SCIENTIFIC AND EVALUATIVE INQUIRY IN EDUCATION

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PREFACE

Within this essay I hope to illuminate some of the inadequacies and limitations of one currently popular approach to educational inquiry. By this I am referring to an easily discernible but unwarranted heavy emphasis upon evaluative inquiry in research. In providing an alternative to this undesirable practice, I intend to present a view of how I believe educational research should be conducted. The approach I advocate stems from a Realist's conception of science and more specifically a Retroductive-hypothetico-inferentialist account of scientific method as developed by B.D.Haig. This account of method I believe is the best available candidate within realist philosophy of science.

In undertaking this project, I work from a fundamentalist perspective of our world. This is concerned with the solving of important world problems. Education I believe has a role in this pursuit. However until our understanding of education is improved its role will remain limited. Importantly, the strength of our understanding of education, or any body of knowledge, is dependent upon research. Thus the focus of this paper. It is my conviction that if research is to improve, our adopted conception or philosophy of science and more specifically our account of scientific method must be a far more adequate one. Most contemporary researchers bear allegiance to a totally inadequate philosophy of science and consequently have an extremely limited insight into scientific method. Herein lies the major cause of the absence of useful educational research and thus the sense of exigence, which surrounds the development of accurate and employable alternatives.

In considering the "received view" of educational research I concentrate on the work of Gene Glass and specifically his paper entitled 'The Wisdom of Scientific Inquiry on Education.'[1] There are a number of reasons for this. Firstly, the paper has been widely influential. Most people engaged in or interested in educational research have read the article. Secondly, the paper is still often cited in the relevant literature. Thirdly, the views of inquiry and the misinterpretations of science expressed typify well the views held by a large number of educational "researchers". Educational research still is often carried out in a theoretical vacuum, narrow in scope and restrictively tight in design. Finally, for expository purposes the paper conveniently sustains the very position I want to refute.

INTRODUCTION

Inquiry or research in Education is varied in approach. Sometimes these variations reflect differing goals of the particular subject area or object of research. Othertimes differences in approach reflect a particular policy-decision of the researcher.[2] The latter situation is illustrated by the position Gene Glass adopts and argues for in his article entitled 'The Wisdom of Scientific Inquiry on Education.' In that article he focuses on distinctions he draws between two approaches to inquiry: elucidation and evaluation. Insistently presenting the two types of inquiry as disparate he provocatively announces in the opening paragraphs of his paper his decision that evaluative inquiry alone in education is where all our energy, time and resources should be directed. In rejecting elucidatory inquiry he declares, 'we should not strive to make research in science education or education generally more scientific', for this he deems 'unproductive'.

Within this essay I want to challenge such an inflexible standpoint. The decision made by Glass including the reasons he presents for his making the decision I find untenable although somewhat typical. I shall argue that the method employed in problem-oriented research should be chosen in accordance with the particular area (or aim) of research. It should not be dictated by the particular disposition of the researchers or the requirements or desires of a client or sponsor. From this standpoint I am able to argue that elucidatory and evaluative approaches to inquiry, far from being repugnant to each other as Glass initially implies, are both integral parts of scientific inquiry. Contrary to Glass' view that for the next few decades evaluative inquiry should replace scientific inquiry, I suggest that scientific inquiry or elucidatory inquiry should include

evaluative inquiry as evaluation aids and indeed is necessary for elucidation but that evaluation per se is a stagnant and unenlightening activity.

In examining more deeply Glass' argument a number of inadequacies present themselves. I draw the readers attention to these and attempt to locate them within his underlying philosophical position. In so doing these inadequacies are in part explained. In critically examining the latter I argue that Glass' thesis stems from and is moulded by an allegiance to an empiricist philosophical tradition. More specifically I indicate that his aims and assumptions clearly reflect a logical positivist conception of science as formulated in a corresponding hypothetico-deductive account of scientific method.[3] Thus in rejecting Glass' immediate claims, I am also challenging a long accepted and widely disseminated philosophy of science. This too I reject.

In advocating an alternative philosophy of science and in suggesting and adopting a different interpretation of scientific inquiry to that of Glass, I espouse a post-empiricist Scientific Realism as promulgated to varying degrees by Harrē, Scriven, Putnam and Maxwell, and introduce the Retroductive-hypothetico-inferentialist account of scientific method as developed by Haig. As should be obvious, from this perspective inquiry is seen in a different light from most researchers and therefore my ideas on how scientific inquiry in education ideally could and should be engaged in differ markedly from most of those who do conduct research in the area.

As mentioned a good part of Glass' paper is devoted to a specific comparison of elucidatory and evaluative inquiry. Glass identifies and outlines what he sees as nine features that

distinguish the two types of inquiry. Before focusing on these features however, Glass makes a number of more general comments about inquiry. In making these comments, he arouses but evades the main philosophical issues underlying his and others' attitudes to inquiry. Specifically, logical positivism is assured as an accurate and therefore adequate conception of science while realism as a serious challenger is ignored. Similarly hypothetico-deductivism as an account of scientific method is implicitly adopted uncritically. Any plausible alternative contenders are either unknown or disregarded. For Glass as for most researchers, their conceptions of and attitudes to inquiry are regarded by themselves as in no way contentious; critical examination of them is thus infrequent.

Prior to turning to specific criticisms though, cognizant of the seeming ignorance about Scientific Realism and the indiscriminate acceptance of Logical positivist Empiricism, I think it expedient to briefly outline the two positions as standardly expressed. In so doing the basis from which my criticism of the view represented by Glass is launched will be made known, and his underlying framework will be revealed. Later I shall elaborate upon issues referred to here and further illustrate the relation between logical positivism and Glass' claims, and my hopes for research conducted along realist lines.

LOGICAL POSITIVISM AND REALISM

Logical positivism as a conception of science lies within the inveterate empiricist philosophical tradition and is a relatively recent expression of it. Most current educational research fits fairly neatly within this mould. Realism is still a comparatively under-subscribed framework for research.

For the logical positivist, science is perceived as an attempt to gain predictive and explanatory knowledge of the external world. The method by which this is to be achieved is however a clear indicator of the difference between positivism and realism. It is characterised by systematic observation and experiment which results in the disclosure of phenomena, the regular relations of which are to be expressed in 'highly general statements.'[4] These general statements are what for the positivist constitute laws or theories. In accordance with empiricism, the domain of science is believed to be within the realm of observable phenomena only; unverifiable claims are designated metaphysical or religious and any suggestion that theoretical terms may refer to 'actually existing yet unobservable items'[5] in the world is rejected. It is not then, the goal of theory or science to pierce through phenomena revealed to us by our senses in order to give us knowledge of the causal mechanisms which necessitate or tend to produce these phenomena.

Explanation then for the positivist amounts to showing that an event is 'an instance of a well-supported regularity.'[6] Traditionally this has been presented in a form of logical argument in which statements of laws and antecedent conditions are emphasised as its premises - a widely employed form is the Deductive-Nomological model of explanation.[7] However such a model for the realist, among others, provides neither sufficient nor necessary conditions for explanation. Although this form of explanation may provide explanation of events, often it does not. For the realist this inadequacy or confusion, sometimes referred to as the epistemic fallacy, lies in a 'failure to distinguish between providing the grounds for expecting that an event will occur, and explaining why it does occur.'[8] To illustrate, an

I.Q. test may predict academic performance but per se it does not explain the performance.

Realists, in accusing positivists of only predicting but not explaining an event, argue that the logical form of positivists' "explanations" inevitably leads to just prediction. This, they obviously object to. For example Putnam writes, 'the meaning of true .... is not fixed by formal logic.'[9] What is further required for an adequate account of explanation is some understanding of the causal processes or mechanisms responsible for the generation of the particular phenomena under consideration. In pursuing this, realists are seeking the discovery of 'the relations of natural necessity that exist in the physical world' rather than positing relations as logical necessities between the explanans and explanandum statements of the D-N model.

