

Paper code: CA05021Y

ENSURING QUALITY OF METHOD IN QUANTITATIVE EDUCATIONAL RESEARCH

Robert F. Cavanagh and Peter S. Reynolds
Department of Education
Curtin University of Technology

Paper presented at the Australian Association for Research in Education 2005 Focus Conference -
Quality in Education Research: Cairns.

Abstract

Quantitative educational research methods are critiqued with a view to identifying how this kind of research can be improved. The paradigmatic considerations of ontology, epistemology and methodology are viewed from a philosophical perspective. A combination of inductive and deductive logic is used to substantiate claims made about quantitative and qualitative research. The substantive content of the paper concerns information on philosophical inquiry, quantitative and qualitative research approaches in education, and the analytic techniques specific to quantitative educational research.

The philosophical critique of quantitative methods highlights limitations of the method in dealing with the temporal and socio-cultural nature of education. This focuses on a bias in the method where more attention is given to methodology than to ontology and epistemology. However, a detailed examination of specific aspects of the quantitative approach suggests that the limitations and bias could be addressed without detracting from the inherent scientific rigour of the incumbent methods.

This is viewed as achievable by incorporating philosophical considerations in the conceptualisation of theoretical models and by exploiting fully multi-variate techniques, statistical modelling techniques, and other recent developments in the construction of attitude scales and analysis of rating scale data.

Address correspondence to Dr Rob Cavanagh
Curtin University of Technology
Department of Education
GPO Box U1987
Western Australia 6845
Email: R.Cavanagh@curtin.edu.au

Note: This paper is an abridged version of:

Reynolds, P.S., and Cavanagh, R.F. (2005). A philosophical perspective on the utility of quantitative methods in educational research. Waugh, R.F. (Ed.). *Frontiers in educational psychology*. (pp.213-230). New York: Nova Science Publishers.

ENSURING QUALITY OF METHOD IN QUANTITATIVE EDUCATIONAL RESEARCH

Introduction

Criticism directed at quantitative research methods has intensified in recent times. A sense has developed that positivistic research approaches are too narrow and limiting – too focussed on the specific and measurable, to account for the range of human phenomena associated with the broad field of education (Luke, 2003; Cobern and Loving, 2001; Allison and Pomeroy, 2000; Evers and Lakomski, 1996a and 1996b; and Carspecken and Apple, 1992). Indeed, the gathering of misgivings about certain aspects of quantitative research methods is deepened by an awareness that in some quarters of the conversation, qualitative research, which expressly observes and analyses context-specific phenomena, is considered the more likely prospect to deliver broad, generalisable conclusions about education that can be used by practitioners (Denzin and Lincoln, 2001; Lincoln and Guba, 2001; and Schwandt, 2001).

A dilemma for the quantitative researcher

Few researchers of either the quantitative or the qualitative stripe will fail to appreciate the irony or observe the emergence of paradox in the criticism directed at quantitative methods. Quantitative research approaches appear to have become both the beneficiary and victim of their own success. They benefit in that the embedded certainty of scientific methods in quantitative research ostensibly removes barriers of dogma, dilemma and doubt associated with inquiries that seek, at least with respect to education, either to extend knowledge or to solve a problem (Wiersma, 1995). As Connell (1995, p.1) observes, in this way quantitative methods in educational research are fundamentally aligned with the successful philosophical-scientific-social legacy of the theologian-philosopher René Descartes (1596-1650), involving: “(a) a quest for certainty; (b) a clear delineation between subject and object; and (c) a view of progress that is always forward moving toward a united system of knowledge”. Acceptance of these positivist features has consequently facilitated a gradual ascendancy or ‘privileging’ of quantitative over qualitative methods during the past 300 years (Jansen and Peshkin, 1992). Alternatively however, these same features also undermine confidence in the method; insofar that the search for certainty, the separation of *res cognitans* and *res extensa* and the implied forward movement toward epistemological unity, can be viewed as constraining and restricting the scope of inquiry itself. Thus a dilemma.

Merely criticising empirical research on these grounds or by contrasting it with other forms of educational research, reinforces a dichotomous view or “...the binary divide” (Luke, 2003, p.92) which bedevils research endeavours within the broader field of educational research (Cobern and Loving, 2001; Ross, 2000; Black, 1999; Carr, 1995; and Garrison, 1995). The authors contend that a pluralist view is a better alternative and that this view should be grounded in the ontological, epistemological and methodological aspects of inquiry acknowledged to form the core considerations of research processes in general (Denzin and Lincoln, 2001; and Neumann, 2000). Denzin and Lincoln (2001, p.18) construe these processes succinctly: The researcher “...approaches the world with a set of ideas, a framework (theory, ontology) that specifies a set of questions (epistemology) that he or she then examines in specific ways (methodology, analysis). That is, the researcher collects empirical materials bearing on the question and then analyses and writes about them”. Assuming there are legitimate grounds for criticising quantitative approaches in educational research, the causes, course and consequences are likely to be identified by recognising and examining the ontology, epistemology and methodology of this research approach. Whilst a congruence of ontological, epistemological and methodological matters is often cited as a strength

of qualitative approaches (Cobern and Loving, 2000) – and forms an almost obligatory deliberation in the design of this kind of research (Denzin and Lincoln, 2001) – it is timely to reconsider the implications of these matters for quantitative research. In advancing this contention, it is important to note that the bifurcation between positivistic and interpretive research is typically justified in terms of the philosophical questions that have historically underpinned scientific research. The bases for these claims can be observed by examining the philosophical arguments directed at quantitative research in philosophical ways – that is to say, with the tools of critique used by philosophers.

A philosophical critique of quantitative research

The question posed here is – ‘why can quantitative methods be criticised as narrow?’ Superficially, this appears to contain the seeds of both its own contradiction as well as that of self-fulfilling prophecy. To ask in broad terms why such and such a thing is so and to enquire as to the cause, reason or purpose of some action, situation or idea, necessitates an immediate and apparently unavoidable narrowing of the speculative attitude that predicates the question in the first place. This carries with it an inherent action to contextualise and situate(s) the subject matter in a way that reduces generality and increases specificity. Indeed, one may go so far as to say that merely contemplating the speculative question ‘why?’ or ‘why not?’ about anything serves in the first instance to circumscribe and delimit the parameters of understanding one may conceive toward that thing.

