

### Details of Module and its structure

Module Detail	
<b>Subject Name</b>	Education
<b>Paper Name</b>	Perspectives and Issues and Research in Teacher Education
<b>Module Name/Title</b>	Synthesizing Research
<b>Module Id</b>	e-PGEDN 10.13
<b>Pre-requisites</b>	Awareness of collating research, narrative and vote counting methods of research
<b>Objectives</b>	<p>After going through this topic the learners will be able to:</p> <ul style="list-style-type: none"> <li>• discuss following methods of synthesizing educational research - Narrative method, Vote counting method, Combine significance method, and Meta-analysis method</li> <li>• discuss concept of research trend analysis</li> </ul>
<b>Keywords</b>	central tendency, variability, pooled standard deviation, effects size

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## 1. Conceptual Background

A single study can rarely provide a generalizable and definitive answer to a research question focused within the social sciences, especially in the discipline known as Education (Cooper, 1989; Hunter, Schmidt & Jackson, 1982; Mc Gaw, 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 behavior complex to explain. In many areas, particularly Education, economic constraints may restrict the scale of any single study. As a consequence, the comprehensive investigation of an area, such as numeracy, may require the combination of results from several individual studies. At the same time, researches done in the field of education are scattered, piece-meal, isolated and thus inconclusive (Mohanty, 2008); Kaul (2006); (Ballad & Bawa, 2003); Gupta (2003); (Sekar, 2008). The individual researches are like the individual reality which is always less, at par, with that of the comprehensive reality. Is there any consistency in these various singleton study findings? Are these individual researches really converges somewhere or these remain stand-alone? How the contradictory results will be resolved lies there among the various studies findings responding to same research question? Are philosophical research studies can be synthesized? What are the methods to synthesizing research outcomes of empirical studies? The present paper tries to focuses on the issue of individualistic research versus the wholistic reality. What can be methods/tools to synthesize these piecemeal researches into a comprehensive truth to arrive at some conclusion? The paper discusses at length some of the methods like Research Trend/Synthesis, Narrative Reflective, Vote Counting, Combined Significant Testing, Effect Magnitude (Meta Analysis), Best-evidence syntheses for synthesizing the research findings. This paper highlights the relative strengths and weaknesses of the contemporary Methods of Research Trend/Synthesis and proposes a multi-stage approach to Research Trend/Synthesis that draws on the strengths of each of these individual methods. At the same time the various statistical techniques of Meta-analysis is also focused in the paper.

## 2. Research Synthesis: Concept and Meaning, Importance and Different Methods

As John Ralston Saul, a famous author, well said, "With the past, we can see trajectories into the future - both catastrophic and creative projections." The quotation points out the relevance of the information in hand. In Research Trend/Synthesis the things are done in the same manner. The term 'synthesis' having the lateral meaning of as "A new unified whole resulting from the combination of different ideas, influences, or objects" or "...Result of combination" and "...the process of combining different ideas, influences, or objects into a new whole." The term is differently used in different areas. The lateral meaning of Research Trend/Synthesis is the practice of collecting information and attempting to spot a pattern in the information. The Oxford Thesaurus (2010) in financial terms, defines Research Trend/Synthesis as "...a comparative analysis of a company's financial ratios over time." Research Trend/Synthesis tries to predict a trend like a bull market run and ride that trend until data suggests a trend reversal (e.g. bull to bear market). Research Trend/Synthesis is helpful because moving with trends, and not against them, will lead to profit for an investor. An aspect of technical analysis that tries to predict the future movement of a stock based on past data. Research Trend/Synthesis is based on the idea that what has happened in the past gives traders an idea of what will happen in the future. In Project Management Research Trend/Synthesis is a mathematical technique that uses historical results to predict future outcome. In Statistics, Research Trend/Synthesis often refers to techniques for extracting an underlying pattern of behavior in a time series which would otherwise be partly or nearly completely hidden by noise. A simple description of these techniques is trend estimation, which can be undertaken within a formal regression analysis. In recent times, Research Trend/Synthesis often refers to the science of studying changes in social patterns, including fashion, technology and consumer behavior. Research Synthesis is "Using the results of several studies to drive generalizations and conclusive statements about the theoretical relationship among variables." Thus, Research Trend/Synthesis is a form of comparative analysis that is often employed to identify current and future movements of events or group of events. The process may involve comparing past and current status as they related to various entities in order to project how long the current trend will continue. This type of information is extremely helpful to persons who wish to make the most from the information of the events. Glass (1978), Pillemer (1980), Cooper (1982) research synthesis is characterized by

