

THE APPLICATION OF META-ANALYSIS IN EDUCATIONAL RESEARCH*

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Abstract. *A meta-analysis is a synthesis of a research project, including a summary of the results of other studies in a meaningful connected display that enables the derivation of general conclusions. Therefore, meta-analysis units are not subjects, but studies, and this is what characterizes this method. Using the meta-analysis, researchers can choose among the two strategies so they can respond to problems: easy integration of studies dealing with the same problem in order to respond to it precisely, and the mutual comparison of different studies, which may not necessarily be focused on the same problem, in order to test the hypotheses that are tested in the initial research. The action of looking for studies in meta-analysis is not significantly different from searching for studies in traditional quantitative reviews. In both cases, the purpose is to find and obtain all the results concerning a given field. The contents of this part of the paper focus on the problem of describing methods of finding and selecting studies, and on determining of the results, the use of which is an absolute necessity in works on meta-analysis. What is presented here are both the procedures of searching for results, and mechanisms of processing results and their reliability.*

Key words: *meta-analysis, educational research, quantitative integrations, results synthesis, application in meta-analysis.*

The development of research activities in the field of education is characterized by a large volume and intense representation of empirical research. The development of methodology for empirical research in recent decades has caused the appearance of something that the profession considers its objective: awareness of the importance and necessity of the empirical foundation of scientific research. Just about the same time pedagogy has de-

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veloped and introduced into practice many new methods (such as tests of knowledge, action research, pedagogical experiments, a variety of complex statistical analyses, etc.). This created room for large-scale use of these methods, and there were extensive reviews of empirical research as well. However, they were not just the mere synthesis of previous knowledge, but an informative overview of what has been done in recent times in the research area of education.

Researchers in the field of education, and of course, all pedagogical workers who use the results of research work, have long been aware of this situation. Scholars in their own narrow field of specialization are even managing to keep pace with the rapid development, but scientific research is intended primarily for students, school teachers, professors, tutors, principals of pedagogical institutions, parents and others, which raises the question of how they keep track of all these achievements. It is obvious that better organization is needed in the case of voluminous literature or, better yet, a great number of research results.

Given that meta-analysis is an extremely valuable method, especially useful in educational research, because it allows us to draw conclusions and generalizations from a variety of patterns and situations, we will point to its definition and application in pedagogy.

THE DEFINITION AND APPLICATION OF META-ANALYSIS

Around the world, in the case of scientific and professional literature, for a very long period of time, reviews could be found, which attempt to summarize major scientific publications and research results for a particular issue. Some of those reviews are in fact a synthesis of the results of a number of research projects. Glass (Glass, 1976) analyzed the shortcomings of the previous scientific review three decades ago. Authors of papers and reviews for the most part choose appropriate research projects and studies – those are the papers (and languages) that are most accessible to them. Papers and their results are described by imprecise formulations, and the conclusions are largely descriptive. The methodology for such reviews is different every time, giving insufficiently reliable and unsystematic conclusions, and do not allow comparisons. In addition, Glass thinks that the authors of the reviews are showing their methodology without transparency (particularly the part that relates to the processing of empirical material). The lack of transparency makes it impossible for readers to assess the adequacy and validity of the final conclusions. Even when a methodological model is described well enough, usually it is a case of fundamental and very simple methodology.

The main reason for this situation is, according to Glass, poor methodology for the synthesis of research results. "We have an urgent need for methods that will enable systematic evaluation of empirical results, so we could draw some important discoveries and findings from the great number of research" (Glass, 1976: 4). Glass believes that ordinary (former) quantitative examinations cannot adequately fulfill these tasks. Therefore, he identified three types of analysis necessary for the progress of research activities in the field of education: primary analysis, secondary analysis and meta-analysis. Primary analysis is the basic method of data processing, which is usually performed by the one who drafted the research. The secondary analysis is the reanalysis of the data, intended to be a search for answers for the same research questions with the help of more complete and

better statistical methods. It is usually performed by researchers who did not participate in the first team, but can use the whole empirical material from the primary analysis. A meta-analysis is, however, a quantitative analysis of the research results (not an analysis of the data). These results are published in reports and studies (and sometimes in the already mentioned research reviews). In a meta-analysis, statistical analyses of quantitative results from individual studies are carried out.