Then, could the answer to the question be self-evident? The reason why quantitative methods can be criticised in this way is because any act to investigate cause, reason or purpose, will inevitably constrain the scope of the subject matter contemplated (and hence, the generalisability of conclusions drawn) simply by virtue of the processes involved in the act of investigation itself. Overtly, there appears to be a grain of truth of truth in this. However equally, one may see the argument evaporate if it is recognised that this conclusion presumes that somehow questions can be posed without a context; or tangentially, that meaningful responses to questions can be disassociated from a supporting framework of contextual constructs.

Of course, it is over questions and choices such as these that the ontological problems confronting researchers begin in earnest. Two interrelated issues are prominent. The first consists in serious, although seemingly, chicken-and-egg propositions as to the nature of being *qua* being. ‘Being’ seems to be temporal, identifiable and definitive solely in the context of a construction of understanding knowledge that provides the basis for meaning. Palmer (1999, p.5) explains, “Being as it occurs in the everyday existence of human beings is understanding. Understanding is the basic way for a human being to exist in the world. To ‘be’ is to understand, it is to interpret the world in terms of one’s own possibilities for being”. Thus, questions as to whether mind and body should be conceived separately or as a unity; whether or not it is possible for the researcher to stand outside of a situation and observe and report objectively on what occurs in the ‘real’ world; whether or not epistemological unity is conceivable or even desirable, are essentially irreducible questions whose answers will occur in different ways to the individual researcher (Palmer, 1998 and 1998). As Lincoln and Guba (2001, p.176) put it, fundamentally, it is “...an open question” as to “...whether or not the world has a real experience outside of human experience of that world”. More tangible however and possibly providing a surer footing for making ontological decisions, is the second issue, touched upon in the preceding paragraph. This is, whether or not questions can be posed and/or answered without acknowledging and addressing the contexts in which they are perceived to exist. More so than in the metaphysical questions outlined above it seems, this is the crucial, defining issue in ontological debates over the verity or otherwise of quantitative and qualitative research methods. Two reasons serve to substantiate this. These concern the temporal and socio-cultural contexts in which research is inevitably situated.

Firstly, there is cogent evidence to suggest that human meaning, and consequently, our interpretation and understanding of words, terms and phrases changes over time (Chantrell, 2003; and Leung, 2000). How this occurs is that the meaning of words can become wider or more specific or perhaps redundant, depending on their imputed attributes, their levels, degrees and contexts of use, the ways in which they are defined and redefined and so forth. The necessary consequence of shifting linguistic meaning therefore is that human interpretations of ideas, actions, situations and texts with which they come into contact will change over time and in different contexts (Shikiar, 2000). This first claim extends not only to our temporal understanding of words, but also to our conception of time and to 'timeless', artificial languages such as mathematics (Poovey, 1998; and Sainsbury, 1993). With time itself, it has been observed that the linear manner in which most humans currently conceive the progression of time has changed markedly down the years (Nisbet, 1979).

A second reason why the authors sense firm ground in claiming that questions can be neither posed nor answered without reference to socio-cultural context can be derived from observations made in the field of hermeneutics; in particular, the eclectic branch of hermeneutics called philosophical hermeneutics, whose principal aim is to understand the processes of human understanding (Gadamer, 1960; Reprinted 2000). There is much that is pertinent to the foregoing that can be drawn from this field of investigation (Gadamer, 2001, 1976a, 1976b; Grondin, 1994). However one conclusion of especial significance here concerns the nature of understanding itself. Kerdeman (1998, p.2) puts it thus:

“Understanding ... is not an optional behaviour for human beings. Neither is meaning something we can deliberately set out to produce. Rather, we human beings cannot help but engage in understanding the people, events, institutions and practices that comprise our everyday world. As Gerald Bruns put it, ‘one can hardly not understand’ [1992, p.3]. Understanding is possible and indeed, unavoidable, because we are ‘thrown’ into socio-historical contexts that are saturated with meaning which have always already been interpreted”.

And, irrespective of the disputable claim as to whether we are ‘thrown’ or otherwise into ‘socio-historical contexts... saturated with meaning’ (Giarelli, 1998), there appears to be considerable commonsense in the broad thrust of this view about understanding. At bedrock, the aim of research is to understand something a little better.

Thus, some kind of resolution concerning the twin issues of temporal and socio-cultural context can be considered paramount in expressing an ontological viewpoint for research endeavours including quantitative inquiry. The logic predicating these can be expressed in a standpoint that accepts, “All research (as) interpretive; (as) guided by a set of beliefs and feelings about the world and how it should be understood and studied” (Denzin and Lincoln, 2001, p.19). The first, again, concerns the topic of context; although in this respect refers to the interrelationships between ontology, epistemology and methodology - specifically in educational research approaches. The second involves the more general problem as to how interactions between the three produce methodologically ‘guaranteed’ endpoints.

Conflation of methodology in discipline-specific research norms

Essentially, the methods used by educational researchers are not specific to education. Rather, they are drawn from a range of related academic disciplines (Denzin and Lincoln, 2001; Burns, 1999; Jaegar, 1998; Cohen and Manion, 1997; Glesne and Peshkin, 1992; and Le Compte, Millroy and Priessle, 1992). Of course, this feature has wide-ranging implications for the way educational research is conceived, conducted and analysed. Schulman (1998, p.5) for example, foreshadows the kinds of explicit issues and inherent problems we may expect if this characteristic is ignored when choosing and applying methods and methodologies in educational research:

“A major reason why research methodology in education is such an exciting area is that education is not itself a discipline. Indeed, education is a field of study, a locus containing phenomena, events, institutions, persons and processes, which themselves constitute the raw material for inquiries of many kinds. The perspectives and procedures of many disciplines can be brought to bear on the questions arising from and inherent in education as a field of study. As each of these disciplinary perspectives is brought to bear on the field of education, it brings with it its own set of concepts, methods and procedures (and often modifies these) to fit the phenomenon or problems of education. Such modifications, however, can rarely violate the principles defining these disciplines from which the methods are drawn”.

