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A Solution to the Problem of Generalisation in Educational Research: fuzzy prediction

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ABSTRACT *This paper substantiates a way of encapsulating the claims to educational knowledge of empirical research and communicating them simply to would-be users by drawing on a concept of fuzzy logic. A fuzzy prediction replaces the certainty of scientific generalisation ('x in y circumstances results in z') by the uncertainty, or fuzziness, of statements that contain qualifiers ('x in y circumstances may result in z'). The paper also tentatively suggests that the likelihood of 'z' occurring can be indicated by a best-estimate-of-trustworthiness which, in the absence of empirical evidence, is based on the researchers' professional judgement (arising from the literature and experience).*

Alone, a fuzzy prediction is no more than the researcher's equivalent of the politician's sound-bite, and as such may have little credence, but when supported by a research account which makes clear the context of the statement and the evidence justifying it, the fuzzy prediction provides a powerful and user-friendly summary which can serve as a guide to professional action.

Fuzzy prediction invites replication and this, by leading either to support of the statement or its amendment, contributes to the edifice of educational theory.

I. INTRODUCTION

Nearly 20 years ago the *Oxford Review of Education* published a paper of mine entitled 'Pedagogic Research: on the relative merits of search for generalisation and study of single events' (Bassey, 1981) [1]. I attacked the way that generalisations had been drawn by a number of eminent researchers of the time and contended that 'the study of single events is a more profitable form of research (judged by the criterion of usefulness to teachers) than searches for generalisations' (p. 73). (In a subsequent paper in this journal I followed Simons (1980) and called the single events 'singularities' (Bassey, 1983.) I also stressed the value of relatability, arguing that the merit of a study of singularities lies in the extent to which teachers reading the report of the study can *relate* it to their own teaching. In a conference version of the paper given earlier to the Classroom Action Research Network (Bassey, 1980) I argued that there were no empirical generalisations of use to teachers.

I have changed my mind. I have come to realise that while my former arguments stand in relation to *scientific* generalisation, it is possible to formulate the outcomes of empirical research as *fuzzy* generalisations, and these can be useful to both practitioners and to policy-makers in education and probably in other fields of social research. In a nutshell the distinction is that the scientific generalisation is expressed in the form:

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particular events do lead to particular consequences; while the fuzzy generalisation is expressed in the form: *particular events may lead to particular consequences*.

While I am amazed that this simple, but powerful, distinction eluded me for 20 years, I note that it also eluded many others who have written about generalisation, although a few empirical researchers were expressing their findings in this form, as I shall shortly show [2].

My early research was in chemistry. Looking back I am methodologically intrigued to read this account of some of my experimental work recorded in the *Journal of the Chemical Society* (Bassey *et al.*, 1955)

> 1:1-Diphenylpropyl hydroperoxide (0.53 g) in chloroform (9 cc) was added to xanthhydrol (0.44 g) in acetic acid (20 cc). The next day the solution was poured on ice, yielding 1:1-diphenylpropyl xanthhydryl peroxide, m.p. 86–87° (from light petroleum) (Found: C, 81.9; H, 5.7. C_{28} H_{24} O_3 requires C, 82.3; H, 5.9%)

This is a general statement that, in effect, states that anyone, anytime, anywhere, who treats the same ingredients in the same way that I did, will make the same chemical compound. It is what I later termed an 'open generalisation' (Bassey, 1981, p. 79), Stenhouse (1978) called a 'predictive generalisation', and Hammersley (1992, p. 91) a 'theoretical inference'. What intrigues me now is that this generalisation was based on a study of a singularity! My activity over 24 hours in a laboratory in central London in 1955 was, I believe legitimately, extrapolated to anyone, anytime, anywhere. Within the positivist paradigm of physical science this was, and is, acceptable.

It was from such a background, and subsequent steeping in Popper's strictures on scientific method (1963), that I examined generalisations in the educational research literature—and found them unsatisfactory. It is only recently that I have recognised that scientific generalisation is but one form of empirical [3] generalisation, and while the physical sciences are well served by the scientific generalisation, other forms are needed in the social sciences.