In rejecting the latter's format as a claim to explanation, the realist is also rejecting the Humean view of causation. For the realist, regularity of succession of events amounts to nothing more than 'empirical, universal conditional statements,'[10] not causal relations. Thus as Harrē has argued, what is demanded is knowledge of the 'intervening mechanism'[11] which lies between the regular occurrence of two events. Moreover as Keat and Urry note, Harrē stresses that to perceive causal relations as 'consisting only of temporal precedence and regular succession, is to fail to distinguish between the meaning of statements asserting such relations, and one kind of evidence upon which they may be based.'[12] The intervening mechanism must then be explored and to do so the verificationist theory of meaning must be rejected for such mechanisms usually are of course not directly observable. In exploring the causal mechanism or structure, "full" explanation is sought. "Why" questions in addition to "how" and "what" questions are tackled instead of

eschewed. This approach gives research methods an entirely different emphasis. Discovery becomes all important. As Hooker writes, the 'fundamental aim of science is discovery and understanding... not pragmatic convenience of control...'[13] Similarly Maxwell affirms: 'scientific method is in essence a method of discovery'[14] and 'rational discovery' is 'the very heart of the rationality of science.'[15] Indeed Maxwell bases his attack against "standard empiricism" around the argument that because it does not countenance a rational method of discovery, science practised within this framework is in fact irrational.[16]

The notion and role of theory as already suggested also clearly distinguishes positivism from realism. As fore-mentioned for the positivist, theories or laws comprise sets of highly general universal statements the truth or falsity of which is decided with near certainty by reference to the outcomes of systematic observation and experiment. Additionally as Keat and Urry note the laws or theories delineating these regularities must meet certain criteria for the positivist. Firstly, the laws must be presented in the 'syntactical form of universal conditionals.' For example, "all politicians are egotists." Secondly, the laws or theories must be applicable across time and space. Thirdly, 'none of the terms... can refer only to particular individual items.' Lastly, they must not purport to represent any 'forms of necessity whether this is logical necessity ... or causal necessity.'[17] Instead, positivist theories must represent only non-necessary or contingent relationships the truth or falsity of which is ascertained by empirical means alone. Thus the emphasis on testing in most research.

Apart from the direct variances with realism which I shall take up later, this predominant concern with logical form has also meant, as Keat and Urry correctly point out, that the historical development of science, the psychological processes involved in the 'theoretical activity' of scientists or researchers, the 'organisation of the scientific community and its relations to other aspects of society,' have all been relegated to an external position to the logic of science. Indeed any 'results' from these areas of concern have been viewed as 'strictly irrelevant' to "science proper." In addition to these general points concerning methodology, this constrained view of the logic of science also of course has had a number of consequences for scientific method. Briefly, having rejected the possibility that an account of scientific method can be derived from a study of the history of science, the positivist also typically believes analogies and models to be of 'psychological interest'[18] only. Theory creation is an alogical process and therefore is largely ignored. Also associated with the positivist conception of science is a sharp distinction between philosophy and science. Philosophy of science for the positivist implicates an analysis of science which is 'not directly dependent upon the actual and specific context' of theories but which is executed at a 'higher' or 'meta' level and somehow produces various 'abstract, universal and objective criteria' to which scientific theory or explanation has to conform. The view of philosophy of science I uphold which maintains that philosophy of science is a part of science, is not conceded.[19] Underlying the positivist view is the conviction that there is only one logic of science for both natural and social sciences. Although this would seem to imply that positivists are naturalists, and this in most instances is correct, it is

important to note that the naturalism positivists advocate is very narrow. In short, all sciences are often perceived as stemming from 'one basic science, usually physics.'[20] As Putnam suggests, 'empiricist scientists look forward to the day when social science will look like physics.'[21] Others however adopt a different line. For example some realists like Harrē maintain that chemistry and biology provide better models for social science.

Still left unanswered adequately then are the questions of how theories are generated and how they can be effectively evaluated. The positivist of course will maintain that it is 'only observation that can provide an objective foundation for scientific theorizing.'[22] This delineation runs straight into a problem though - a problem which has come to be known as the "problem of induction." This amounts to the fact that no finite amount of observational evidence can establish definitely the truth of a statement or law. The jump from a past to future event, a sample to the universal etc is not fail-safe. Some swans are black and some politicians are not egotists!

One serious attempt to counter this problem and that of the evaluation of theories was the introduction of Karl Popper's notion of falsification which gave particular expression to the hypothetico-deductive account of scientific method. However this approach still remained within the positivist tradition and saw theory formulation as 'purely a matter of conjecture,'[23] and theories themselves as being just 'statements about regular contingent relationships in nature.'[24] Again observations alone are used to evaluate theories with observation statements being 'verified and falsified without reference to the truth or falsity of theoretical statements.'[25] Thus aside from the many specific criticisms of falsificationism,[26] Popper and hypothetico-deductiv-

ists generally, have not solved all the problems related with Inductivism. As Keat and Urry note, the problem of 'finding some epistemological foundation for scientific theories' with which to distinguish between the degrees of certainty' of 'various kinds of statement...'[27] remained. Similarly, unsolved was the problem of assessing the relative attributes of competing scientific theories. Thus I turn back to a further consideration of realism.

As previously suggested, for the realist, theory takes on different meaning and significance to that held by the positivist. As a realist, I would argue that the primary purpose of theory is to enable us to extend our referential reach. It is in this pursuit that we obtain causal explanations of phenomena and of the regular relations that exist between them. Instead of eschewing description of the structures that generate the observable phenomena, the realist constructs theories to describe them.

In extending our referential reach the task for the realist then, is to attempt to describe something he or she cannot see. Thus a model(s) is developed and employed as 'an attempted representation of the nature of that which is the subject of the model.'[28] The idea that theories are inductively arrived at and the hypothetico-deductive conjectural notion of theory formulation are both rejected. Instead, the realist relies on retroduction in reasoning from observation to proto theory[29] and then in moving from proto theory towards a more developed theory reasons by analogy via models. Once the model has been developed to the scientist's satisfaction it is then tried out or tested as a 'hypothetical description of actually existing entities and their relations.'[30] If it is "successful" then there is reason to further explore and perhaps eventually believe in the reality of

the structure the model is representing.

Following Mackinnon,[31] I believe that once this level of development has been attained, the structure that the theory purports to represent becomes an entity in its own right and the "intellectual scaffolding" comprising the model can be gently removed.

DIRECTIONS FOR RESEARCH

Anti-Realism

Glass, I believe, places undue emphasis on the role of evaluative inquiry. Indeed, as I have mentioned he maintains that currently evaluative inquiry should ideally replace elucidatory inquiry. Additionally the view of elucidatory inquiry he does brush aside, is a constrained and blighted one. This I argue, reflects the logical positivist conception of science he upholds.

It is in his very opening paragraph that Glass first reveals his anti-realist conception of science. There he declares that he is 'diametrically opposed' to Ralph Tyler's call for a 'more theoretical, scientific perspective' of 'research on science teaching.' Such an approach is exactly what Glass intends to reject; thus his call for researchers to 'turn away from elucidatory inquiry in all areas of education.'[32] Confirming his anti-realist stance, we learn that it is <u>because</u> elucidatory inquiry is 'directed toward the construction of theories or models for the understanding and explanation of phenomena' that it is discarded. This aim is considered by Glass as with many other researchers, to be 'currently unproductive' and a 'profligate expenditure of precious resources of time, money and talent.'[33]

To forestall such waste, Glass' sole recommended focus is 'evaluative inquiry of educational developments.' These he believes are the 'creations of masterful teachers inspired by what reliable knowledge' already 'exists in psychology, sociology and the other sciences concerning the evaluating process.'[34] Such a blueprint I reject.

Realism

In contrast to Glass' stance, for the post-empiricist realist theorizing is a vital part of scientific practice. For example Roger Trigg argues that 'if we wish to allow for reference to unobservable entities' then 'we must emphasise theory more than observation...[35] Similarly B.D.Haig regards theorizing as the main duty of the scientist. He suggests that 'in the interests of upgrading both the products and methods of our elucidatory research efforts' educational researchers 'should be prepared to engage responsibly in modest theorizing..'[36] Theorizing far from being an activity reserved for the "grand masters," should permeate all stages of research and scientific development. Without it real progress is precluded and stagnation is bound to occur. For without theory science can only produce a set of unrelated and relatively useless "facts" - something which ironically Glass deplores in a different article.[37] As Patrick Suppes has noted, 'recognition of theory' as 'the main carrier of progress'[38] is essential for the revival and well-being of educational research. It is only through theory that the realist can ever hope to obtain some explanation of cause. Theory provides the criteria with which to distinguish between a causal regularity and an accidental one. With theory we gain knowledge of the semi-permanent structures which constitute the world and give rise to its order because for the realist it is theory that provides a representation or description of these structures and

provides a 'set of conditional statements' accounting for how the particular structure 'reacts in particular circumstances'[39] as manifested by the external phenomena.

Hypothetico-deductivism

In addition to Glass' anti-realist philosophy of science, a logical positivist construal of the hypothetico-deductive account of science is also implicit within the opening paragraphs of his paper. This view is manifested within his definitions of elucidatory and evaluative inquiry. Glass defines elucidatory inquiry as 'the process of obtaining generalizable knowledge.' He equates this process with 'contriving'(not reasoning to) and 'testing claims about relationships among variables or generalizable phenomena.' This he assures us leads 'ultimately' to theories. The knowledge contained within the theories,'combined with knowledge of particular circumstances,'[40] he believes presents us with explanations.