In other words, there appears to be a clear and present danger for those conducting educational research, that the methodology one chooses and applies when observing, recording and analysing an educational phenomenon, will be predicated by – or perhaps worse, confused and conflated with – the ontological and epistemological norms and aims of the discipline from which these methods were originally drawn.

Obviously, this feature of educational research processes is hardly unique to empirical research and the work of quantitative researchers. A case can be put with comparative certainty that it occurs equally in the choice, applicability and generalisability of research of those engaged with work from both qualitative and quantitative perspectives. Scriven (1988) for example, makes converging and commonsense points that a qualitative researcher conducting analyses of educational concepts, is as likely to produce philosophy for its own sake, as much as a quantitative researcher is likely to confuse the statistical with educational significance of observed phenomena. Indeed, Suppes (1995, p.9) makes precisely this point in providing three appendices to illustrate why conflicting goals in education and other disciplines “...cannot be settled by first-level rational argument but require negotiation and bargaining among interested parties”. The propensity for confusion and conflation therefore, can be said to exist in equal measure for researchers of both the quantitative and qualitative variety.

However, this adds further depth to the original question posed here: Why, in despite of an apparently equivalent propensity for both qualitative and quantitative research in education to become conflated with the ontological and epistemological norms and aims of the discipline from which research methods are originally drawn, is the charge of conflation levelled with greater persistence at the quantitative rather than qualitative camp of educational researchers? The answer would seem to lie with the second aspect indicated above concerning the more general problem as to how interactions between ontology, epistemology and methodology combine to produce methodologically guaranteed endpoints.

Irrespective of the ontological standpoint one conceives and the epistemology one devises to ask and respond to research questions, the method chosen to complement these aspects will, inevitably, pose certain liabilities. Why? Primarily because method provides an instrument to propel one *toward* something or *to do* a thing. In education, as in other fields of research, what this means is that in most cases an image of where exactly one is heading will become necessary because research is an inherently purposeful activity.

This general difficulty associated with conflating ends with means has been examined in various ways. The Greeks’ original conception of the problem issued from the idea called ‘*techne*’ (literally, skill, art, craft, knowing how) whereby the artisan produced some article by following a guiding image or ‘*eidos*’. Broadly therefore, *techne* can be said to represent the means by which some end is reached. It involves disciplinary knowledge, it is oriented toward ends, it seeks to produce useful results and requires mastery of general rational principles that can be explained and therefore taught (Hoffman, 2002). The defining characteristic however, is that *techne* is primarily

concerned with the *uses* for which the image is conceived. In outlining Gadamer's concerns with this concept, Blacker (1995, p.5) highlights this feature with the comment that;

“...(the) image is of the *use* to which the product will be put, which...persists unaltered in the realisation of the thing. In technological thinking, the guiding image or end becomes hidden and resists being called forth by understanding; the ends of our activities tend to become sedimented beneath an all-encompassing concern with the means. The attitude of questioning is thereby suppressed in favour of the norms of a purely instrumental rationality”.

The results of this propensity to conflate ends and means are recognisable in virtually every field of human endeavour. This has been considered at length (although with mixed results [Cobern and Loving, 2001]) in many of the more 'technological' disciplines such as medicine (Hoffman, 2002), computer engineering (May, 1994), and science generally (Elster, 1989 and 1983). However, educational research contains the added potential for means and ends to become conflated in other key ways noted in the preceding. These can occur, firstly, through the inevitable intrusion in educational discourse of the twin aims of education - the intrinsic and instrumental (Carr, 1995). Secondly, as a matter of necessity when dealing with the range of related disciplines with which education is concerned (Schulman, 1998). Finally, when dealing with the core ontological choices required of the educational researcher – expressed variously as the 'subjective-objective dyad' (Jansen and Peshkin, 1992) or the 'objectivism-subjectivism controversy' (Couch, 1987), or 'objectivism versus relativism' (Bernstein, 1983), or more evocatively perhaps, 'empiricist-idealist' (Riley, 1974) viewpoints.

Undoubtedly, all of these characteristics are present in both qualitative as well as quantitative research. However it seems that the reason why these pose more of a problem to quantitative rather than qualitative methods is their tendency to appear in combination in quantitative research. As well, these exist in many cases in raw, unchallenged form in the questions that frame the research and the results produced (Evers and Lakomski, 1996a and 1996b). An unquestioning adoption of 'objectivity' as *raison d'etre* is to leave oneself open to the views that on one hand, research can be conducted without reference to context, and on the other, that perhaps, there may be other, better ways of conducting research. Why this should occur seems to the authors to have much to do with the declarative stance of 'certainty' taken by a position that assigns to itself endpoints that can be attained through its own actions. Common sense dictates that some form of empiricism is essential to make sense of the world. Although, an approach which assumes that methodologically guaranteed endpoints are unassailable smacks both of academic idleness; and worse, of an illogical intellectual corruption that serves to negate the proposition on which it is based. Recognition that the speculative attitude of philosophy exists and serves to inspire research in the first place seems to be, if not the most incisive way of dealing with the problems associated with quantitative research, then at least an ethical and intellectually honest starting point.

Extending the boundaries of contemporary quantitative educational research

The nature of quantitative research

Precise explication of what methods and analyses constitute quantitative research is inherently difficult due to the multiplicity of data collection methods, and the treatments of data applied in the guise of quantitative research. The view that quantitative research produces numerical data in contrast to qualitative research producing textual data (words) is one way, albeit an overly simplistic means, of differentiating between quantitative and non-quantitative research (Krathwol, 1993). This simplicity can be illustrated by the generation of numerical data in qualitative research methods such as content analysis and non-participant observation - numerical data based upon frequency of occurrences or observations can be produced (Fraenkel and Wallen, 2002). One way to

sharpen focus on quantitative methods is to examine the type of numerical data collected. For example the production of ordinal data that presents a comparison of varying degrees in a characteristic of persons or an object of measurement might be construed as more 'quantitative' than categorical data representing occurrences or frequencies. Similarly, production of interval data which can be plotted on a line or scale in which the intervals between the points on the scale are equivalent in magnitude might be construed as more 'quantitative' than production of ordinal data. While such comparisons may appear crude, they do illustrate some fundamental differences in the techniques and tools of quantitative research.

