process of meta-analysis.

Identifying and Coding the Variables

A coding sheet is developed to record the demographic and substantive variables and key findings of individual reports. Each report is then closely examined to fill in the relevant information in the coding form. The next subsection describes the procedure for calculating an Effect Size to quantify individual findings on a common metric.

Calculating the Effect Sizes for Individual Studies

Effect size is the measure of the magnitude of the effect of an independent variable on the dependent variable or a measure of the relationship between two variables (Rosenthal, 1994). In Education, we often use the standardised difference between the means of the experimental group and the control group as a measure of the effect size.

Algebraically

$(M_e - M_c) / SD$

where M_e is the mean of the experimental group, M_c is the mean of the control group and SD is the standard deviation (Glass, McGaw & Smith, 1981). The effect sizes calculated thus, referred to as g-statistics, often give biased estimation of population effect size, especially for studies with small samples (Hedges & Olkin, 1985). To remove this bias, each g-statistic should be converted to the metric termed d-statistic. The d-statistic can be computed from the g-statistic using the following formula:

$d = J(N-2)g$ where $J(m) = 1 - \frac{3}{4m-1}$ and m is an integer.

Rosenthal (1994) and Fleiss (1994) provide a detailed discussion of the applications of different formulae for effect sizes and the formulae for transformations between different representations of the effect size

Computation of a Composite Effect Size

To provide an estimate of the central tendency of the individual effect sizes, a composite effect size is computed. This could be the median of individual effect sizes, the median of appropriately weighted effect sizes, mean individual effect sizes or the mean of appropriately weighted effect sizes. The decision to use a particular measure of central tendency should take into consideration several factors such as the nature of the spread of the individual effect sizes or the purpose of research synthesis.

Homogeneity Analysis

The pooled effect size is not treated as a conclusive result on the subject. An attempt is made to explain any marked differences between the pooled effect size and those of the individual studies (Slavin, 1986; Hedges & Olkin, 1985). Study outcomes within each category are analysed for homogeneity to determine if a single effect size is a good representation of the individual studies (Mullen & Rosenthal, 1985; Hedges & Olkin, 1985; Johnson, 1989).

Within each category the homogeneity statistic between the studies (Q_B) is estimated. Q_B is assumed to have an approximate chi-square distribution with $m-1$ degrees of freedom, where m is the number of studies within each category. A non-significant value of Q_B indicates that the outcomes are consistent across the studies. In these cases the composite effect size is taken as a conclusive result (Mullen & Rosenthal, 1985; Hedges & Olkin, 1985; Johnson, 1989).

However, often the Q_B value is significant which indicates a considerable inconsistency in the study findings. In these cases, the composite effect size does not adequately describe the studies since the magnitudes and perhaps the directions of their findings are very different from each other. Further analysis is carried out for these studies to account for the differences in outcomes. First, an outlier diagnosis is used to isolate the studies with significantly different outcomes from the composite effect size (Hedges & Olkin, 1985; Johnson, 1989). Following this isolation, the remaining studies are subjected to categorical model testing to identify the potential moderator variables of the effect. The next section describes outlier diagnosis and categorical model testing in detail.

Outlier Diagnosis

At this stage of analysis, the study that reduces the homogeneity statistic, Q_B, by the largest amount is identified. If the methodology of the outlier markedly differs from the remaining studies, then the outlier will be isolated and the difference noted. Once again the remaining studies are subjected to an outlier diagnosis. This isolation procedure is carried on until major differences are observed in the methodology and aims of the isolated studies from the remaining studies (Johnson, 1989). This preliminary outlier diagnosis is frequently followed by categorical model testing to explain the remaining heterogeneity between the findings of individual studies.

Categorical Model Testing

Categorical model testing, which is analogous to analysis of variance (ANOVA), is used to account for the heterogeneity of outcomes of different studies. To begin with, the studies are divided into subgroups based on a study characteristic. Within each class, composite effect size and within group homogeneity statistic, Q_W, are estimated. Q_W is assumed to have an approximate chi-square distribution with $k-1$ degrees of freedom, where k is the number of studies within each subgroup. A non-significant Q_W value indicates consistency of outcomes within a class. Along with the within group homogeneity statistic (Q_W), the between group homogeneity statistic (Q_B) is also estimated. A significant Q_B indicates that the study characteristic under consideration significantly moderates the effect size (Hedges & Olkin, 1985; Johnson, 1989).

Dynamic Interplay between Synthesis of Quantitative and Qualitative Findings

At every stage of the synthesis, the process of synthesising qualitative findings should be guided by the synthesis results of quantitative findings and vice-versa. For instance, synthesis results of qualitative findings should be used to prepare the coding-sheets for meta-analytic procedures for the identification of potential moderator variables of the effect size. The results of qualitative synthesis should be tested quantitatively using meta-analytic procedures. Likewise, results of meta-analytic procedures should be used to explain the qualitative findings. This dynamic interplay between the synthesis of quantitative and qualitative findings should facilitate a better understanding of the phenomenon and also increase the level of confidence in the synthesis results.

Summary

As research reviews play an important role in the dissemination of knowledge and in shaping future research and practice, the methodology of research synthesis is crucial. This paper

argues that a comprehensive research synthesis should include both quantitative and qualitative research findings. The process of research synthesis should be inductive, interpretive, dialectic and hermeneutic.

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