II. THE PROBLEM OF GENERALISATION

For the chemist, and in most circumstances the physicist, there is no problem with generalisation. Provided that the few significant variables are defined, the statement that something happened through a juxtaposition of inanimate objects is generalisable and can be used to predict future happenings. It stands firm until challenged by a contrary happening and, if this occurs, it is usually explained as a missed variable in the first happening. Only at subatomic levels does the physicist have problems—when some of the variables cannot be defined and Heisenberg's Principle of Uncertainty [4] is invoked.

For scientists like the meteorologist or the ecologist the systems studied have large numbers of variables and so making strict scientific generalisations, in the sense of 'particular events do lead to particular consequences', is problematic. They try to overcome the difficulty of certainty by massive data collection from which they can formulate probabilistic generalisations, in the form 'there is a p% chance that particular events will lead to particular consequences'.

But the educational researcher, in common with other social scientists, has the problem that there are many variables and usually little data. In consequence scientific generalisations cannot be made, nor usually probabilistic generalisations. The teacher

may give what appears to be the same lesson in exactly the same way in a second classroom, but the outcome of the second lesson may be quite different because some un-noted variables of the setting, or the class, or individuals within the class, are sufficiently different to affect the outcomes. The option of repeating the lesson in a number of other classrooms and giving a probabilistic generalisation, is not usually possible.

The public problem of generalisation in educational research, and throughout the social sciences, is that researchers are expected by policy-makers, practitioners and the public at large to make scientific generalisations, but cannot because they cannot identify, define and measure all of the variables that affect the events that they study.

III. CONCEPTS OF GENERALISATION IN THE METHODOLOGY LITERATURE

In *Case Study Research in Educational Settings* (Bassey, 1999, pp. 30–36) I explored what different writers have said about the problem of generalisation from case study. The confusion that I felt was expressed in a chapter 'endpiece':

> The reader might expect me to summarise the various positions and terminology of the [writers cited] into one coherent framework. I cannot. Perhaps Yin's concept of an 'analytic generalisation' is very similar to Stenhouse's 'retrospective generalisation', Erickson's 'assertion' and Stake's 'propositional generalisation'.... Perhaps Tripp's 'qualitative generalisation' is akin to Stake's 'naturalistic generalisation'. But to draw such comparisons is a dangerous game for I cannot be sure that I have correctly elicited what these writers have meant by the terms they have used and, dare I say it, neither can we be sure that these writers themselves had clear, unambiguous concepts in their minds and managed to express them coherently.[5]

I would like to add a few further references to generalisation.

A methodological text that has had a long career is that of Gall, Borg and Gall, *Educational Research: an introduction*. They hanker for the general law, as this quotation shows.

> The physical sciences have achieved prominence among the academic disciplines because of their demonstrated ability to discover highly generalisable laws that explain features of physical reality. The social sciences and allied professional disciplines such as education have not achieved the same level of respect and authority because their ability to discover general laws remains in doubt. If one subscribes to the assumption of postpositivist epistemology that meaning is imbedded in local, immediate contexts, it follows that generalisations about features of social reality necessarily will be difficult and tentative. The positivist assumption of an objective, relatively constant social reality leads to the more optimistic view that general laws governing social reality can be discovered. (1996, p. 23)

In this paper I argue in effect that the 'respect and authority' of the social sciences cannot arise from 'general laws' ('scientific generalisations' as I term them) but should come from other forms of generalisation.

Hammersley (1992), writing about ethnography, draws a distinction between *empirical generalisation* and *theoretical inference*. To him empirical generalisation entails generalising from events in one setting and time to predict events in other defined settings

over a defined period of time: in other words within a finite and defined population. Hammersley distinguishes this from theoretical inference, which to him is about inference to features that all members of a category of events possess, wherever and whenever they occur. Hence theoretical inference implies causal relationships expressable in universal laws. He notes that most contemporary ethnographers reject the claim that there are such laws, but for himself cautiously says, 'I would not want to dismiss the possibility of universal laws of social phenomena' (1992, p. 92). (In this paper I am using a broader interpretation of 'empirical generalisation' than Hammersley, and take a more dismissive view of 'the possibility of universal laws of social phenomena'.)