The nature of these differences can be viewed in terms of measurement. For example Wright and Masters (1982) identified four requirements of measurement. These are:

1. Uni-dimensionality - data measures a single or dominant trait;
2. Qualification - data can be compared;
3. Quantification - variables are measured in common units; and
4. Linearity - data is positioned on a line or scale.

Another perspective on these differences can be obtained by examining the difference between 'stochastic' and 'deterministic' measurement models. In stochastic models, the relationship between total score and a person's ability to correctly answer questions is probabilistic - the probability of a person being successful on a given item is a function of the interaction between that person's ability and the difficulty of the item (Bond and Fox, 2001). Alternatively, in deterministic measurement models, the relation between the observed responses and person ability is explicated as a causal pattern - raw scores are often taken as a measure of person ability (Bond and Fox, 2001). Further, application of stochastic models including the Rasch model enable person and items measures to be plotted on an interval-level scale in contrast to the use of 'untransformed' raw scores in deterministic techniques which are ordinal but not necessarily interval. The point in drawing attention to the properties of different measurement models concerns the implications of using the respective models in educational research – a stochastic model produces an more accurate measure and hence a highly valid representation of what is being investigated.

The predominant tools of quantitative educational research are questionnaires, checklists, tests and scales (Gay and Airasian, 2003; and Kerlinger, 1986). These are measuring instruments – they provide numerical scores that are typically assigned to an individual to indicate the individual's (subject's) level of possession of what is being measured (object). In the behavioural sciences, the object of measurement is classified typically and arbitrarily as a trait, an attitude or a value (Kerlinger, 1986). From a behavioural research perspective, a trait is a relatively enduring characteristic of the individual. This characteristic is evidenced by a certain manner of response or behaviour(s) in all situations (e.g. mathematics achievement, reading ability and intelligence). Alternatively, attitudes are organised predispositions concerning thinking, behaviours or feelings towards a referent or cognitive object (e.g. student predilection for self-paced learning, teacher preference for cooperative learning strategies and school principal disposition towards collaboration). On the other hand, values are culturally weighted and express preference for a mode of conduct or an ideal situation (e.g. democratic school governance, pupil rights in the classroom and parental participation in schooling). The strong influence of psychology in early educational research placed initial emphasis on measurement of behavioural traits. The development of sociology broadened the scope of educational research with proposition of psycho-sociological and socio-cultural theories about learning and learning environments. While this trend saw the emergence and strengthening of qualitative educational research, it also led to increased emphasis on quantitative educational research concerning attitudes and values about education.

The reason for presenting this brief and somewhat simplistic view of developments in quantitative educational research is twofold. Foremost, it serves to draw attention to a change in the object of measurement in quantitative educational research; and secondly, to examine the

implication of this change for research design. The object of measurement has moved beyond the behavioural characteristics of individual students to more intricate phenomena such as processes of learning and the social systems in which learning occurs. Fortunately for quantitative researchers, there has been a corresponding development in analytic data processing techniques and the power of computers to perform appropriate analyses - complex multi-variate and multi-factorial tests can now be easily and quickly conducted on personal computers. Thus, educational problems that have been traditionally deemed to require use of qualitative interpretive research methods can now be investigated in quantitative ways. For example, investigating socio-psychological and socio-cultural dimensions of education such as parental receptivity towards the classroom environment (Waugh and Cavanagh, 2002), university students' attitudes and behaviours towards studying and learning (Waugh, 2003), and client satisfaction with public education (King and Bond, 2003).

However, advocating more widespread use of quantitative methods for educational research on the basis of the appropriateness and capacity of analytic techniques requires a tempering in cognisance of the need for thoroughly attending to conceptual matters in research design. Statistical data analysis is only one component in the quantitative research process and even the most sophisticated analyses cannot compensate for poor research design. Indeed the validity of empirically derived results and the utility of these results are highly contingent upon the attention to conceptual issues and detail applied in gaining a preliminary understanding of the phenomenon under investigation. Thus the challenge for quantitative educational researchers investigating new and multifarious problems lies in addressing conceptual matters rigorously *prior* to collecting intricate data and conducting complex data analyses.

Philosophical reasoning is an ideal method for gaining this initial conceptualisation of what is being investigated. To philosophise about the nature of a problem involves assaying existing knowledge to identify variables and propose relationships between these variables. Usually this involves formulating propositions that can be tested. Given the brevity required in a study of the present kind however, such a thoroughgoing approach is impractical. Thus the approach taken here is to present a series of axioms to emphasise the implications of the respective discussions for quantitative educational research.

Three axioms

Three axioms were framed from the preceding discussions of philosophical inquiry and quantitative research:

1. Philosophical considerations underpin quantitative as well as qualitative educational research;
2. A pluralist philosophical orientation is consistent with the objectives of quantitative research methods; and
3. Theorising in quantitative educational research requires consideration of the interpretive dimension of qualitative research.

Axiom 1: Philosophical considerations underpin quantitative as well as qualitative educational research.

Philosophising is indispensable to research processes. Philosophy – meaning literally, ‘a love of wisdom’ (from Archaic Greek; *philosophia*) – was originally a blanket term used for dealing with all questions about humanity, the physical universe and the manner in which perceptions about the two were perceived to interact through rational human thought (Mautner, 2000). Whilst questions about the physical universe (i.e. ‘natural’ philosophy) were gradually hived off into specific disciplines such as biology, chemistry, physics and so on, the present concerns of ‘philosophy’ have become increasingly focussed in three areas. These are:

1. Epistemology, or enquiry into the nature and ground of experience, belief and knowledge;

2. Metaphysics, or the immanent or transcendent investigation of the world and of what really exists; and
3. Ethics, or how people should act in general, rather than as a means to an end (Bullock and Trombley, 1999).