Primary analysis attracts most of the attention and energy of researchers in the field of education. Most of the funds of various scientific foundations and associations are spent just on primary research and professional journals are in a sense competing to publish such works. On the other hand, only rarely does secondary analysis draw the attention of experts. There were such cases, but they all required a lot of effort and very high standards of quality, in order to achieve scientific acceptance that primary analysis would have achieved. Those were cases that involved secondary analysis, "New evaluation of Pygmalion" by Elashoff and Snow (Elashoff & Snow, 1971), which became as famous as the primary analysis of the "Pygmalion in the classroom" by Rosenthal and Jacobson (Jacobson & Rosenthal, 1992).

At a time when Glass first mentioned meta-analysis (in his speech at the ceremony when he became the president of the AERA association), such secondary analyses, like all quantitative reviews, did not enjoy a high reputation in scientific circles. Also, the methodological literature for this field was not particularly good or systematically developed.

Literature on many topics in education is expanding rapidly (on the graph it is represented by the all the upright lines). In one decade, hundreds of articles have appeared: e.g. burden on students, the factors of school success, the interests of children, etc. But the conclusions are often not comparable, given the different contexts of research, in different situations, social groups and the like. Often, dozens, even hundreds, of similar studies are not providing sufficiently strong and clear answers, which could easily be used in practice.

Glass's classification of the three aforementioned analyses is to some extent unclear. In the first place, defining the boundaries between primary and secondary analysis is unclear. In both of the analyses the basic data are processed (basic empirical material). The research questions are same, and the only substantial differences are the statistical methods that are used. The fact that secondary analysis comes later (when the primary analysis has already been completed), and that it is usually performed by other researchers, is not an important feature. To say the least, these differences are too small to reasonably use the terms primary and secondary analysis. In this light, the distinction between the first two analyses and meta-analysis is quite clear. A meta-analysis does not use primary empirical material, but the results obtained from the basic data.

Perhaps the following classification is better:

1. primary analysis, in which known (conventional) methods and techniques of educational research and related phenomena are used (e.g., sociometric methods, experiments, the use of assessment scales, scales of attitudes, etc..) and

2. secondary analysis, which includes actions that are not directly used for the investigation of a phenomenon alone, but we process the results obtained using primary analysis.

Of course that this classification (as well as Glass's) refers to the general methodology of social science, rather than just educational methodology and methodology of research in education.

In this sense, meta-analysis is just one type of secondary analysis, in other words, it is a secondary analysis used for integration (synthesis) of the results derived from multiple primary analyses. Regardless of the adequacy of the first or second classification, Glass's current definition of meta-analysis is valid, and according to that definition, meta-analysis is a "statistical analysis of a set of analytical results from individual studies, with the purpose of synthesis of the scientific research findings" (Glass 1976: 3).

In the meta-analytic research: objective methods to search for and select primary studies are used, the characteristics of primary studies are described using quantitative terms, the effects in all the studies on a unique scale "force effect" are expressed (weighting effect on a single scale) and statistical methods to determine the relationship between characteristics of studies and their results are used (Glass, 1976: 3-4).

META-ANALYSIS: QUANTITATIVE METHOD FOR THE SYNTHESIS OF RESEARCH FINDINGS

The beginning of a meta-analysis is an example of meta-analytic research in the field of psychotherapy (Smith & Glass, 1977). What is most important at the beginning of this development are the meta-analyses conducted by Glass et al. In their analyses, Glass and associates for the first time displayed and integrated the results of 475 controlled evaluations of psychotherapy. They used the standardized deviations between the results of treated and untreated patient groups and categorized all the studies by the basic features. Using multivariate analyses, it was determined that psychotherapy is effective (of course, in studies that included a meta-analysis), and that raises the average patient with the fiftieth percentile to the seventy-fifth percentile of the untreated group. The results have also shown that various forms of therapy (e.g., behavioral and non-behavioral), are slightly different in efficiency. Later the same authors presented detailed results of this meta-analysis in a book on the evaluation of meta-analysis (Smith, Glass & Miller, 1980).