This basis for elucidatory research, which although may be an accurate portrayal of much research practice, is of course totally inadequate. As Trigg among others points out, the empiricist insistence on observation, is misguiding in that it makes 'observations the only basis for theory.'[41] An incomplete account of theory building ensues. Aside from this, his meaning of the term explanation he volunteers is 'in the sense of Braithwaite'[42] which not surprisingly is a covering-law account of explanation. Perusal of Braithwaite's work discloses that for him the foundation of science or explanation is the establishing of 'general laws covering the behaviours of .... empirical events or objects' thereby 'enabling us to connect together our knowledge of the separately known events and to make reliable predictions of events as yet unknown.'[43] To discussion of these inadequacies I shall return.

With respect to evaluative inquiry this Glass describes as the determination of the worth of a thing. The methods later suggested for obtaining the information he regards as necessary to determine the worth of a thing again clearly reflect an empiricist, logical positivist conception of science.

EVALUATION VERSUS ELUCIDATION

Having introduced his central tenet that evaluative inquiry should be pursued alone in preference to elucidatory inquiry, Glass then proceeds to identify and outline nine characteristics of inquiry which he believes distinguish between the two approaches. His purpose is to now convince the reader that his decision to opt for evaluative inquiry alone is a decision worth emulating. It is to his discussion of these that I now turn for they further illuminate the logical positivist nature of his notion of scientific inquiry and also highlight some of the inadequacies mentioned, which I believe inevitably emerge from the holding of such a position.

The first alleged distinguishing feature between elucidatory and evaluative inquiry identified by Glass is the "Motivation of the Inquirer." He opens his discussion promisingly by acknowledging that they seem to be undertaken for different reasons. However what he fails to realize is that different reasons reflect and entail different purposes or immediate aims of a particular piece of research in the sense that each has a different accent although both are a part of the same scientific process. Instead, to use his own words, Glass becomes 'bogged down' in a pointless and unsubstantiated description of the mental states (not motivational reasons) of the researcher. He declares that the elucidation researcher is 'intrigued' and desires to 'satisfy curiosity' whereas the evaluator is 'concerned'.

Only the evaluator, he maintains, 'contribute(s)'[44] to the solution of a practical problem. The researcher engaged in elucidatory inquiry it seems pursues some personal whim! That curiosity and intrigue may arise out of concern is not considered and of course that they are important ingredients to imagination and thereby an aid to theory building is, even if realized, unimportant for Glass. Similarly the often integral part of theory or model employment to problem-solving is ignored. Evaluation alone for Glass is able to solve practical problems; one is forced to conclude therefore that for him, the solution is already somehow contained within the problem.

Aside from these specific inadequacies in Glass' argument, I believe a more deep-seated criticism can be made. For Glass it seems that all scientists undertake research for one of two reasons: to satisfy curiosity or to attempt to solve practical problems. Again, although this may be an accurate account of why a lot of research is engaged in, it is in no way an ideal situation and therefore I believe has to be challenged. I argue from a fundamentalist's standpoint. Thus for me the ultimate and underlying motive or reason to engage in any scientific activity is the solving of important world problems. Research then is perceived as a means by which one can make the world a better place. Questions to be answered are of the following type: what is the world like, what is our place in it, how can we make it a better place etc.[45] The pursuit of the answers to such questions leads to the advancement of human knowledge and gives inquiry an impetus and meaning as well as justification. The attainment of truth, the expansion of knowledge, the search for explanation and the solution of problems, are all secondary motives to the basic fundamentalist drive. Truth unharnessed to the improvement of our world is a hollow idol. Increasing

knowledge for its own sake is an egotist's ideal and the solving of insignificant and unimportant problems is a pointless activity as is the explanation of trivia.

This standpoint obviously runs contrary to the client-oriented evaluative inquiry espoused by the likes of Glass but it also opposes the widely held view that elucidatory inquiry is concerned with "knowledge" and evaluative inquiry with practice or action. To illustrate, quoted in E.A.Suchman (a resource of Glass) is A.C.Fleck who writes, 'the distinguishing feature converting a search for knowledge into an evaluation project is the presence of a purpose that the knowledge sought is to be used as a guide for practical action.[46] Moreover, Suchman himself states that 'a basic research project has as its major objective the search for new knowledge regardless of the value of such knowledge for producing social change.'[47] As a realist and a fundamentalist my belief is that all basic research or elucidatory inquiry should incorporate evaluation and should be conducted with action or praxis in mind. Without such a "tagging" the status quo will never seriously be challenged; something which Bhaskar believes is inevitable if the social scientist is to be rational, when 'conceptual criticism ... passes over into social criticism and change.'[48]

Lastly in this regard I would point out that elucidatory inquiry incorporating evaluation far from avoiding action is all the better to guide action for change than evaluation per se for its findings are generalizable. As Patrick Suppes has emphasised, bare empiricism can legitimately provide not even 'a practical guide for future experience or policy.'[49] Indeed for him it is because of a concern for action that he calls for more theory in educational research!

Turning to Glass' second distinguishing characteristic which is closely related to the first, "The Objective of the Search", Glass opens his paragraph in a similar fashion to before. He states: 'elucidatory and evaluative inquiry seek different ends.' Predictably what Glass does not recognise however is that elucidatory and evaluative inquiry should seek different particular ends but within the same overall objectives of science. As I suggested in my introduction, for the realist these are conjunctive not disparate parts of research practice.

Glass however thinks differently. He maintains that elucidation 'seeks conclusions' while evaluation 'leads to decisions'. This claim it seems is at best incorrectly assumptive. Again Glass has unnecessarily tied particular methods of inquiry with particular areas or concerns of inquiry. Evaluative inquiry can and does aid the reaching of conclusions which can and should lead to decisions.

John Tukey as early as in 1955 noted that 'science does not live by decisions alone' and warned us that 'one sided development ... will ultimately deflect some, if not all, of our practices into unwise bypaths.' Further he maintained that 'conclusions are even more important to science than decisions.'[50,51] Implicitly, truth at least was important to Tukey but evaluation or decision theory is not interested in this. Instead, decision theory focuses on reward (worth for Glass I suggest). Tukey writes, the inquirer (evaluator) is to judge 'whether to act as if the reward of alternative A will indeed prove to be greater than that from alternative B.' ("A>B"). However no appraisal as to the truth or certainty beyond a reasonable doubt of the statement "A>B", let alone any fundamentalist considerations, are made. All that has been carried out is a weighing of 'the

evidence concerning the relative merits of A and B and also the probable consequences in the present situation of various actions.' Importantly though when decisions are made and action undertaken often this is executed under the impression that 'A were truly >B.'[52] This clearly has not usually been established. A lot of relevant information is missing. I would add to Tukey's comments that because of this dearth of information (the sort of body of knowledge Tukey later suggests that conclusions are made in respect of) the decision-makers become open and susceptible to lobbying under a guise of science. Concurrently the chances of attaining wisdom decrease as the pursuit of more immediate "rewards" takes precedence. Equally discouraging is the fact that evidence can be false and without appropriate elucidatory inquiry the chances of recognising it as such diminish.

Finally it should be recognised that much concern with distinguishing between and keeping separate, decisions and conclusions is fruitless. As Tukey has indicated so called decisions are often 'much more nearly'[53] what he has portrayed as conclusions. Clearly though there is a difference between the two but the important point particularly with respect to (and opposing) Glass' recommendation, is that there is 'a real place for both.'[54] For example, for Tukey the 'aim and purpose of pure science lies in the conclusions which build up knowledge.' Yet these conclusions are reached because 'individual scientists decide to attack certain problems in certain ways. In turn these 'decisions are built upon the conclusions of pure and applied science.' Simply, the two are 'interrelated and intertwined'[55] but not muddled. What elucidatory inquiry needs then is a decision-theoretic framework for action.

With regard to "Laws and Description" as a distinction between elucidatory and evaluative inquiry, Glass once more discloses a strongly logical positivist, hypothetico-deductive conception of science and scientific method. Elucidatory inquiry he portrays as the 'search for laws' defined strictly as 'statements of relationships among two or more variables or phenomena.'[56] Later we are informed that elucidatory inquiry is characterized by 'a succession of studies in which greater control ... is exercised at each stage so that relationships among variables can be determined at more fundamental levels.'[57] This of course is an archetypical characterization of a logical positivist's aim for inquiry.