Firstly, from an epistemological viewpoint, educational research concerns either directly or indirectly those who are the object of instruction or those who choose to engage in learning. From the researcher's perspective there is an absence of 'objective reality' in the object of research since education cannot exist apart from those who are being educated. Also, how individuals perceive education and their own educational experiences is a process of cognitive construction in which these perceptions are influenced by personal and cultural factors. Whilst matters of objectivity and subjectivity can be addressed by controlling variables in the design of quantitative empirical research, this has not always been possible, nor may it be necessarily desirable for all cases considered.

This is particularly so in investigations into behavioural dispositions, attitudes and values. When the object of investigation is a latent trait that cannot be measured directly, the trait is assumed to be indicated by 'observable' variables and instead, it is these variables that are measured. The theoretical assumptions applied in conceptualising the manifestation of latent traits exemplify philosophical methods of inquiry. Theorising and hypothesis formulation is typically informed by the findings of previous empirical research but the processes employed in the initial stages are themselves not empirical. Rather, they require application of all of the three main kinds of logical reasoning (i.e. inductive, deductive and inductive-deductive). Thus although the validity of the resulting conceptualisation will be tested by empirical methods, the veracity of the initial theoretical model will be dependent upon the logic applied and the rigour of the reasoning.

Secondly, metaphysics is a less obvious but still crucial issue in quantitative educational research. The metaphysical aspect of philosophy invokes fundamental questions about the world and how we construct meaning about the world. A case in point is the application of chaos theory and fuzzy logic to social science research and how this affects the way research is conducted and the results are interpreted (Dimitrov and Hodge, 2002). Chaos and complexity theories are advanced as providing a more accurate representation of natural and social phenomenon in that they acknowledge uncertainty as evidenced by the presence of random events and behaviours. However, from a measurement perspective, errors of measurement have to be carefully differentiated from naturally occurring fluctuations in the object of research since unaccounted for variance in the data could be a characteristic of what is being measured. What is perceived as 'noise' in data obtained from one sample or at one time could be due to an unidentified variable that might be measurable in a larger sample, or perhaps, in a longitudinal investigation, or a future investigation, or perhaps be revealed by meta-analysis. However, drawing attention to non-traditional views of the world and how it is understood is not an argument for replacing science with metaphysics. Rather, metaphysical considerations provide the impetus for creation of 'new' sciences based upon alternative methods of inquiry and analysis.

As was noted previously, the analytic methods applied in quantitative educational research are often described in terms of probabilistic and deterministic approaches (Banerji, Smith and Dedrick, 1997). The results of applying probabilistic techniques in empirical investigations produce a different view of the object of inquiry to that obtained when deterministic techniques are applied. The concomitant metaphysical issue that arises from this observation is considering the relative merits of viewing the world as probabilistic or deterministic. In mathematical terms, the deterministic view is that $2 + 2 = 4$. Alternatively, the probabilistic view is that the summation of these two numbers is likely to produce a value larger than 2 and less than 6. Although probabilistic psychometricians have strong grounds for asserting the utility of algorithms based purely on

probability theory, the hypothesis and model testing techniques applied in deterministic statistics also apply probability theory when estimating the significance of a result. However, it is worth noting that the use of this theory in deterministic measurement approaches is grounded on assumptions about normally distributed populations producing normally distributed data that is assumed to be a measure of the subjects (persons). In contrast, probabilistic methods such as Rasch modeling treat item data and person data separately but within one measurement model (Andrich, 1982; Andrich, 1988; Wright and Masters, 1982).

The relative merit of these approaches is not an esoteric issue in quantitative educational research since the results (indeed, the intention) of this research (will) affect the lives of students, teachers and other educational stakeholders. Hence, the choice of the statistical algorithms used to standardise or calibrate educational measures could be viewed from an ethical perspective, which is the third concern of philosophy.

The debate about what is ethical and unethical in educational research has recently assumed such a high level of importance that possibly the larger portion of the philosophical debate turns on the prescription of ethical standards for conducting research. The ethical requirement for research to be methodologically valid and reliable is now inextricably linked with the ethical matter of protecting subjects, particularly children, from physical and psychological harm. Thus, ensuring consent, subject anonymity, and the right to withdraw from participation, can place limitations on sampling procedures, access to appropriate subjects and sufficiently large samples, and samples that are randomly distributed. The point however, is that the ethical imperatives faced by a researcher, form only one aspect of the wider philosophical considerations, issues and problems involved. These of course, require consideration of context as well as those difficulties arising when the outcomes of deliberations are predetermined by the methods used or alternatively, when the method delimits understanding of the problems involved.

Axiom 2: A pluralist philosophical orientation is consistent with the objectives of quantitative research methods.

In quantitative educational research, the classical dualism of educational research, the tension between subjectivity and objectivity is often addressed by adopting an objectivist, empiricist or positivistic approach, and then by applying a scientific research design. This assumes that researcher bias can be eliminated, in contrast to qualitative research that assumes objectivity cannot be guaranteed nor is desirable. Consequently, an interpretive methodology is selected such as ethnography, phenomenology or perhaps critical theory. The methodology-ontology nexus is potentially limiting on the choice of problems investigated in quantitative research because phenomena that are pluralist or subjective may not be considered researchable topics. This is itself an ontological matter in that the initial view of what is to be researched is largely influenced by pre-existing researcher orientations.

One way to address this problem and to avoid delimitation of both the problem and possible solutions when initially conceptualising a problem is to develop preliminary theoretical models *inclusive* of dualisms. Care must be taken however, in conceptualising complex models since conceptual inconsistencies at this stage can lead to data that may or may not be amenable to certain forms of analysis. For example the correlational basis of Exploratory Factor Analysis makes this analysis very amenable to identifying structure in multi-dimensional data. To produce a multifactorial solution, the data within factors should be strongly associated, albeit in conjunction with weak association between the data in different factors. In contrast, the Rasch modelling analytic technique that tests the fit of data to a model, requires the data be strongly associated if it is to fit a uni-dimensional model. Although the requirements for data to model fit are also stringent in structural equation modelling techniques such as Confirmatory Factor Analysis and Latent Variable Path Analysis, the measurement and structural models tested can be multifactorial.