Other meta-analytic investigations of Glass and his associates raised a lot of attention (Smith & Glass 1980, Glass, Cahen, Smith, & Filby, 1982), mostly research in which they integrated research into the school success of students, dependent on the size of the school division. Smith and Glass (Glass & Smith, 1980) noted that the literature in this field varied greatly. Because of that they could not integrate the same methods as in the aforementioned meta-analysis of psychotherapy. Samples have varied in size so that it was impossible to compare a small sample in some studies with very large samples in other studies. In addition, they did not have strong arguments for the assumption of the existence of a linear relationship between the size of the samples and academic achievement. They considered that the effect of increasing the sample by, for example, ten students could be quite different if the initial size of the sample was twenty or thirty students. This problem, the problem of the quantitative expression of increasing a sample, was solved and a logarithmic relationship between the size of the department and school achievement was found.

The integration of such a scale before Glass and Smith was not possible. The earlier quantitative surveys are not comparable with their studies because those studies contained far fewer studies and did not contain statistical methods for integration. These reviews, also, are not as precise in terms of control over factors that could affect the results of primary studies.

Today it is obvious that the meta-analytic investigations of Glass and Smith opened up entirely new horizons, because, on the one hand, they enriched the fundamentals of pedagogical science, and, on the other hand, developed a new methodological models. Their contribution can be summarized in four points:

1. Glass and Smith were the first to use the standardized mean values between experimental and control groups as a dimensionless measure of the volume effect in the synthesis of experimental research. This significantly expanded the area of integration. Later, other researchers upgraded this idea and used their measures of the volume effect for the statistical design of experiments, but the most important step was the step Glass and Smith took.

2. Glass and Smith, in practice, showed that the number of studies that can be integrated is much larger than it previously appeared. One of the most famous previous quantitative examinations in the field of psychotherapy (Eysenck, 1952), included only 19 studies, while the Glass and Smith meta-analysis in the same field included 475 studies of psychotherapy. Another mentioned meta-analysis of Glass and Smith on the size of the school sample included 77 studies with 724 individual comparisons.

3. Their contribution is contained in the development of methods by which we control the impact of various features included in the study. The earlier quantitative reviews either had no control over those influences or could control only one feature or two (or categorization by one or two characteristics). In the aforementioned meta-analysis of 475 studies, Glass and Smith categorized the studies based on more than twenty variables (characteristics). Then they analyzed the impact of all these variables on the results of the study. The variables were related primarily to the methodological characteristics of individual studies, but also on the content differences, ways of publishing the results and so on.

4. The analytical methods that Glass and Smith used, are a major developmental step in relation to the methods that were used in previous quantitative surveys. We will mention only regression equations for the relationship between the therapeutic effects (dependent variable) and type of therapy, type of treated individual, ways of measuring effects and so on. In this way they could predict the effectiveness of different therapies that have been tested in very similar studies.

At the very beginning, Glass, although his first meta-analysis was conducted in the area of psychotherapy, clearly saw the possibilities and prospects of the use of this methodology in the other social sciences, especially in the field of educational research.

Glass's predictions and assessments were quickly confirmed. Within a few years he published several reports on a conducted meta-analysis, and at the same time many other authors published their papers. After just five years the first bibliography of meta-analytic research was published, with more than 250 papers (Lamb and White, 1981). Of course, those were not meta-analyses just from the area of pedagogy.

CONTESTATION AND ACCEPTANCE OF A META-ANALYSIS

Besides a great positive impact, the new methodology has caused criticism. Immediately after the first meta-analysis by Glass appeared, the first criticism also appeared (Eysenck 1978, Mansfield & Busse 1977; Presby 1978; Educational Research Service, 1980; Slavin 1984).

We will present the four most important points of criticism:

1. It is impossible to get scientifically-based conclusions from the integration of studies, which encompass a variety of measurement procedures, very different variables and very diverse populations.
2. The results of a meta-analysis are unreliable, since they integrate studies of a very different methodological quality: from the most correct to the most problematic.
3. A meta-analysis depends too much from the published results (which can significantly vary from unpublished results).
4. A meta-analysis often uses multiplied results drawn from the same studies. In this way the sample is artificially increased and therefore the results are distorted.