Usher (1996), in *Understanding Educational Research*, puts it more strongly. In trying to answer the question 'what are we doing when we do research?' he first notes the esteem in which generalisation is held throughout the realm of empirical research.

> A generalisation is prized precisely because, in not being limited to a particular setting, it is seen as making application possible. Thus generalisations have traditionally been considered the highest level of research and very often as what research should always strive for … In the natural sciences generalisations are sought because they enable predictions to be made … [and] prediction makes control possible. (p. 10)

He goes on to recognise that although this may be the position in the natural sciences, it is not so in the social sciences.

> Prediction and the search for generalisations has not been realised in educational and social research. Two possible explanations can be given for this. The first is that generalisations are possible but they will tend either to be truisms or to be much too general[6]. The second is that the search for generalisations is probably doomed to failure since it is questionable whether generalisable and predictive knowledge is possible in the social domain. (p. 14)

I hope to show in this paper that prediction is possible in educational and social research, but it does require a rethink of the concept of generalisation.

Hitchcock and Hughes (1995, p. 326), in *Research and the Teacher*, are nearer to my position. They argue that it is possible to generalise from case studies provided the research is designed with this in mind. They quote Schofield (1990, p. 226) as saying that generalisability depends upon 'the *fit* between the situation studied and others to which one might be interested in applying the concepts and conclusions of that studied'. This seems a similar concept to 'relatability' (Bassey, 1981, p. 85) and this becomes clearer in Schofield's quoted paper, for she goes on to say: 'This conceptualisation makes thick descriptions crucial, since without them one does not have the information necessary for an informed judgement about the issues of fit.'

Schofield (1990, pp. 226–227) takes the argument one stage further by identifying 'three useful targets for generalisation' as '*what is, what may be* and *what could be*'. She says:

> Studying *what is* refers to studying the typical, the common and the ordinary … Studying *what may be* refers to designing studies so that their fit with future trends and issues is maximised … Studying *what could be* refers to locating situations that we know or expect to be ideal or exceptional on some *a priori* basis and studying them to see what is actually going on there.

I find this a helpful analysis of the potential agenda for educational research.

Frankfort-Nachmias and Nachmias (1996), in the 5th edition of their *Research Methods in the Social Sciences*, assert that 'the ultimate goal of the social and all other sciences is to produce a cumulative body of verifiable knowledge. Such knowledge enables us to *explain, predict* and *understand* the empirical phenomena that interest us.' They identify two kinds of scientific explanation: deductive explanation, in which 'a phenomenon is explained by demonstrating that it can be deduced from an established law', and probabilistic explanation, which derives from a 'probilistic generalisation' expressed as either 'an arithmetic ratio between phenomena (*n* per cent of $X = Y$)' or expressed as a tendency '(X tends to cause Y)'. They also identify two kinds of prediction: those made from 'universal laws' and those from 'probabilistic generalisations'.

To my mind this careful edifice that they construct for enquiry in the social sciences is half destroyed by their own recognition that in the social sciences 'few, if any, meaningful universal generalisations can be made'. They quote Gergen (nd, p. 12) as saying:

> it may be ventured that with all its attempts to emulate natural science inquiry, the past century of socio-behavioural research and theory has failed to yield a principle as reliable as Archimedes' principle of hydrostatics or Galileo's law of uniformly accelerated motion.

I have separated their two kinds of probabilistic generalisation, calling the second one 'fuzzy' and it is to this concept that I now turn.

IV. FUZZINESS

In struggling to find a way of expressing succinctly the idea of a generalisation which is true in most situations, but not necessarily all, I came across Fourali's paper 'Using fuzzy logic in educational measurement' (Fourali, 1997) This resolved a problem with which I have often struggled as an examiner of student papers. Instead of trying to give an exact mark—like 57 out of 100 for an essay, Fourali advocated giving a fuzzy mark, like 50–60 out of 100. If another examiner gave a fuzzy mark of 55–70, then it might be appropriate to combine the two and give a narrower range of 55–60 as the moderated mark. It dawned on me that this was what I was looking for: my 'qualified' generalisation could be described as a 'fuzzy' generalisation.