For the realist however, as Putnam has plainly asserted, 'this picture of social science as based on laws' is 'false.'[58] Likewise Bhaskar, notes that within society 'invariant empirical regularities' simply 'do not obtain' and thus his emphasis on the fact that society, as an object of inquiry is 'necessarily theoretical...'[59] As Harrē has argued the hypothetico-deductive depiction of scientific method 'derives merely from it being deductivist' and it 'restricts statements to sentence forms between which deductive relations hold.'[60] In rejecting deductivism he accuses it of incorrectly maintaining that 'logical order somehow reflects the natural order,'[61] of constraining the method of science to that of 'analysis and synthesis' and of fallaciously presenting mathematics as constituting'the ideal of knowledge.'[62] What at heart is being objected to is the logical positivist's assertion that this is how science should be characterized i.e. how it <u>is</u> conducted. The realist maintains of course that this simply is not the case. For example Harrē notes that 'deductive systems are quite rare'[63] in scientific practice. He suggests that much more typical are attempted

descriptions of structures and 'attributions of power' - exploratory work in general. To illustrate this point, Harrē makes reference to Newton's 'Opticks'. Harrē argues that although Newton's chosen language suggests a deductive system, 'the order is actually exploratory.' He points out that the experiments 'move from more obvious phenomena to the more recondite,and the account always passes from effects to their causes;'[64] a direction directly opposite to the deductivist cause-to-effect current. As a realist then he sees the role of inquiry as unlocking the nature of the structures which the world consists of and explaining the 'patterns of phenomena' they are 'responsible for'. It is of course a theory which constitutes 'a representation or description'[65] of such structures. Science or research then for Harrē unlike for Hempel is 'certainly not interested in establishing only predictive and explanatory correlations among observables.' Instead, it is 'interested in discovering the structure and inner constitution of natural things and their relations in the cosmos ...' and it is 'theoretical terms' which are 'precisely the best way of achieving sciences' real aim.'[66]

Returning to Glass, evaluation he claims, 'merely seeks to describe a particular thing with respect to one or more scales of value,'[67] the determining of which incidentally he leaves safely unexplored. His apologetic qualifier, merely, referring to the practice of description is indicative of the typically undervalued role description has in inquiry. I however regard it as being a neglected but vital part of elucidatory inquiry and suggest that it is usually an under-played part of evaluation studies. With regard to the latter, it seems that neither the language of logic nor the practice of testing has much room for description and with regard to the former, data-

exploratory and description-oriented patterns of reasoning are conspicious by their absence in elucidatory research.

John Tukey deplores this situation. In his paper entitled 'We Need Both Exploratory and Confirmatory'[68] he bewails the dearth of knowledge about, let alone practice of, exploratory data analysis among researchers and students. In depicting exploratory data analysis as being an attitude, a flexibility and some graph paper, he argues that the 'heart' of it is a 'willingness to look for what can be seen, whether or not anticipated.' He maintains that it is sophisticated description[69] via the 'picture-examining eye' rather than an applied 'catalogue of techniques'[70] that is most likely to achieve this end.

In examining "The Role of Explanation," Glass' fourt distinguishing feature, he presents us with the classic logical positivist belief: 'scientific explanations require scientific laws,' but firmly reminds us that 'explanations are not the goal of evaluation.'[71] Numerous objections can be made in regard to this claim. Some of these I have already discussed. Perhaps most obviously, as Harrē has indicated, 'a large class of explanations is dogmatically denied to be explanatory'[72] under this construal. But Glass goes further. In order to justify this position in regard to evaluation, he upholds the belief that a 'fully proper and useful evaluation can be conducted without producing an explanation of why the product or programme being evaluated is good or bad or how it operates to produce its effects.' For Glass then, explanation is neither the object nor a necessary part of inquiry.

Not only does Glass reject explanation as being important and thereby rejects one of the realist aims of science, but he further misinterprets the role of explanation by suggesting that this process sees science becoming 'an endless search for

subsurface explanations.'[73] He accuses elucidatory inquiry of 'chas(ing) subsurface explanations.' Ironically he lays these charges because he observes that people do seek the 'answer to the next "why"?'[74] But such knowledge he still maintains is superfluous to frugal inquiry.

What it seems Glass is not aware of however is that as Alan Musgrave has indicated, a 'genuine explanation' does not 'somehow' have to be 'ultimate'. He argues that otherwise it becomes a 'person relative affair.' An explanation may result in a further question but nevertheless the 'explanatory problem which remains is different from the problem that has been solved.'[75] Apart from this rebuff to Glass, for the realist of course, why questions must be asked. As Suppes has realised, it is this that sets us on our 'search beyond the facts for a conception of mechanism ...'[76] Likewise Harrē has affirmed that scientific explanation 'consists in finding or imagining plausible generative mechanisms for the patterns amongst events, for the structures of things.... for changes within persisting things and materials.'[77] Thus the realist view of theories is needed within evaluative as well as elucidatory inquiry. Without it, significant data patterns in the phenomena being observed will remain either undetected or ignored and the hope of eventually explaining the generative mechanisms causing the data patterns will remain forlorn.

Glass' fifth distinguishing feature refers to the "Autonomy of the Inquiry." Here his intentions are not clear to me. If he upholds Kaplan's belief as quoted that the 'pursuit of truth is accountable to nothing and to no one not a part of that pursuit itself'[78] then that evaluation is conducted 'at the behest of the client'[79] relegates it to some kind of pseudo-scientific consumerism. Glass makes no response to this implication. Additionally

it appears that an important issue here has been brushed over. Inquiry although essentially subjective in the sense that human beings conduct it and indeed for the realist are 'at the centre of science'[80] is still also autonomous with respect to the inquirer in the sense that the human being whilst practising realist science at least, is attempting to uncover and explain reality, irrespective of whether this may answer a client's 'particular questions'[81] or not.

Glass next turns to a consideration of the "Properties of the Phenomena Which are Assessed." He characterizes evaluation as 'an attempt to assess the worth of a thing' and elucidatory inquiry is 'an attempt to assess scientific truth.' "Worth" he confines to being synonomous to social-utility ignoring powerful arguments that postulate the pursuit of justice or solutions to important world problems (fundamentalism) as candidates of "worth". The pursuit of scientific truth, advocated by Kaplan, but which previously Glass has deemed 'unproductive', he does now acknowledge is 'highly valued and worthwhile'. Yet he still continues to discourage elucidatory inquiry, confirming that for him worth and its pursuit can be undertaken without regard for truth. This I object to. To use an example of Glass, happiness, based on say a false sense of security, is precarious to say the least.

Part of the underlying reason as to why Glass shuns the pursuit of truth, alluded to in his belief that it 'may ..... but only indirectly' be 'socially useful', lies within his conception of the rorms of scientific truth. These are (i)'empirical verifiability of statements about general phenomena, with accepted methods of inquiry' and (ii) 'logical consistency of such statements,' His logical positivist mould has again influenced his decision making. Little wonder, some would remark,

that under these conditions the pursuit of scientific truth is dropped! For the realist, trivial research easily fits the bill with regard to these conditions and any possible fundamentalist aims are lost as goals for scientific enterprise.

Glass moves on to also reaffirm his claim that 'all inquiry is seen as directed toward the assessment' of the two 'properties of statements about phenomena'[82] mentioned, as well as their social utility. Again though this represents a totally inadequate view of inquiry. Assessment, as outlined, is only one part of appraisal which in turn is only one part of the scientific process. Social utility as a goal I have already challenged. Empirical verifiability alone, directly opposes realism and the logical consistency requirement denies the possibility of "scientific revolutions" which are evident in the history of science.

Glass' seventh distinguishing feature is the "Universality of the Phenomena Studied." He readily points out that elucidatory inquirers work with 'constructs having a currency and scope of application which make the objects one evaluates seem parochial by comparison.' He suggests three aspects of the "universality" of a phenomenon: generality across time; generality across geography; applicability to a number of specific instances of the general phenomenon. Evaluation he explains has 'limited generalizability across time and geography' whereas the concepts associated with educational elucidation are 'supposed to be relatively permanent, applicable to schooling everywhere and they should subsume a large number of instances of teaching and learning.'[83] Again though Glass has too strongly associated approaches to inquiry with particular subject areas. Evaluation studies may and indeed should substantiate claims to generalization. Elucidatory inquiry does not necessarily make claims as to

universality in application and, temporal and geographic scales are of significance in the context of the subject of inquiry not the method. Perhaps even more disturbing is the fact that given Glass' definition of evaluation and being cognizant of his call to abandon elucidatory inquiry, we are forced to conclude that he condones an ever increasing tendency towards specialism and the fragmentation of knowledge that necessarily ensues. For outside of the framework of elucidatory inquiry, the "results" of evaluative inquiry remain raw and unrelated; evaluative inquiry in denying the importance of theory precludes the possibility of accurately integrating any knowledge claims. For the realist this tendency then, acts against the attainment of a full understanding of the world.