The first criticism is justified in the sense that it is really difficult to integrate very different results. The same or a very similar topic can be explored by various methodological models. So you can use different approaches to solve specific issues, such as, how to explore, how to verify hypotheses, how to obtain empirical data, how to process them, etc. Because of all the stated reasons, a meta-analysis researcher can really find himself in quite a complex situation. But, on the other hand, a meta-analysis cannot be limited only to the research, which in a sense, represents the repetition of almost the same research. The second argument can be found in the analysis of development of the meta-analysis (accompanied by the criticism). It turned out that it is possible to find the procedures for resolving problems and dilemmas associated with the integration of very different results. The procedures for calculating the measures of the "volume effect" clearly showed how very different results can be integrated. In addition, we must emphasize that, in addition to these well developed procedures, some issues of meta-analytic methodology still remain open, and the aforementioned criticism represented a starting point for finding new answers.

Another criticism of the different methodological level of integrated studies refers more to a particular Glass meta-analysis, than the methodology itself. In the meantime, the possibilities of taking the methodological level of the individual studies into account were found. One of the most interesting (and also the most controversial) is the method that we will not depict in detail (more on that: Slavin, 1986). Today meta-analytic methodology has a number of procedures for the identification and control of methodology validity in certain studies (Hunter & Schmidt 1990; McGuire, 1985).

Criticism that the meta-analysis relies on publicly disclosed results, rather than unpublished data (e.g., dissertations, research reports in several copies, etc.), is certainly justified. It will never be possible to obtain data on all unpublished research, nor will those research projects be as accessible as published research. It turned out that if we just publish some paper, we will have an impact on the results. Results in the published works, generally speaking, are different from those of unpublished studies. The question is should we give up from the integration of the available results, because there is a risk that some results are not taken into account? This criticism should be understood in the sense that a meta-analyst must do everything in his power to obtain unpublished studies and results.

The most justified criticism is the one targeted at the integration of multiple results from the same study. This artificially increases the sample, since, in fact, these are not independent results. Joint processing of results from several independent studies and multiplied (dependent) results from other studies is not justified and correct. In the already mentioned meta-analysis of 475 studies, over 2000 individual statistical results were inte-

grated. It was not an isolated case, because there are some other cases with a similar occurrence. It is also one of the most difficult dilemmas of meta-analytic methodology, which has not been resolved satisfactorily.

THE RECOGNITION OF MATERIAL FOR INVESTIGATION

One of the most important stages of meta-analytic research is the correct recognition of research material, i.e. the appropriate selection of investigation methods. This stage is, first of all, characterized by unlimited research space, which, in consequence, results in using an unlimited quantity of investigation for meta-analysis.

The basic distinctness of traditional quantitative reviews has limited possibilities for integration. That is why, in such reviews, the selection of research studies is neither located in the centre of attention of a researcher, nor in that of a reader. This is, because the essence of reviews is systematizing and describing the results of research studies, while integration is more qualitative than quantitative. Therefore, the researcher can attribute different degrees of significance to individual studies. Any procedures associated with this are accidental and non-systematic. However, they have turned out to be sufficient for quantitative reviews. Contrary to the quantitative review, meta-analysis determines its purposes in a different way.

Kulik and Kulik, who studied it both theoretically and empirically, dealt with the selection issue very intensively. Due to the requirements of meta-analysis, they also studied the integration practice used for research studies so far. They have proved that, in quantitative reviews, the selection of studies was more often accidental than deliberately made by making allowances for traits studies and their methodological model (Kulik and Kulik, 1989, page 257). The possibilities of a meta-analysis allow noticing another aspect of the discussed issue. For a meta-analyst, there are no quantity limits concerning investigations that he or she takes advantage of. This may result in a suggestion that the selection of studies is just a side issue in meta-analysis. However, this feeling is illusory, because, on considering the fact that in meta-analysis one analyzes the traits of studies, their selection turns out to be a much more serious task than in quantitative reviews.

The selection of studies has its content-related and methodological aspects. The former are strictly associated with defining a research problem, while methodological aspects concern mainly settlement of selection criteria.