- Pulling together the existing evidences which is known as discovery
- Integration of research studies requires conscious mind.
- A method as an area of serious inquiry
- Quantitative research synthesis methods to proceed independently

### **Importance of the Research Trend/Synthesis**

Analysis, followed by the synthesis, is an essential activity in social sciences. The reasons for this are various. It mainly emphasized on threefold aspects

- To summarize the findings across studies
- To maintain the consistency of findings
- To resolve contradictory findings

### **Importance of Research Trend/Synthesis synthesizing deals with**

- Accumulation of the knowledge
- Importance of maintaining high standards in their execution according to the findings
- Resolving the conflicting findings to give it a new shape
- Helps in characterizing the methodologies used in the field of inquiry
- Helps in finding out the new methods

### **The process of a Research Trend/Synthesis**

It begins with identifying the category of the events that are under consideration. Once the focus is established, one takes a long at the general performance for the category over the last couple of years. This helps to identify key factors that led to the current trend of performance for the entity under consideration. By understanding how a given event reached the current level of performance, it is then possible to determine if all or most of those factors are still exerting an influence. After identifying past and present factors that are maintaining a current trend in performance, one can analyze each factor and project which factors are likely to continue exerting influence on the direction of the event. Assuming that all or most of the factors will continue to exert an influence for the foreseeable future, one can make an informed decision on the future course of action. So Research Trend/Synthesis is important both in it as a scientific

activity & of the practical uses made of the conclusions which are derived from research trend synthesis. The process of the trend analyzing the educational research can be systematically done with using the following Methods like Narrative method, Vote counting method, Combine significance method, and Meta analysis method.

### **A. Narrative approach**

As the name indicates, it is a verbal description of the research studies arranged chronologically about what the researcher did in each study & the results found. It is most suitable when the number of the studies on a topic is small. The strength of the narrative approach is

- It provides richness of the details about the study characteristics
- Allows the researches to trace the evolution of thought because of the chronological arrangement.
- It can be used to synthesize two or more different lines of research that may bear only indirectly on each other.

### **Summarizing results across the studies**

Narrative approach relies heavily on the statistical significance and reported results of the individual. The statistical technique portrayed for the research result is a highly subjective matter. The subjectivity in summarizing the findings inherent in narrative approach can lead in different conclusions.

### **Assessing the results across studies**

Narratives approach provides no significant mechanism for assessing the consistency of the results other than a verbal description.

### **Resolving contradictory findings across studies**

There is no systematic mechanism for resolving contradictory findings. Narrative approach is always susceptible to the confusion between research criticism and research integration.

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## **Limitations**

The sample of studies examined in a narrative review is based on the author's whim, rather than on publicly shared standards. Narrative reviews lack acceptable rules of inference for going from the findings of studies to overall generalizations about the research literature. Narrative reviews are not well-suited for analyzing the impact of moderating variables. Authors of narrative reviews rarely reach clear conclusions regarding how methodological variations influence the strength of an effect. They also typically fail to report the rules they use to classify studies when looking for the effect of a moderating variable.

### **B. Vote counting method**

It is the most popular and is supplanted from narrative method, when there are a larger number of the studies. It involves categorizing the studies on the basis of the direction and statistical significance. The strength of vote counting method is:

- Once the relevant set of studies to be synthesized has been identified, the method can be executed quickly.
- Results of vote counting are replicable because it is less subjective.

The intrinsic role that vote counting method play are:

#### **Summarizing results across the studies:**

It is a straight forward process and the category into which the statistical results of the most studies fall in described as the treatment effects or the relationship between variables.

#### **Assessing the consistency of results across studies:**

It assumes that there will be inconsistency in findings across studies & the objective is to identify which statistical result among the set of inconsistent findings is most prevalent. Thus, vote counting methods provides no systematic mechanisms for assessing the consistency of results.