In rejecting this tendency towards specialism and fragmentation of knowledge, I advocate wholism. By wholism I am referring to the belief that the scientist works rationally and logically in both the areas of theory generation and theory appraisal. Additionally as a fundamentalist I emphasize that any process away from wholism detracts from the attainment of wisdom and the integration of knowledge claims; something I regard as a "higher" goal than specialized but isolated knowledge because of the fact that it is impossible to solve significant problems without the perspective of broad context.

David Bohm holds similar views. He maintains that science and technology are 'flawed activities' because they 'reflect a serious flaw in society itself: fragmentation.' This he argues leads to 'detrimental repercussions on society' and he points to a growing number of people who emphasize a need for 'general social control of science (rather than say "client control") to ensure that it will really benefit mankind....'[84] What he sees

as deplorable is the movement in science away from its original aim to 'give man a wholeness of knowledge and understanding...'[85] I would suggest that until scientific inquiry concentrates on elucidation rather than evaluation this movement deplored by Bohm will continue.

In regard to Glass' penultimate distinguishing feature, "Salience of the Value Question," he claims that value questions are the 'sine qua non of evaluative inquiry' whereas with elucidatory inquiry they are 'less obvious' although still 'germane'. 'Assessing the value of things' in regard to elucidatory and evaluative inquiry is for Glass a difference of 'degree not kind.'[86] Again, I disagree with Glass. It seems to me he has again succeeded in mistakenly interpretating the issue. I would argue that "all things being equal" the salience of the value question applies equally to evaluative and elucidatory inquiry. If the value question permeates all the activities of inquiry then its salience is not going to fluctuate in relation to the particular approach to inquiry or part of the inquiry process a researcher may be engaged in.

This aside, I want further to suggest that "all other things are not equal"; the evaluator it seems to me is in fact in a less appropriate position to make value claims. To illustrate my argument I refer to Michael Scriven's much more comprehensive consideration of the value question in his paper entitled 'The Exact Role of Value Judgements in Science.'[87] From the taxonomy of value judgements presented here it is clear that Glass' use of the term value equates with Scriven's 'value-performance' claim. Scriven's example is the ascription of 'exceptional acceleration'[88] to a particular sports-car. What Scriven stresses is that this type of value judgement or evaluation to be made legitimately, requires consideration not only of content but also

of the context of claims. Given Glass' overall strategy for evaluative inquiry though, the evaluative researcher is not in a position to be able to obtain this contextural knowledge. Thus I conclude that his or her assessment of 'the value of things' is much more limited than that of the researcher engaged in elucidatory inquiry.

Glass' last characteristic identified as a distinguishing feature between evaluative and elucidatory inquiry is "Investigative Techniques". Ironically it is similarities and sameness of techniques that he stresses; he in fact mentions no distinguishing features in this regard at all. However in citing Stake and Denny in support of his argument ('the distinction between research and evaluation can be overstated as well as understated') he neglects to also stress that they additionally emphasize that it is important that 'researchers and evaluators' must <u>both</u> receive 'skill development in general educational research methodology.'[89] This is of course what Glass throughout his paper has explicitly and implicitly argued against and denied is important or desirable. Stake and Denny, Tukey,[90] and I see the necessity of placing evaluative inquiry in context with the more general elucidatory inquiry. As fore-mentioned, I maintain that evaluative inquiry per se is relatively barren. However incorporated within elucidatory inquiry as it should be, evaluation greatly aids the attainment of research goals. Research undertaken without any evaluation incorporated within it can reach only unsubstantiated and possibly misleading conclusions. Moreover if evaluative inquiry as an activity moves beyond its almost exclusively associated confirmatory data analysis techniques towards exploratory data analysis techniques then its place within elucidatory inquiry will be greatly enhanced and research as an enterprise will be substantially improved.

Having outlined his nine supposedly distinguishing features between elucidatory and evaluative inquiry, Glass proceeds to further his discussion of the two. The fetters of logical positivism and a hypothetico-deductive construal of scientific method continue to permeate his discussion. Glass presents two analogies both claiming to describe the relationship between evaluative and elucidatory inquiry. The first is parasitic and the second symbiotic. Those advocating that the relationship is parasitic he explains argue that 'evaluation borrows techniques and knowledge .... from basic sciences and contribute little in return.' Further (and something which Glass underplays) this view sees evaluation as relying on 'knowledge produced by basic elucidatory inquiry' in determining 'whether a particular finding from an evaluation study counts as good or bad.'[91]

The second view he illustrates with reference to Suchman. Suchman maintains that 'evaluations of the success or failure of .... programmes' should be 'intimately tied to the proof or disproof of .... the best available scientific knowledge and theory of that field.' For Suchman the evaluator should therefore approach his or her task 'in the spirit of testing some theoretical proposition rather than a set of administrative practices....'[92] Glass correctly notes that this view of evaluation perceives it as being 'based on scientific knowledge and theory.' I find more sympathy with this latter view. It is this view however that Glass rejects.

In justifying his rejection, Glass maintains that 'there can hardly be said to exist an "intimate" connection between the success of a programme in the field and some theory or hypothesis from a basic discipline.' To exemplify the point he writes 'the tribal medicine man may be effective for all the wrong reasons...' Such a pathetic argument is of course totally untenable. To

continue his analogy, to know that the tribal medicine man is effective but for the wrong reasons requires as a pre-requisite, knowledge of what are the right reasons. In other words there is a strong connection between medical knowledge and the medicine man - in this example, probably the medicine man is often totally ineffective! Furthermore, our medicine man would be more consistently effective if he knew why he was effective when he was and why he was not when he was not! Although Glass still maintains that 'we can know how well or how poorly without knowing why,'[93] he ignores the fruits of generalizability and denies science and its benefactors access to progress. An evaluation of phenomena without explanation as Glass advocates is a superficial and blighted evaluation. Indeed an evaluation of such an evaluation exercise itself, using Glass' own criterion of social usefulness, would surely not score highly!

Glass does offer one further reason as to why he avoids answering "why" questions. He complains that the greater knowledge these questions point to, is 'knowledge of particulars and not codified knowledge in the form of an abstract system of laws.' Therefore, he declares it is of 'no significance'. He concedes that knowledge of particulars 'does contain explanations' but still maintains that because it is uncodified it is of no 'general interest.'[94] Once again we are reminded of his logical-positivist tie.

As a realist, my first objection to Glass' reasoning is that codified, law-circumscribed knowledge as such is like "knowledge on the shelf." Until it is applied to the particular it remains impotent. I am not here necessarily disagreeing with William Alston's argument that points out the 'disabilities' of explaining 'particular facts that "fall under" a given law'.[95] He indicates that not all facts that fall under a law will fit

the bill. All I want to point out is that until the law or codified knowledge is applied, the exceptions that make the rule cannot be known. As an aside I would also point out that in fact evaluative inquiry as depicted by Glass is all about particulars and not codified systems of knowledge. Thus as Suchman laments, it is so repetitive.[96] Does this mean that he now thinks that evaluation is of no general interest? It seems Glass is confused. Again what I suggest is needed is both evaluative and elucidatory inquiry so that general knowledge may be applied to particular concerns and the knowledge therein gained used in turn to extend our general knowledge. Additionally in reference to his own anecdote where he writes, 'my car continually loses front-end alignment because of the accident that sprang the frame'[97] it should be noted that such a statement includes an explanation as Glass does acknowledge. However for Glass because these explanations are indirect answers to why questions he views them as being of no general interest. This attitude I regard as being an over-reaction to the problem of induction and basically untenable. Surely even Glass after having worn out his fourth set of tyres, would regard as of some 'significance' the information he has on the suspected relation between his earlier accident and his tyre performance! Here before Glass' eyes is salient information for the elements of theory generation which he blatantly refuses to develop. Transposing Scriven's words, 'previous knowledge' of three sets of tyres being worn out 'gives good reason to believe'[98] that a fourth set will have a similar fate.