METHODOLOGICAL ASPECTS OF SELECTION

From the point of view of the criteria of quality of a methodological model, the meta-analysis develops in two main directions. Glass and his students, who approve of greater tolerance when considering methodological quality and characteristics of studies were the first to isolate the direction (Glass, McGaw and Smith, 1981; Hunter and Schmidt, 1990). According to the researchers mentioned above, meta-analyses can at the same time include both experimental and quasi-experimental research studies, or experiments with different methods of inner control of the experimental situation, etc. The need for studying the effects of traits can be regarded as an argument supporting such an approach. In order to find correct answers to the research questions, meta-analysis must be based on a suffi-

ciently large empirical basis. This is possible when a meta-analysis includes studies whose traits are sufficiently dispersed.

The other direction mentioned above involves more restrictive requirements which should be met by the methodological criteria of selection of the meta-analyzed studies. The most outstanding representative of this outlook is Slavin, who claims that not all studies are equally appropriate to be included in a meta-analysis. What is most important in the procedure of the selection of investigations is to take into consideration the methodological model and to select only the studies that possess sufficiently high methodological value. This means selecting studies that contain results obtained by means of the methodology that guarantees their sufficient reliability. The presented approach concerning the selection of studies derives from the postulate that the level of reliability of final settlements depends more on poorer results than on better ones. It is true that, in scientific research studies, one of the most significant criterions is correctness and reliability of new findings. Is the level of final findings really determined by the poorest of the used results, though? It is difficult to find any significant argument supporting this approach. On the other hand, it cannot be ignored that all results affect correctness and reliability of the new findings.

The solution to this problem can be found in a reasonable association of these two trends concerning the quality of studies. The main idea of Slavin's theory, concerning different loads of individual studies deriving from their methodological traits, should be accepted. On the other hand, Glass's postulates concerning statistical control and a need for taking these traits into account should also be considered seriously. Therefore, in a meta-analysis, there is a need to use all the methodological traits that allow quantitative descriptions as variables. As a result of applying such a method, the best methodological studies would possess the greatest significance, weaker studies would possess a correspondingly smaller significance, and the most doubtful studies could occasionally be completely excluded from meta-analyses.

An additional answer to such a dilemma can be obtained from the experiences resulting from the research practice made so far. Re-analysis, discussed by McGaw (1988 p. 679), seems to be a fundamental operation in the analyzed problem. The authors of the study, Landman and Daves, analyzed experimental research studies on the effectiveness of psychotherapy. The studies were integrated within the confines of Glass and Smith's meta-analysis (Smith and Glass 1977). Out of the total number of 475 investigations, Landman and Daves selected those, which, in their opinion, were the most correct in terms of methodology. The power of effect obtained on such grounds turned out to be very similar to the power of the effect obtained in the investigation of the entire set. This enabled the authors to confirm the findings of Smith and Glass concerning the selection criteria of studies included in meta-analyses. In the opinion of McGaw, that argument was sufficiently strong to confirm the approach in which methodological traits (considered as a quality) form the basis for statistical analysis, but do not serve as selection criteria for studies included in meta-analyses.

It is difficult to accept such arguments without reservations. The results of Landman and Daves's analyses can be interpreted as a confirmation of the correctness of the attitude that more restrictive criteria of study selection are appropriate. Including the whole set of studies, as postulated by McGaw, did not yield significantly different results. This means that the presented approach is insignificant in meta-analyses. The results confirm, at least partly, the correctness of Slavin's theory.

In view of the presented attitudes, the following question arises: how to measure the significance of each investigation or each single result? The simplest solution was that offered by Slavin, who rejected any investigation that did not meet the assumed criteria, and, therefore, their determined significance was equal to zero. At the same time, any study included into meta-analysis was given the same significance. However, such an approach is satisfactory only when there is no possibility of measuring the significance of the investigations more precisely.