Provided the research is designed with a clear understanding of the strengths and limitations of particular analytic techniques, quantitative methods are also most appropriate for investigating educational problems of a subjective nature, such as those studied in socio-cultural research. The argument against using quantitative methods in this field is typically framed in terms of the need for developing a contextualised understanding obtainable solely by application of interpretive methods. The process of interpretation assumes that researcher objectivity is undesirable since the subjectivity in the phenomenon investigated can only be fully revealed by the researcher not being objective. Whilst this is clearly an example of the previously examined notion of methodological conflation and can be criticised from this perspective, it also presumes that collection of data from persons (the ‘subjects’) will not be sufficiently detailed or comprehensive. If this is the argument accepted, then the limiting factor in application of more objective methods concerns the type of data collected and scope of data collection rather than the issue of researcher subjectivity-objectivity.

The utility of using quantitative methods to study culturally situated problems therefore is likely to be dependent upon decisions about instrumentation and sample selection in conjunction with non-reductionist methods of data analysis. This can be recognised for example, in the development of attitude scales. The items need to elicit data that are; relevant to the problem; sufficiently comprehensive to cover all aspects of the problem; and that are also ‘sensitive’ to differences between respondent views of the problem. That is, using a scale construction process that ensures fit of data on both items and on persons to a well-conceptualised theoretical model. Accounting for variation in person data is particularly important since incorporation of this procedure alleviates the reductionism that results from analyses of only item data. In this regard, the use of Rasch analyses to develop and evaluate attitudinal rating scales, supplies ample evidence of the viability of contemporary quantitative methods for research into subjective educational problems.

Axiom 3: Theorising in quantitative educational research requires consideration of the interpretive-philosophical dimension of qualitative research.

Much of the preceding discussion of quantitative research has emphasised the problem solving aspect of research and presented an ‘applied’ in contrast to ‘basic’ view of quantitative educational research. According to Wiersma (2000 p.10), the difference between these views is a matter of purpose; “The primary purpose of basic research is the extension of knowledge; the purpose of applied research is the solution of an immediate, practical problem”. Gay and Airasian (2003 p.7) considered “that many educational studies would be located on the applied end of the basic-applied continuum”. These authors view basic research as theory development or enhancement and noted; “it most closely resembles laboratory conditions and controls usually associated with scientific research” (Gay and Airasian, 2003, p.7).

The association between basic research and scientific research implies that the purpose of quantitative educational research is more closely aligned with that of basic research. This perspective provides an explanation of why quantitative educational research is criticised on non-utilitarian grounds as being insufficiently applied. Indeed, as has been previously noted, the attention given to scientific methods in this kind of research is often perceived to limit the utility of quantitative research to solve educational problems. Views such as this provide a reminder as to why the method as applied in educational research is subject to criticism and importantly, reiterates how this criticism can be countered.

Theorising is a component of both quantitative and qualitative research, although it may be applied at different times and for distinct reasons throughout the research process. In traditional quantitative research, theorising is typically applied in the initial stage of the research endeavour with conceptual matters being addressed prior to commencement of the empirical investigation. The

purpose of this initial theorising is development of theoretical models and hypotheses that will be subject to empirical testing. In qualitative investigations, theorising and hypothesising, although described in different terms, are often applied repeatedly and continuously within the empirical investigation. This is an inductive exercise in which data collection and interpretation are regularly applied to provide description and understanding – in other words, a process of theory building. There are recognisable similarities between this procedure and the processes applied in the development of quantitative theoretical models.

Theorising in quantitative educational research usually commences with an examination of previous research and literature anticipated to be pertinent to a particular problem. The process is developmental with different constructs being identified, compared, contrasted, and related to the research problem. Induction is applied to classify and examine potential associations between constructs and develop a preliminary conceptual structure. Deduction is applied to assess the validity of these associations and of nascent conceptual structures with respect to the research problem. This continues in an exhaustive cyclical manner until all potentially relevant constructs have been either rejected or incorporated in a hypothetical model and this model has been subject to content validation against existing assumptions and knowledge. Ostensibly, the major difference between this process and that of qualitative research is the source of the data/information that was assessed. In the latter, the information is empirically derived, whereas in the former, the information is obtained from published sources.

The reason for drawing attention to this procedural similarity is to assert the potential for the philosophical approach as applied in qualitative educational research to benefit theoretical model development in quantitative research. Fundamentally, this requires consideration of the three fields constituting the paradigmatic bases for inquiry – ontology, epistemology and methodology. Additionally, in certain circumstances, a greater focus upon the dominant concerns of present-day philosophy; especially epistemology and ethics. One way of understanding and justifying this proposal is to take a holistic view of ‘methodology’, by giving concurrent and conjoint attention to ontological, epistemological and methodological issues. When applied to theoretical model development, this approach has the potential to infuse what some might consider a purely epistemological process with elements of personal and social subjectivity. However, the proposition becomes more convincing when the infusion results from dialogue between researchers *and* self-reflection on the part of the individual researcher – the cornerstones of classical philosophy.

Conclusion

The thesis of the paper concerned strengthening the role of quantitative research in the field of educational research. The authors contend that for too long the benefits of philosophising have accrued in qualitative educational research and in view of this, it appeared timely to examine how the principles and methods of philosophic inquiry might reasonably profit, indeed, strengthen, quantitative educational research. Further, the authors assert the consequences of inattention to philosophical matters when designing and conducting quantitative investigations in education will likely be further marginalisation of the quantitative method to the detriment of educational research in general.