For the realist, this disposition of Glass, unacceptable though it is, is to be expected. It is Harrē who has pointed out that deductivism 'has led to the consequence that many philosophers have taken for granted that rationality, can be

maintained only through the use of the true/false logic of statements' and yet we have 'certain intuitions of what ways of thinking are rational', and in accordance with these we have been conducting our intellectual lives (as well as our "home mechanics" lives) very successfully.[99] Similarly Putnam wishes to "redress the balance" by 'asserting the claims of that upon which we depend and with which we live and breathe and have our being every day of our lives.'[100] Likewise Scriven points out that even 'our concept of mathematical entities is not fully formalizable' and so is 'partly intuitive'[101] and further he indicates that 'although' one can 'often communicate the results of (ones intuitive) judgements 'one' cannot communicate (fully ones) reasons.' He concludes that the 'intuitions of scientists... can provide a good workable basis for a discipline even if they are necessarily informalized.'[102] Finally Maxwell also opposes Glass' view of rationality. He reminds us that 'in actual scientific practice we entirely ignore the infinite ocean of aberrant rivals to our best scientific theories in an entirely a priori fashion' and further he points out that 'not for one moment do we set out to refute experimentally such theories' as to do this would result in 'scientific progress....coming to an immediate halt just because there will always be an endless supply of aberrant versions of our best scientific theories.'[104]

COMMENTS ON EDUCATIONAL ELUCIDATORY INQUIRY

In commenting upon 'elucidatory inquiry on education' itself over the past fifty years Glass concludes that it has been 'for the most part a failure'. I want to suggest however that the criteria with which he appraises it, renders this conclusion foregone. Firstly, Glass compares research in

education with that of the natural and physical sciences, employing the same criteria for success. Holding tightly to his logical positivist, hypothetico-deductivist standpoint, he searches for 'probablistic laws' which he maintains 'are the order of the day throughout the sciences, physical, natural or social.' The mark of successful scientific educational inquiry then for Glass is a 'body...of codified knowledge' of 'tendency statements about the occurrence of phenomenon A tending to be associated with the occurrence of phenomenon B.'[104]

Glass has assumed that the aims and methods of social science are exactly those which are appropriate for the physical or natural sciences. Further he has assumed that this is how it should be. To the realist however this is not necessarily so. Different subject areas of research may require different methods of inquiry and may demand different aims. For example Putnam notes that 'although we do sometimes succeed in constructing good explanatory models of some natural kinds in physics,' it is hopeless to seek an explanatory model of the natural kind with 'human beings'.[105] Glass further complains that the 'phenomena and facts that educational research has unearthed are so fragile as to scarcely deserve the name "fact".' Interaction, he correctly notes, 'predominates in the accumulated wisdom of educational research' and 'relations among variables appear and disappear so often as a function of extraneous conditions that one generally never knows when to expect to see the relationship'.[106] However Scriven maintains that in the 'social sciences and in other fields with a very large number of significant independent variables,' especially when memory effects are important 'verbalizable knowledge' is more appropriate than probablistic laws and furthermore it is 'likely' to be expressed in terms of weak knowledge claims and always will be limited to this.[107] Further, I would point out that given

this situation of a subject matter in flux, elucidatory inquiry is all the more urgent. Evaluative inquiry alone will never allow us to gain some grip on these elusive variables for, as mentioned before, it avoids the task of integration. This aside, to expect that social science inquiry will constitute equivalent methodology and outcomes is unwarranted and pointless. To state that the most useful scientific laws are those of physics is plainly incorrect - they are only the most useful to physics. In the words of Putnam, 'scientizing the social sciences...is a confusion.'[108]

Perhaps Glass' most basic flaw is his response to what he sees as the miserable results of educational research. That is of course to abandon it. Even given this situation, which is debatable,[109] to abandon elucidatory inquiry is a defeatist's reaction. Indeed in one sense the "poorer" the results the greater the need for elucidatory inquiry - but obviously with the proviso that our research methodology needs to be improved.

"Poor results" suggests to me poor methodology. Patrick Suppes makes a similar response. In noting the pessimism surrounding educational research, he acts to counter this situation with a call for 'a serious thrust to theory' and 'enlightened'[110] research. Something which Haig points out is particularly necessary for educational research as education's cardinal objectives are 'unobserved mental states.'[111] Thus for the realist, retraction to evaluative inquiry alone is a retrograde step. Further given that Glass bemoans that existing 'educational developments'[112] are 'a failure for the most part',[113] I would have thought that to be consistent he would have to agree that further titivation of these "results" via evaluation would be akin to flogging a dead horse! This conclusion however he does not share.

In drawing towards a conclusion Glass again posits the question of 'whether education should persevere in attempts to build a science of education.' (In a slightly different form he has already answered this question in the negative in his opening paragraph). Predictably his answer once again is a firm no. Although he does concede that it could be possible to 'pursue with success the construction of a science of education', the 'price' and effort required to reach that goal now he believes is not 'worth'[114] it.

In elaborating upon why he maintains that the "time is not right" to engage in such a pursuit, it seems to me that the reasons he presents could never be avoided. For example, he frets at the "problem" of the 'rapidly changing object of study' in social sciences and finds deterring the fact that 'inquiries become obsolete'. An underlying fear of having ones sacrosanct research results superceded permeates his reasoning. To exemplify I refer to another of Glass' anecdotes. He recounts how 'recently a biologist in charge of one of the most massive undergraduate general biology courses' informed him that 'in reviewing a 1940s vintage college biology text he discovered virtually no content he would want to teach today.'[115] For the realist of course this situation is expected and welcomed. It is the evidence that science has progressed and our knowledge grown with it. Surely to abandon elucidatory inquiry in an effort to preclude the inevitability of the "problem of obsolescence' is a deplorable and thoroughly negative suggestion.

A further reason Glass offers as to why elucidatory inquiry should be discouraged in effect amounts to, that not enough of it is engaged in! In comparing it to the 'health sciences' and agriculture in terms of persons-hours spent in the 'construction of a systematic body of knowledge'[116] Glass notes that education

ranks pitifully. This dearth of research, attributed to a lack of resources for inquiry of any type in education provides then a further reason for Glass to abandon the ship of elucidatory inquiry. Additionally Glass again takes the opportunity to decry theory; this time with a slightly different emphasis. It seems that he now wants to suggest that theory is not only a luxury we cannot afford, but that in any case it should only be treated as a "last resort". In citing Scriven favourably, Glass subscribes to his view that 'it is much better to move into theory exactly where and only when obliged to by the combination of data and needs that define our task.'

Contrary to this view, I stress that a realist should employ and recognise theory at all times during scientific inquiry. Theory is not just an "end product". For example data exploration may throw up the elements of theory generation, but it is also guided by theory. Until this is realized, the 'irresponsible gambling with society's resources'[117] which Scriven and Glass hope to avoid, I believe is greatly risked. That is why I maintain that evaluative inquiry alone is exactly such: a relatively uninformed and therefore risky gamble with society's resources.

Before finally summarizing his main thesis, Glass presents one last reason as to why he believes elucidatory inquiry should be abandoned. This one takes the prize. Predictably it is again very negative. He states, 'we can afford not to seek a theory of education at this time simply because men have always lived without complete understanding'! Moreover he maintains that 'it is usually better and safer at the level of the whole society to know how well than to know why...'[118] (Plato?) For client-oriented empiricist research not interested in challenging the status quo, this situation may be satisfactory. For those who

believe science is about progress then the suggestion is ridiculous. If ignorance is bliss then we should abolish all research in all fields whether it be evaluative or elucidatory.

ALTERNATIVE ACCOUNT OF SCIENTIFIC INQUIRY

Realism and the R.H.I. Account of Scientific Method

That I believe scientific or elucidatory inquiry is essential should be obvious. Additionally I have also stressed that the tradition of "standard empiricism" and logical positivism cannot provide an acceptable framework from which to build scientific method; hypothetico-deductivism simply is not adequate. In providing an alternative, I have argued that scientific Realism as a philosophy of science provides a promising conception of science from which to view and shape research. Already, in contrast to logical positivism, I have suggested a number of realist attitudes to and accordant practices of research. I want now to focus more specifically on the Retroductive-hypothetico-inferentialist account of scientific method because, as mentioned in my introduction, I maintain that this normative description of the scientific process, placed within the context of an epistemically rational science policy, contains a propitious blueprint for scientific inquiry. If adhered to, it would change the entire basis to and praxis of research and I believe greatly improve upon both the products and methods of most current educational research programmes.