#### **Resolving contradictory findings across studies;**

It does not attempt to resolve contradictory findings across the studies but contradictory findings are likely to exist. The researchers have not used such approaches to resolve the contradictory findings in any consistent or systematic way.

### **C. Combined significant tests**

This method involves the combining of probabilities or common test of significance statistics across several studies addressing the same research questions & assessing the statistical significance of this over all values. This method was introduced because of the inadequacy of voting method. The main importance of combined significance method is that they help to eliminate the low treatment effect of vote counting method. Rosenthal (1978) provided an excellent description of the procedures, advantages, limitations and applicability of nine combined significance tests Adding logs; Adding 'P's ;Adding 't' s; Adding 'Z' s; Adding weighted 'Z' s ;Testing mean 'p'; Testing mean Z; Counting and Blocking. This is highly significant method but it does not have any mechanism explaining the variability of results across studies.

### **D. Effect magnitude Method**

Meta-analysis is a research synthesis that uses a quantitative measure, effect size, to indicate the strength of relationship between the treatments and dependent measures of studies making up that synthesis. Glass coined the term 'Meta-Analysis' to refer to the methods of Research Trend/Synthesis that are statistical in nature. Meta analysis is a formal statistical method which assessed the magnitude of an effect. Glass developed this technique, so that a variety of findings could be quantified, standardized & then compared across studies. The most common effect size indices used in meta-analyses are  $d$ ,  $r$ , and odds ratio (OR), although risk ratio (RR) and number needed to treat (NNT) also have been used. Here for the purpose the simple index of Meta analysis uses the 'Effect size ( $E_s$ )' statistics (also called as Cohen's  $d$ )

$E_s = (X_t - X_c) / SD_c$  where,  $X_t$  = mean of the treatment group;  $X_c$  = mean of Control group ;  $SD_c$  = Pooled Standard Deviation of the control group and Experimental Group i.e. simple formula is  $\sigma_{pooled} = [(\sigma_1^2 + \sigma_2^2) / 2]$  and more specifically by Thalheimer & Cook, (2002) is

$$s_{pooled} = \sqrt{\frac{(n_t - 1)s_t^2 + (n_c - 1)s_c^2}{n_t + n_c}}$$

Where  $s$  = pooled standard deviation,  $n$  = number of subjects *Subscripts: t* refers to the treatment condition and *c* refers to the comparison condition (or control condition).

This statistics provide a composite figure for treatment effect which synthesizes the general impact of the treatment across the different studies. An effect size for each of the finding in a study is computed and Es are then averaged together. This allows for significance & non significance findings to influence the total ES equally, thus minimizing the possible influence of type I & type II errors, evaluating research findings.

Meta analysis fulfils three criteria

- i. Only studies examining the effect of a series of lesson or training treatment were included.
- ii. Only those studies which are equal in a single variable are included which is done for the comparability among studies in terms of the characteristics.
- iii. The third criterion for including a study in meta-analysis is a technical one. In order to be included, a study has to provide sufficient data from which an ES can be calculated.

Summarizing these methods the emerging overall picture is tabulated in table 1. Thus it is clear that, research done in any field need to be reviewed at the regular interval of the time so to improve the quality of the research.

**Table 1**

*Methods Addresses the Three fold Aim of Research Trend/Synthesis*

Sr.	Method	How the results	How consistency	How conflicts in
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No.		summarized	of results assessed	findings resolved
1	<b>Narrative Reflective</b>	Verbal description of procedures used and statistical significance reported results	No systematic mechanism	No systematic mechanism
		Overall conclusions based on reviewer's subjective weighting of studies	Verbal description of concurrence of statistical results	Verbal description of study characteristics that seem to mediate reported results
2	<b>Vote counting</b>	Tabulation of direction & statistical significance of reported results: positive, negative & no significant results	No systematic mechanism	No systematic mechanism
		Category into which most studies fall is the effect or relationship between variables	Proportion of studies falling into each category	Tally studies separately for subsets of studies
3	<b>Combined significance test</b>	Combined p-values or size of test statistics (t-ratios, chi-square, z etc.) and assess statistical significance of this overall index	No systematic mechanism	No systematic mechanism
4	<b>Effect magnitude</b>	Average standardized indices of effect magnitude computed for each study	Post distribution of effect magnitude	Correlation of study characteristics with indices of effect magnitude
			Statistical test of homogeneity of effect magnitude	Test homogeneity of effect magnitude separately for clusters of studies that differ on study characteristics