References

- Allison, P. and Pomeroy, E. (2000). How shall we know? Epistemological concerns in experiential education. *Journal of experiential education*, 23 (2) 91-99.
- Andrich, D. (1982) Using latent trait measurement to analyse attitudinal data: a synthesis of viewpoints, in: D. Spearitt (Ed.), *The Improvement of Measurement in Education and Psychology*, pp. 89-126. Melbourne: Australian Council for Educational Research.
- Andrich, D. (1988) *Rasch Models for Measurement*. Sage university paper on quantitative applications in the social sciences, series number 07/068. Newbury Park, CA: Sage Publications.
- Aristotle. (L. Barnes [Transl. & Ed.]). *Metaphysics*. Melbourne: Penguin.
- Bernstein, R.J. (1983). *Beyond objectivism and relativism: Science, hermeneutics and praxis*. Philadelphia: Philadelphia University Press.
- Black, J. (1997). Education versus training? [on-line]. *Malaspina Univeristy College*. Available: [URL:http://www.mala.bc.ca/~black/training.html](http://www.mala.bc.ca/~black/training.html)
- Blacker, D. (1993). Education as the normative dimension of philosophical hermeneutics. *Philosophy of education yearbook, 1993* [On-line]. Available: URL: [http://www.ed.uiuc.edu/EPS/PES – Yearbook/93_docs/BLACKER.HTM](http://www.ed.uiuc.edu/EPS/PES-Yearbook/93_docs/BLACKER.HTM)
- Bond, T.G., and Fox, C.M. (2001). *Applying the Rasch model: Fundamental measurement in the human sciences*. New Jersey: Lawrence Erlbaum Associates, Publishers.
- Bullock, A., and Trombley, S. (1999). *The new Fontana dictionary of modern thought*.
- Burns, R.B. (1998). *Introduction to research methods (Third Edition)*. Melbourne: AddisonWesley Longman.
- Carspecken, P.F., and Apple, M. (1992). Critical qualitative research: Theory, methodology and practice. In, Le Compte, J., Millroy, W.L., and, Priessle, J. (1992). *The handbook of qualitative research in education*. London; Harcourt Brace.
- Chantrell, G. (2003). *Oxford essential dictionary of world histories*. Berkley: Berkley Publishing Group.
- Coburn, W.W., and Loving, C.C. (2001). In defense of realism: It really is commonsense. *International history, philosophy and science teaching group meeting, USA, 162*.
- Cohen, L., and Manion, L. (1997). *Research methods in education (Fourth Edition)*. NewYork: Routledge.
- Connell, J. (1995). Reconstructing a modern definition of knowledge: A comparison of Toulmin and Dewey. [On-line]. *Journal of the Philosophy of Education Society*. Available: [URL:http://www.ed.uiuc.edu/EPS/PES-Yearbook/1995/conn.html](http://www.ed.uiuc.edu/EPS/PES-Yearbook/1995/conn.html)
- Couch, C.J. (1987). Objectivity: A crutch and club for bureaucrats/ Subjectivity: A haven for lost souls. *The sociological quarterly*, 28, 105-118.
- Denzin, N.K., and Lincoln, Y.S. (Eds.). (2001). *The handbook of qualitative research*. New York: Sage.
- Denzin, N.K. (1978). The logic of naturalistic inquiry. In, Brynner, J., and Stribley, K. (Eds.) (1978). *Social Research; Principles and procedures*. London: Longman.
- Dimitrov, V., and Hodge, B. (2002). *Social fuzziology*. New York: Physica-Verlag Heidelburgh.
- Elster J. (1983). *Explaining technical change: A case study in the philosophy of science*. Cambridge: CUP.
- Elster, J. (1989). *Nuts and bolts for the social sciences*. Cambridge: CUP.
- Evers, C.W., and Lakomski, G. (1996a). Postpositivist conceptions of science in educational administration. *Educational Administration Quarterly* 32 (3) 339-373.
- Evers, C.W., and Lakomski, G. (1996b). Science in educational administration: A positivist conception. *Educational Administration Quarterly (Special Edition)* 32 (4) 379-402.
- Fraenkel, J.R., and Wallen, N.E. (2002). *How to design and evaluate research in education*. New York: McGraw Hill.
- Gadamer, H-G. (1976b). Man and language. In D.E. Linge [Ed. And Trans.] *Philosophical hermeneutics*. Berkley: University of California Press. (Original work published in 1966).
- Gadamer, H-G. (1976a). The universality of the hermeneutical problem. In D.E. Linge [Ed. And Trans.] *Philosophical hermeneutics*. Berkeley: University of California Press. (Original work published in 1966).
- Gadamer, H-G. (2001). Education is self-education. *Journal of the philosophy of education society of Great Britain*, 35 (4), 529-538.
- Gadamer, H-G. (2002) *Truth and Method* (2nd Rev.ed.). (J.Weinsheimer and D.G. Marshall, Trans.). New York: Continuum.
- Garrison, J. (1995). Distinctions, dualisms and Deweyan pragmatism: A response to David Carr [On-line]. *Journal of the philosophy of education yearbook, 1995*. Available: [URL:http://www.ed.uiuc.edu/EPS/PES-yearbook/95_docs/garrison.html](http://www.ed.uiuc.edu/EPS/PES-yearbook/95_docs/garrison.html)