In examining the R.H.I. account of scientific method it should first be recalled that Haig upholds this post-empiricist realist view of science from an evolutionary, naturalist, systematic, fundamentalist standpoint. It is evolutionary in the sense that he takes account of a biological rendition of how man has evolved, naturalistic in that he emphasizes the continuity

between science and philosophy and systematic in that a primary aim is to come up with a "world picture". It is fundamentalist in that the primary under-lying concern of science is seen as the solving of important world problems. With regard to the function of philosophy of science for the researcher, Haig sees it as providing an evaluation of the methodology of science and he "commissions" philosophers to provide 'methodological illumination and guidance for the practicing researcher.'[119] This disposition stems from his stressed belief that philosophy and science should not be thought of as 'different kinds of inquiry, but rather as inquiries of the same kind where the differences are of degree only.'[120] For Glass none of these considerations are viewed as significant; evaluative inquiry, as an approach to research, simply does not countenance these issues.

Additionally it should be realised that Haig sustains a wholistic view of scientific method. The traditional distinction between the context of justification (where the hypothetico-deductivist scientist works) and the context of discovery (where the inductivist scientist works) has become redundant. The realist scientist works rationally and logically in both the areas of theory generation and theory appraisal. They are indeed concurrent tasks. Owing to this modest logic of discovery (which has seen a dilution of the strong logic of discovery characteristic of simple inductivism) the emphasis upon testing, associated with hypothetico-deductivism and reflected in Glass' thinking, has considerably waned. For example, exploratory data analysis plays just as an important role as the usual monopolizing confirmatory data analysis. Finally it should be realised that Haig advocates methodological pluralism. He indicates that a weak logic of discovery (retroduction) gives us a manageable set of plausible theories that warrant further investigation. Indeed

as theories are underdetermined by the data, in the context of theory generation and theory appraisal, theoretical pluralism is in fact forced upon us.

Lastly by way of introduction to the R.H.I. account, a brief word should be made about retroduction. In rejecting the likes of Braithwaite's precept that hypothetico-deductivism is the "essential feature of science," Haig postulates that retroduction provides a good general account of theoretical reasoning and the logic to theory creation. Following from C. Pierce and N.R.Hanson, Haig formulates retroduction as follows:

> some surprising phenomena P is observed;
> if t were true P would follow as a matter of course;
> hence there is reason to think t is true.

Importantly any theory or hypothesis must be treated as an historical entity with its own developmental history. Thus there is the need for phasic evaluation of theories and consequently "ad hocness" can be defensible at the creation stage of a theory's career. Indeed for Haig methodology itself should be regarded as evolutionary.

In turning to the R.H.I. account of scientific method itself, it should first be noted that method is a dynamically interacting multiple-context affair. In contrast to hypothetico-deductivism and evaluative inquiry it involves a large number of activities: problem selection and formulation, data collection and analysis, theory generation, development and appraisal.

For Haig and his R.H.I. account of scientific method, science begins with problems formulated against a theoretical background. He endorses Thomas Nickles' belief that the 'formulation and solution of problems is the very heart of scientific research.'[12] This position is of course at variance with inductivism and hypothetico-deductivism. Both these accounts of scientific method neglect problems. The former begins its account of inquiry with

observations, while the latter begins with hypothesis or theories. The R.H.I. account however fosters a rich notion of problems. It maintains that an adequate theory of method should explain how inquiry is possible and provide for its effective regulation. Within this account then it is problem selection and formulation which does just this in respect of theory generation, development and appraisal. To achieve this task, the R.H.I. account adopts a "constraint inclusion" account of problems. By this is meant that within the selection and formulation of a problem, lies the constraints on the solution in addition to the demand that the solution be found. Examples of such constraints are, empirical data constraints, coherence and consistency constraints arising from existing theory, and methodological constraints. Haig points out that scientific problems themselves usually involve providing a satisfactory explanation for a data puzzle. Importantly they are also evolutionary. Problems are <u>generated</u> during analysis of data in the context of theory generation. They may then be <u>developed</u> as constraints come to the fore and recede as the context of inquiry shifts. Also of course they may be modified; no constraints are inviolate. Given these considerations a constraint inclusion account of problems as an integral part of method provides for a genuine, i.e. regulative, method.

With respect to data collection and data analysis, the R.H.I. account adopts Naive inductivism's stressing of the data-to-theory thrust of research but rejects its portrayal of data as theory free. Additionally it also rejects Hypothetico-deductivism's emphasis, indeed almost sole concern, with theory testing as exemplified in its employment of <u>confirmatory</u> data analysis alone. Instead and stemming from its wholistic view of science, anything is seen as potentially relevant, if plausible, and therefore should be explored. For example, Haig noting the substantial amount of scientific work which is non experimental e.g. (astronomy and some

aspects of economics), encourages both introspective and extrospective observation as possible data sources. By admitting theory generation as a methodological context, the R.H.I. account demands from the researcher a greater emphasis on data collection and analysis than is typically placed. Naturalistic inquiry and Campbell's "quasi-experiments" (case studies, participant observation studies, ex post facto studies) are all to be encouraged. The emphasis upon control and "objectivity" usually found in research programmes has been relaxed. In opposition to Glass, but accordant with the desire for researchers to spend their time working at discovery, Baconian or exploratory experimentation as opposed to the currently dominant Galilean or confirmatory experimentation, is to be encouraged. Such experiments are designed to enrich our data repertoire and coupled with exploratory data analysis should result in a heavier information yield from our data. John Tukey has illustrated well how exploratory data analysis, in supplanting mere summary and presentation of data, detects patterns and discovers anomalies. It involves looking at data to ascertain what it seems to say; it exploits simple arithmetic (substraction) recognises appearances as partial descriptions and therefore advocates the necessity of proposing theoretical mechanisms to deepen our explanations. During these activities the researcher is involved more in detective work than judicial; something which Glass wants to wipe his hands of for the next few decades.

In the context of theory generation, exploratory data analysis is of course followed by confirmatory data analysis. The then analysed data serves as a launching pad for the generation of new explanatory theories. With the intention of developing such theories, Haig propounds Bayesian statistical techniques as opposed to the usually employed inferential statistical methods. Bayesian statistical methods focus on belief

rather than action. Significant to the context of theory generation, it also doubles as a decision theory. Having taken into account beliefs, utilities and background knowledge or theory, it recommends a course of action.

In turning to theory generation explicitly, it should first be noted that in admitting a logic of discovery, via retroduction, the R.H.I. account of scientific method opposes hypothetico-deductivism which of course denies the use of such a logic. Additionally as forementioned, it retracts from naive inductivism and adopts a weak logic of discovery concerned with theoretic ampliative inference rather than the descriptive ampliative inference of enumerative induction. "Hidden-entity-postulating" theories are retroduced. Unlike the inductivist claim, retroduction as a weak logic of discovery produces a <u>set</u> of plausible theories that warrant further investigation, not a single and allegedly highly probable theory. As previously indicated theories are therefore under-determined by the data within this context of theory generation and therefore theoretical pluralism is forced upon us. Further development and appraisal is required. Haig also argues that the characterization of retroductive inference is of limited use unless it is co-joined with a set of regulative principles that enable us to operate and judge sound cases of such reasoning. Such principles will include heuristic principles (e.g. give preference to simple theories), aim oriented principles (e.g. theories must be candidates for science's goal of explanatory truth), and metaphysical principles (e.g. theories must respect human-kind's essential rule-governed nature). These regulative principles then, are constraints that will comprise part of our explanatory problem.

In reference to theory development it should be recalled that Haig stresses a developmental view of science. Theories

themselves are viewed as historical entities with a consequent developmental history. This developmental history reflects the gradual expansion of our knowledge of a theory's hidden entities. For Haig it is model construction and analogical reasoning that are most characteristic of science rather than the usually suggested systematic formulation and testing of hypotheses. For the realist, science is typically concerned with iconic paramorphic models which in attempting to identify the nature of the unknown theoretical entities, stimulate reality in a concrete visualizable image.

Finally, turning to theory appraisal, it should become obvious that the R.H.I. account of scientific method contenances a much wider interpretation of theory appraisal than either naive inductivism or hypothetico-deductivism. Cognizant of the folly of chasing ever increasing enumerative inductions, the hypothetico-deductivists' fettish with testing is also mitigated. Contrary to what Glass and the like maintain, empirical adequacy alone does not constitute theory appraisal. The "confirmational predicament" identified in Duhem's thesis and the inability of Popper to adequately overcome this problem with his dictate to assume auxiliary hypotheses are true, has forced the notion of theory appraisal to expand. Further, given the methodological pluralism associated with retroductive reasoning, theory appraisal implicates theory comparison. The under-determination of theory by evidence has necessitated a multi-criterial view of theory appraisal. Haig suggests six conceptual criteria which an adequate theory appraisal is likely to include. First, existential depth, in that we are in pursuit of theories that extend our referential reach by postulating entities of a different kind from those being explained. Second, initial plausibility, in that we need a prospective assessment

of the pursuit-worthiness of our nascent theories. Third, explanatory power, is stressed above the typically emphasised prediction and control. Fourth, heuristic worth, in the sense that new low-order ad hoc theories should not act as a heuristic block to future research, but should rather be perceived as potential full-blooded theories. Fifth, systematization, in the sense that we are interested in attaining a "world view". Internal and external coherence, order and scope become important in this respect. And sixth, guide to action. This criterion is applicable only to our mature theories; it is not reasonable to expect nascent theories to offer any clearly discernible guide to action. Indeed this point can be made in regard to all aspects of theory. As theories are developing entities within an often long historical dimension, it is necessary to adopt a phasic strategy in appraising them. Finally, before concluding, it should be realised that owing to the multi-dimensional complexity of theory appraisal, one should expect divergent theory appraisals to ensue and therefore accept that a rational defense can be given for most competing theories.