A popular text on fuzzy logic is Kosko's *Fuzzy Thinking* (1994). (He attributes the word 'fuzzy' to Lofti Zadeh, who began publishing on fuzzy sets in the 1960s, and chose the word in preference to 'vague'.) Kosko links the word 'fuzzy' to principles, sets, logic, systems, the past, the future, and much else!

> The fuzzy principle states that *everything is a matter of degree*.... Fuzziness has a formal name in science: multivalence. The opposite of fuzziness is bivalence or two-valuedness, two ways to answer each question, true or false, 1 or 0. Fuzziness means *multi*valence. It means three or more options, perhaps an infinite spectrum of options, instead of just two extremes. It means analog instead of binary, infinite shades of gray between black and white. It means all that the trial lawyer or judge tries to rule out when she says, 'Answer just yes or no'. (1994, p. 18)

Kosko does not use the term but I can see nothing in his writing that would quarrel with the concept of fuzzy generalisation as I use it here.

A fuzzy generalisation is one that is neither likely to be true in every case, nor likely to be untrue in every case: it is something that *may* be true. In consequence it is important for the researcher who enunciates a fuzzy generalisation to endeavour to explore the conditions under which it may, or may not, be true. Later in the paper I suggest a way in which the trustworthiness of the generalisation may be estimated.

V. THE CONCEPTS OF SCIENTIFIC, PROBABILISTIC AND FUZZY GENERALISATION

By *scientific generalisation* I mean the kind of empirical general law which in its simplest form is like this: *if x happens in y circumstances then z will occur in all cases*. The requirement 'in all cases' means that it has to be rejected or at least modified if one contrary instance is found that challenges its verity. As I understand it this is the Popperian view of scientific laws (Popper, 1963) and good science is that which tries to refute, rather than support, such statements. In my attacks on generalisation of 20 years ago this is the kind of generalisation the existence of which I was challenging as far as education is concerned. But I now realise that there are at least two other forms of empirical generalisation.

A *probabilistic generalisation* is one which says something like this: *if x happens in y circumstances then z will occur in about p% of cases*. It arises as the result of a careful study of a representative sample of a population: it can be expected that any other representative sample of the same population will give the same result. (For example 'x' could be increasing the time spent on supervised individual work in sixth form mathematics [compared to the previous year]; 'y' could be the circumstances of sixth forms in England where there are 10 or more students in the class all using a particular syllabus and where in the previous year less than half of the students got A gradings; and 'z' could be an improvement in A-level grades [compared to the previous year] which has been found in p% of the sample.)

A *fuzzy generalisation* is expressed in a tentative way: *if x happens in y circumstances, z may occur*. (For example 'there *may* be an improvement in A-level grades.') The important issue of examining 'may'—and trying to assess the likelihood of the fuzzy generalisation applying in a particular case, is discussed later in the paper in Section VIII.

Analysis of the Concepts

Consider situations in which certain actions do, or do not, lead to particular results: the terminology to be used is:

s = situation s_r = randomly chosen situation s_o = opportunistically chosen situation
x = action
y = circumstances in which the action takes place
z = particular result of the action

Suppose that in an opportunistically chosen situation (s_o) it is found that the carrying out of x in y circumstances leads to z. [In the above example, suppose the research has been carried out in a school well known to the researcher, and hence access is relatively easy.]

The tentative general statement, or proposition, can be put forward that in other situations like s_o it is possible that x in y circumstances may lead to z.

There are two approaches to testing this further in order to ascertain how likely it is that x in y circumstances generally will lead to z: the search for a probabilistic generalisation or the search for a fuzzy generalisation.

Search for a Probabilistic Generalisation

Here the academic emphasis is on defining the characteristics of x, y, and z; on identifying the population of situations where x in y circumstances may occur, and then *randomly* sampling this population when x is carried out.