- Gay, L.R., and Airasian, P. (2003). *Educational research: Competencies for analysis and applications*. Upper Saddle River, New Jersey: Pearson Education, Inc.
- Giarelli, J.M. (1993). Education and philosophical hermeneutics. *Journal of the philosophy of education yearbook, 1993*. Available: [URL:http://www.ed.uiuc.edu/EPS/PES-Yearbook_93_docs/giarelli.html](http://www.ed.uiuc.edu/EPS/PES-Yearbook_93_docs/giarelli.html).
- Glesne, C. and Peshkin, A. (1992). *Becoming qualitative researchers*. Melbourne: Longman.
- Gregory, M. (1997). Skills versus scholarship (or liberal education knows a hawk from a handsaw) [On-line]. *Bulter University*. Available: [URL: http://iet.open.ac.uk/reasearch/herg/han/1997/Marshall_Gregory.html](http://iet.open.ac.uk/reasearch/herg/han/1997/Marshall_Gregory.html)
- Grondin, J. (1994). *Introduction to philosophical hermeneutics*. (J.Weinsheimer, Trans.). New Haven and London: Yale University Press.
- Hoffman, B. (2002). *The technological invention of disease: On disease, technology and values*. Oslo: Unipub.
- Hogan, P., and Cleary, J. (2001). The reciprocal character of self-education: Introductory comments on Han-Georg Gadamer's address 'Education is self-education'. *Journal of the philosophy of education society of Great Britain, 35* (4), 519-527.
- Jaeger, R.M. (Ed.). (1988). *Complementary methods for research in education*. Washington: American Educational Research Association.
- Jaeger, R.M. (Ed.). (1997). *Complementary methods for research in education*. Washington: American Educational Research Association.
- Jansen, G., and Peshkin, A. (1992). Subjectivity in qualitative research. In Le Compte, M.D., Millroy, W.L., and Priessle, J. (Eds.) (1992). *The handbook of qualitative research in education*. London: Academic Press.
- Kerlinger, F.N. (1986). *Foundations of behavioural research (3rd ed.)*. New York: Holt, Rinehart & Winston).
- Kerdeman, D. (1998). Between Interlochen and Idaho: Hermeneutics and education for understanding [On-line]. *Journal of the philosophy of education yearbook, 1998*. Available: [URL:http://www.edu.uiuc.edu/EPS/PES-Yearbook/1998/kerdeman.html](http://www.edu.uiuc.edu/EPS/PES-Yearbook/1998/kerdeman.html)
- King, J.A., and Bond, T.G. (2003). Measuring Client Satisfaction with Public Education I: Meeting Competing Demands in Establishing State-wide Benchmarks. *Journal of Applied Measurement, 4*(2) 111-123.
- Krathwol, D.R. (1993). *Methods of educational ad social science research: An integtared approach*. New York: Longman.
- Lacey, A.R. (1976). *A dictionary of philosophy*. London: Routledge and Kegan Paul.
- Le Compte, M.D., Millroy, W.L., and Priessle, J. (Eds.) (1992). *The handbook of qualitative research in education*. London: Academic Press.
- Leung, S.K. (2000). *Language and meaning in human perspective*. London: Janus.
- Lincoln, Y.S., and Guba, E.G. (1986). Judging the quality of case study reports. *International journal of qualitative studies in education 3*(1) 53-59.
- Lincoln, Y.S., and Guba, E.G. (2001). Paradigmatic controversies: Cotradictions and emerging confluencies. In Denzin, N.K. and Lincoln, Y.S. (Eds.). *The handbook of qualitative research*. New York: Sage. London: Fontana.
- Luke, A. (2003). After the marketplace: Evidence, social science and educational research. *The Australian educational researcher, 30* (2), 87-108.
- Macquarie University. (1981). *The Macquarie dictionary*. St. Leonards (NSW): Macquarie Library.
- Mautner, T. (2000). *The penguin dictionary of philosophy*. Melbourne: Penguin.
- Neuman, L. W. (2000). *Social research methods: Qulaitative and quantitative approaches*. New York: Allyn and Bacon.
- Nisbett, R.A. (1977). *Social change and history: Aspects of the Western theory of development*. Melbourne: OUP.
- Palmer, R.E. (1999). The relevance of Gadamer's philosophical hermeneutics to 36 topics or fields of human activity [On-line]. *Lecture at Southern Illionois University*. Available: [URL:http://www.mac.edu/~rpalmer/relevance.html](http://www.mac.edu/~rpalmer/relevance.html)
- Palmer, R.E. (1998). *Hermeneutics*. Evanston (US): Northwestern University Press.
- Rasch, G. (1960/1980). *Probabilistic models for some intelligence and attainment tests*. Copenhagen: Danish Institute for Educational Research, 1960. (Expanded edition. Chicago: The University of Chicago Press, 1980.)
- Riley, G. (Ed.). 1974. *Values, objectivity and the social sciences*. Reading (Massachusetts): Addison-Wesley.
- Ross, K.L. (2000). Relativism [On-line]. *Relativism*. Available: [URL:http://www.friesian.com/relative.html](http://www.friesian.com/relative.html)

- Sainsbury, M. (1993). *Logical forms: An introduction to philosophical logic*. Oxford (UK): Blackwell.
- Schwandt, T.A. (2001). Three epistemological stances for qualitative inquiry: Interpretivism, hermeneutics and social constructivism. In Denzin, N.K. and Lincoln, Y.S. (Eds.). *The handbook of qualitative research*. New York: Sage.
- Scriven, M. (1988). Philosophical inquiry methods in education. In, Jaegar, R.M. (Ed.). (1988). *Complementary methods for research in education*. Washington: American Educational Research Association.
- Shikiar, D. (2000). How does thinking begin? *Thinking fundamentals IWM Junior Visiting Fellows Conference, Vienna 2000*, 9 (1), 402-439.
- Shulman, L.S. (1998). Disciplines of inquiry in education: An overview. In, Jaeger, R.M. (Ed.) *Complementary methods for research in education*. Washington; AERA.
- Suppes, P. (1995). The aims of education. [On-line]. *Journal of the philosophy of education yearbook, 1995*. Available: [URL:http://www.ed.uiuc.edu/EPS/PES-Yearbook/1998/suppes.html](http://www.ed.uiuc.edu/EPS/PES-Yearbook/1998/suppes.html)
- Waugh, R.F., and Cavanagh, R.F. (2002). Measuring parent receptivity towards the classroom environment using a Rasch measurement model. *Journal of Learning Environments Research*, 5(3), 329-352.
- Waugh, R.F. (2003). Measuring Attitudes and Behaviors to Studying and Learning for University Students: A Rasch Measurement Model Analysis. *Journal of Applied Measurement*, 4(2),164-180.
- Wiersma, W. (2000). *Research methods in education: An introduction*. Sydney: Allyn and Bacon.
- Wright, B.D., and Masters, G.N. (1982). *Rating scale analysis: Rasch measurement*. Chicago. IL, MESA