CONCLUSION

To conclude then, I have argued in this essay that most current educational research is plagued by a number of crippling inadequacies and tainted with an unnecessary number of limitations. I have indicated that this stems from the predominant acceptance of an inaccurate account of scientific method, derived from an inadequate philosophy of science, amongst the scientific community. In this regard I have denounced the empiricist tradition and logical positivism and have criticized hypothetico-deductivism. To illustrate the fate of such a basis for research, I focussed on the attitudes and recommendations of Gene Glass and argued that the evaluative inquiry approach to research advocated by him,

represented a dangerous, negativist and unscientific trend within educational research. To counter such claims as those of Glass and to improve the methods and products of research, I suggested that a much more accurate conception of science and more specifically a more accurate account of scientific method must be adopted.

In offering an alternative framework from which educational research could be conducted in the hope of achieving such an improvement in research practice, I have indicated some of the strengths of Realism as a philosophy of science. I have also introduced the Retroductive-hypothetico-inferentialist account of scientific method as developed by B.D.Haig as the best available candidate within realist philosophy of science. Additionally I have pointed out that with respect to educational research in particular, because some of its cardinal objectives are not directly observable or externally behavioural, a realist framework for research is particularly apt.

Finally, I have explained that this project was undertaken from a fundamentalist's perspective; a perspective which has determined the priorities indicated within the recommendations of this essay. From this standpoint I again stress that the necessity to realign the direction of educational research is an urgent one.

NOTES AND REFERENCES

1. Gene V. Glass: The Wisdom of Scientific Inquiry On Education; Journal of Research in Science Teaching, V.9, 1, 1972.

2. An obvious example is those involved in Skinnerian type behaviour modification programmes. They decide to attend only to behavioural objectives.

3. Corresponding in the sense that hypothetico-deductivism is not necessarily logical positivist. It usually is though.

4. Russel Keat and John Urry: Social Theory As Science; P4.

5. Ibid., p.18

6. Ibid., P.9

7. For details see p.11.

8. Ibid., p.13

9. Hilary Putnam: Meaning And The Moral Sciences; p.37

10. Keat and Urry, op cit., p.28

11. R.Harrē: The Principles of Scientific Thinking; p.106

12. Keat and Urry, op cit., p.29

13. C.A.Hooker: Systematic Realism; p.431

14. Nicholas Maxwell: The Rationality of Scientific Discovery Part 1; p.125

15. Ibid., p.147

16. See p.126

17. Keat and Urry, op cit., p.14

18. Ibid., p.23

19. Note: not all realists uphold this view. For example Bhaskar stresses his belief that philosophy of science is completely separate from "science".

20. Keat and Urry, op cit., p.25

21. H.Putnam, op cit., p.66

22. Keat and Urry, op cit., p.15

23. K.R.Popper: The Logic of Scientific Discovery; p.107

24. K.R.Popper: Conjectures and Refutations; p.30

25. Keat and Urry, op cit., p.19

26. See for example Maxwell's paper: A Critique of Popper's View on Scientific Method.

27. Keat and Urry, op cit., p.22

28. Ibid., p.33

29. A proto-theory being an undeveloped theory or existential hypothesis.

30. Keat and Urry, op cit., p.36

31. See Edward Mackinnon: A Reinterpretation of Harrē's Copernican Revolution.

32. Gene Glass, op cit., p.3.

33. Interesting parallels can be drawn with Skinner's views on research. He also shunned from the use of theory in "current" research. See B.F.Skinner: Are Theories of Learning Necessary?

34. G.Glass, op cit., p.3

35. Roger Trigg: Reality at Risk; p.67

36. B.D.Haig: The Redirection of Educational Research Methodology; p.50

37. See: Gene V Glass and Reinhold M.Kliegl: An Apology for Research Integration in the Study of Psychotherapy p.28

38. Patrick Suppes: The Place of Theory in Educational Research; p.5

39. R.Harre, op cit., p.2

40. G.Glass, op cit., p.4

41. R.Trigg, op cit., p.65

42. G.Glass, op cit., p.4

43. Richard Bevan Braithwaite: Scientific Explanation;p.261 (my underlining)

44. G.Glass, op cit., p.4

45. Maxwell implies similar views. See: What's Wrong with Science; p.61

46. Cited in E.A.Suchman: Evaluative Research; p.75

47. E.A.Suchman: Evaluative Research; p.75, (my underlining)

48. Roy Bhaskar: On the Possibility of Social Scientific Knowledge and the Limits of Naturalism; 23. His argument is as follows: 'the object that renders illusory beliefs necessary comes...to be criticised in being explained...so that the point now becomes, ceteris paribus, to change it. p.23

49. P.Suppes, op cit., p.6

50. John Tukey: Conclusions v's Decisions; p.423

51. Although I would say the two must go hand in hand.

52. Ibid., p.424

53. Ibid., p.427

54. Ibid., p.429

55. Ibid., p.430

56. G.Glass, op cit., p.5

57. Ibid., p.13

58. H.Putnam, op cit., p.75

59. R.Bhaskar, op cit., p.18

60. R.Harrē, op cit., p.24

61. Ibid., p.8 for details.

62. Ibid., p.9

63. Ibid., p.10

64. Ibid., p.9

65. Ibid., p.2

66. Ibid., p.21

67. G.Glass, op cit., p.5 (my underlining)

68. John Tukey: We Need Both Exploratory and Confirmatory;

69. Sophisticated description in the sense of perceptive rather than technical.

70. J.Tukey, op cit., p.24

71. G.Glass, op cit., p.5

72. R.Harrē, op cit., p.16

73. G.Glass, op cit., p.5

74. Ibid., p.6

75. Alan Musgrave: Explanation, Description and Scientific Realism; p.734

76. P.Suppes, op cit., p.5

77. R.Harrē, op cit., p.125

78. Cited in Glass, op cit., p.6

79. G.Glass, op cit., p.6

80. C.A.Hooker, op cit., p.412

81. G.Glass, op cit., p.6

82. Ibid., p.6

83. Ibid., p.7

84. David Bohm: Fragmentation in Science and in Society; p.159

85. Ibid., p.162

86. G.Glass, op cit., p.8

87. Michael Scriven: The Exact Role of Value Judgements in Science:

88. Ibid., p.233

89. G.Glass, op cit., p.8

90. For example Tukey: We Need Both Exploratory and Confirmatory; He writes: 'we, as statisticians or as data analysts, have thought too little about the broad general inquiry..' p.24.

91. G.Glass, op cit., p.9

92. Cited in Suchman, op cit., p.9

93. G.Glass, op cit., p.9

94. Ibid., op cit., p.10

95. William Alston: The Place of the Explanation of Particular Facts in Science; p.13.

96. See Suchman, op cit., p.77

97. G.Glass, op cit., p.10

98. Michael Scriven: Objectivity and Subjectivity in Educational Research; p.96.

99. R.Harrē, op cit., p.4

100. H.Putnam, op cit., p.76

101. M.Scriven, op cit., p.106

102. Ibid., p.130

103. N.Maxwell: The Rationality of Science, p.129

104. G.Glass, op cit., p.10

105. H.Putnam, op cit., p.73

106. G.Glass, op cit., p.13

107. M.Scriven, op cit., p.114

108. H.Putnam, op cit., p.76

109. For examples see Suppes' lists throughout his article.

110. P.Suppes, op cit., p.4

111. B.D.Haig, op cit., p.65

112. G.Glass, op cit., p.3

113. Ibid., p.10

114. Ibid., p.14

115. Ibid., p.15

116. Ibid., p.16

117. M.Scriven cited in Glass, op cit., p.16

118. G.Glass, op cit., p.16

119. B.D.Haig, op cit., p.53

120. Ibid., p.54

121. Thomas Nickles: Scientific Discovery, Logic and Rationality; p.1.

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