The only possibility of the correct determination of the value of individual studies is their assessment by methodologists. Such assessments are subjective, however. Therefore, there is a need for a greater number of methodologists and their assessments. Rosenthal (1991) proposes a double procedure of the evaluation of the methodology of studies, which involves a double evaluation by the same expert. The first evaluation should be made on the grounds of the description of methodology of each study report. It is a fact that the first evaluation is made before the expert knows the results of the evaluated study that is important in the author's opinion. When doing the second evaluation, the expert should take into account the description of the methodology and interpretation of the results. To implement such a method of evaluation, several questions should be prepared, starting from the most general ones and ending with the most detailed ones. To each question, the expert is expected to give an answer, which is the evaluation. The final result is the sum of all the evaluations or their average. The evaluations should be used as scales when determining the quality of the studies. When a given study has a three times higher evaluation, it should be given a three times higher scale in statistical analyses. This means that the contribution of each study to the final conclusions is directly proportional to its methodological quality. This approach should be regarded as a significant step in searching for more objective methods of selecting studies.

CONCLUSION

The preliminary stages of meta-analysis, i.e. a review of the literature and selection of studies, are much more complicated than in quantitative reviews that have been completed so far. Describing and categorizing the study traits that are to be statistically controlled in meta-analysis are at least equally or even more complicated. This is what makes meta-analysis fundamentally different from ordinary reviews. To allow the calculation of the significance of the results of individual studies and the measurement of their contribution to the final findings of a given meta-analysis, their basic traits should be quantitatively described and statistically analyzed. This refers to both to the methodological and content-related traits of the studies. The categorization and description procedures provide a researcher with the necessary empirical material.

The previously given theoretical observations and particular examples present a relatively significant innovation in the methodology of educational research. In our country, these ideas were not adequately represented, and meta-analytic research did not receive significant attention. Simple examples of the attempts for a synthesis of empirical results can be found in our literature, but they still were not meta-analyses. The latest comparative studies of the achievements of student the same age and same year of schooling in different countries, an example that justifies the existence of meta-analyses. (It is a meta-

analytic study that is at its very beginning, and not rounded up in all the segments.). In our country, the period of meta-analytic research is yet to enter the scientific stage. This debate has just one aim, and that is to point out the possibility of that new form of research. In later articles we intend to develop and present a meta-analysis in detail, including statistical procedures for meta-analyses.

A meta-analysis has essentially changed quantitative research, which led to great progress, especially in the field of teaching. The possibilities of quantitative integration and synthesis expanded the limits of empirical studies of pedagogical issues.

The achievements of some great meta-analytic studies in the world have confirmed the achievements of this new methodology. First the researchers were predisposed to the previous quantitative methodology, and soon after realized the deficiencies of this approach, so they began to adapt the old methods and develop new ones. As a result, within the period of some thirty years there were more fundamental works published, and the meta-analysis has become one of the most frequently published topic in the field of educational research.

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PRIMENA META-ANALIZE U PEDAGOŠKIM ISTRAŽIVANJIMA

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Meta-analiza predstavlja sintezu istraživanja, uključujući sažimanje rezultata drugih istraživanja u smislenu povezan prikaz, omogućavajući time izvođenje opštih zaključaka. Prema tome, jedinice meta-analize nisu ispitanici, nego istraživanja, i to je ono što karakteriše ovu metodu. Služeći se meta-analizom, istraživači se mogu odlučiti za dve strategije kako bi odgovorili na postavljene probleme: jednostavno integrisanje studija koje se bave istim problemom, kako bi se na njega preciznije odgovorilo, i međusobno upoređivanje različitih istraživanja, koja ne moraju nužno biti istog problemskog usmerenja, kako bi se proverile hipoteze koje nisu proveravane inicijalnim istraživanjima. Proces traženja studija u meta-analizi ne razlikuje se značajno od traganja u tradicionalnim kvantitativnim komentarima. U oba slučaja, cilj je da se pronađu i pribave svi rezultati u vezi date teme. Sadržaj ovog rada se fokusira na problem opisivanja metoda pronalazjenja i izbora studija, kao i na utvrđivanju rezultata, čije korišćenje je neophodno u radovima o meta-analizi. Ono što je ovde predstavljeno je i procedura traženja rezultata kao i mehanizmi obrade rezultata i njihova pouzdanost.

Ključne reči: *meta-analiza, pedagoška istraživanja, kvantitativne integracije, sinteza rezultata*