*(Source: Goel, D. R. (). Synthesizing Research Findings. In D. R. Goel (Ed.) CASE Publication, Vadodara: M.S.U. Baroda. pp. 150-157)*

**Table 2**

**Research Trend/Synthesis methods Suitability and Techniques**

Sr. No.	Method	Suitable for	Technique
1	Narrative Reflective	Number of studies are small, Philosophical/Qualitative/descriptive	Content Analysis
2	Vote counting	All the studies have data on dependent variable and specific independent variable. Tabulation of direction & statistical significance of reported results: positive, negative & no significant results	Frequency count of the positive, negative & no significant results
3	Combined significance test	Studies having the empirical/ statistical values like p-values or size of test statistics (t-ratios, chi-square, z etc.) and assess statistical significance of this overall index	$X^2 = -2 \sum_{i=1}^k \log_e(p_i),$ <p>When the p-values tend to be small, the test statistic <math>X^2</math> will be large, which suggests that the null hypotheses are not true for every test</p>
4	Effect Magnitude	Studies having the empirical/ statistical values	<p>Calculating Cohen's <math>d</math> i.e. 'Effect size (<math>E_s</math>)' from t-tests statistics (a) <math>E_s = (X_t - X_c) / \sigma_p</math> where, <math>X_t</math> = mean of the treatment group; <math>X_c</math> = mean of Control group ; <math>\sigma_p</math> = Pooled Standard deviation</p> <p>(b) When an experiment that uses a t-test does not list standard deviations, you can calculate Cohen's <math>d</math> as follows using the t statistic:</p> $d = t \sqrt{\left( \frac{n_t + n_c}{n_t n_c} \right) \left( \frac{n_t + n_c}{n_t + n_c - 2} \right)}$ <p><math>t</math> = t statistic; <math>n</math> = number of subjects</p>

### 3. Illustration: Conducting Meta Analysis

Suppose the study “a study of effectiveness of modular approach for teaching science to class ix students in terms of their achievement and reactions towards modular approach” is being replicated ten times with similar samples with the same null hypothesis “There is no significant difference between the achievement scores of class IX students taught through Modular approach and that by the conventional approach.” (Table 3) Synthesis of these researches simply requires that to convert each study outcome to a standard metric. This can be done in two basic ways: Statistical significance and Effect size (Es). Both provide a “metric-free” measure that allows combination across different kinds of outcomes. The kind of effect size used distinguishes the major types of meta-analysis:  $d$  (Cohen; Glass),  $g$  (Hedges),  $r$  (Rosenthal; Hunter & Schmidt) and others. Synthesis across the studies provides an overall test of the common hypothesis: “Do groups exposed to Modular approach exhibit more achievement than exposed to Traditional Approach?” The mean effect size gives an indication of the strength of the relation. Typically, effect-size estimates are interpreted in two ways. One way is to rely on commonly accepted benchmarks that differentiate small, medium, and large effects. Perhaps most well-known are those benchmarks presented by Cohen (1988) for interpreting Cohen's  $d$ , whereby 0.2 equates to a small effect, 0.5 equates to a medium effect, and effects larger than 0.8 equate to large effects. Thus, in the example above, the difference represents a large effect (Cohen, 1988). The second way to interpret an effect size value is to explicitly compare the reported effect size to those reported in prior studies of a similar nature (Thompson, 2002a; Vaccha-Haase & Thompson, 2004). For instance, hypothetically a researcher might study the impact of a Modular approach study for Achievement compared with that of a no-treatment control condition. Let's assume that post-treatment measurement of Achievement, indicated an effect size of  $d = 0.5$ , medium in size based on Cohen's benchmarks. A savvy reader, however, is particularly interested in how this treatment's effect size compares to those of other treatments studies conducted earlier. As a complement to providing the effect size ( $d = 0.5$ ) and its standard interpretation (medium in size), the researcher also should point out how this effect compares with those of other treatments of Modular Approach. For example, perhaps a previously published study found an effect size of 0.92 for a same treatment. This effect size provides a useful comparison to interpret the impact of the treatment program. It is not enough to know that one treatment is better than

another; readers of the research literature should expect authors to quantify and explain how much better.

**Table 3**

*Mean Standard Deviations and Effect Size of the various studies*

Study	$X_c$	$\sigma_c$	$X_t$	$\sigma_t$	Pooled $\sigma$	$E_s$
1	30	3	34	3	4.5	0.89
2	40	3.4	26	3.6	5.2	-2.69
3	45	4	47	4.1	6.05	0.33
4	34	3.9	47	3.7	5.75	2.26
5	35	4.5	40	4.8	6.9	0.72
6	30	3	34	3	4.5	0.89
7	40	3.4	26	3.6	5.2	-2.69
8	45	4	47	4.1	6.05	0.33
9	34	3.9	47	3.7	5.75	2.26
10	35	4.5	40	4.8	6.9	0.72
					<b>Average <math>E_s</math></b>	<b>0.30</b>

Inclusion of effect sizes has an important benefit beyond the calculation of practical effects. Specifically, effect sizes can be compared across studies using a technique called meta-analysis. In a meta-analysis, a researcher statistically summarizes and integrates the effect sizes of multiple studies to calculate an average effect size. Statistical analysis common to Meta-analysis is the test for homogeneity of the effect size distribution. Is the mean effect size of a particular construct representative of the population effect size? How much variability should be expected around the mean effect size? The assumption is made that if the distribution is homogeneous, then the variability around the effect size is no greater than would be expected from sampling error (Lipsey and Wilson, 2001). However, if the variability around the mean effect size is large (effect size distribution is heterogeneous), then it appears that each effect size is not estimating a common population mean. To test for a homogeneous distribution, a common test used is the Dixon's Q test. If Q is statistically significant, the null hypothesis of homogeneity is rejected and

the researcher assumes a heterogeneous distribution. Another statistical test that can be used to test for a homogeneous effect size distribution is the  $\chi^2$  test of goodness of fit. Connor and colleagues reported a significant mean effect size indicating that stimulant treatment reduces clinicians' ratings of aggression. They followed up this finding by testing the mean effect size distribution for homogeneity using the  $\chi^2$  test of goodness of fit. Their result was statistically significant, rejecting the null hypothesis of a homogeneous distribution.

Calculate the Homogeneity of the effect Size distribution using the  $\chi^2$  test of goodness of fit or Dixon's Q test. Also One-Sample T Test procedure tests whether the mean of a sample effect size distribution differs from the Effect size population mean.

**Table 4**

*N, M,  $\sigma$ ,  $SE_m$  for the Effect Size (ES) distribution*

One-Sample Statistics				
	N	Mean	Std. Deviation	Std. Error Mean
ES	10	.3020	1.71963	.54379

**Table 5**

*One sample t- test for the Effect Size (ES) distribution*

One-Sample Test						
				Mean	95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Difference	Lower	Upper
ES	.555	9	.592*	.30200	-.9281	1.5321

*Note. \* Not significant*

From the table 5, the calculated t value found to be not significant at .05 levels. Thus there is no significant difference between the mean of effect size distribution and the population means of the all such effect sizes. Thus the effect size distribution is homogenous. Therefore, the overall

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effect size ( $E_s = 0.30$ ) implies medium impact of the Modular approach on achievement as far as the summarizing the different findings is concerned.

#### **4. Conclusion**

Researcher is formidable task is to find the absolute truth which is philosophically utopia. Further researchers do some interpolate/extrapolate to approximate the reality as it appears to oneself. The various such researchers will find the different approximations for the same absolute reality waiting to take a shape of theory. As far as the empirical studies are concerned the well defined statistical methods are available. At the same time the traditional narrative reflective methods are also find some grounds for synthesizing the research findings of qualitative studies. Although the subjectivity lies there but still such tasks are not suitable hands in the area of educational research. Summarizing the results of many studies as an effect size index provides important strength of relationship information. Such methods of synthesizing research can help the varied and numerous researches to reach at some convergence and conclusive thesis.