Suppose that in ten randomly chosen situations (s_{r1} to s_{r10}) the results of carrying out x are as follows:

in s_{r1} x in y circumstances leads to z
in s_{r2} x in y circumstances leads to z
in s_{r3} x in y circumstances doesn't lead to z
in s_{r4} x in y circumstances leads to z
in s_{r5} x in y circumstances leads to z
in s_{r6} x in y circumstances leads to z
in s_{r7} x in y circumstances leads to z
in s_{r8} x in y circumstances leads to z
in s_{r9} x in y circumstances leads to z
in s_{r10} x in y circumstances doesn't lead to z

In 8 of these 10 cases, x in y circumstances leads to z. Suppose that a substantial number of further cases are examined and the same proportion leads to z. Then the probabilistic generalisation is drawn that 'in situations like s_r there is an 80% chance that x in y circumstances will lead to z'. Of course, if the probability were found to be 100%, then this would be a scientific generalisation.

Search for a Fuzzy Generalisation

Here the academic emphasis is on defining the characteristics of x, y, z and of the situation s_o, leading to the question 'in this situation s_o, why does x in y circumstances lead to z?' Suppose that a couple of replications are carried out in chosen situations s_o2 and s_o3 and it is found that:

in s_o2 x in y circumstances leads to z
in s_o3 x in y circumstances leads to z

The fuzzy generalisation is drawn that:

in situations like s_o, x in y circumstances *may* lead to z.

In this formulation there is no statistical measure of 'may' but a competent research paper would give a careful description of the variables so that others (in our example, other mathematics teachers with A-level students) might consider whether to act in the same way.

Modification of a Fuzzy Generalisation through Replication Study

Suppose that in a further replication at s_o4 it is found that:

in s_o4 x in y circumstances does not lead to z

This is where an important leap forward in understanding may be made. The researchers examine in detail not only what happened in s_o4, but go back through s_o1, s_o2 and s_o3 and try to modify the description of x or of y to find either that:

in s_o1, s_o2, s_o3 and s_o4 x^1 in y circumstances leads to z

or that

in s_o1, s_o2, s_o3 and s_o4 x in y^1 circumstances leads to z

(For example they might find that this only applies when the sixth-form students had previously obtained less than a C grade at GCSE mathematics.) This suggests the way that fuzzy generalisation provides a mechanism for cumulative research, or the 'standing on each others' shoulders' which is often seen as a characteristic of the natural sciences. Each modification would reduce the fuzziness.

VI. FUZZY PREDICTIONS

For the user of research, generalisation in the form of prediction is what is usually wanted. Users want to know what may happen in their situation if a particular action is taken. Teachers, for example, are likely to be interested in what has happened in other classrooms insofar as it predicts what may happen in their own classrooms. Managers and policy-makers seek predictions of what may be the consequences of policies they are operating, or proposing to introduce. They know—or if they do not, they need to learn—that research can only guide their actions, it cannot tell them what to do. Research can inform decision-making, not determine it.

Hitherto researchers have usually avoided making such predictions, as the examples below illustrate. The argument of this paper is that the widespread introduction of *fuzzy* generalisation (which would be a change in the prevailing culture of much educational research) would enable researchers to make predictions of value to teachers and to policy-makers without compromising the researchers' ethic of seeking truth.

VI(A). EXAMPLES OF FUZZY PREDICTIONS ARISING FROM INDIVIDUAL RESEARCH STUDIES

The *British Journal of Educational Psychology* publishes many reports of empirical research which are predominantly quantitative in methodology. The journal has an unusual style of summarising papers which, instead of the 'abstract' favoured by most academic journals, entails authors responding briefly to these headings: background, aims, samples, methods, results, conclusions. I have examined the 1997 volume of this journal and under the heading of 'conclusions' found papers which give scientific generalisations (which I judge to be inappropriate), papers which give recommendations about practice, and a small number of papers which give what I am calling fuzzy predictions. Two examples of each kind follow. But it is possible to turn the results of all of these papers into fuzzy prediction. The following fuzzy predictions have been derived by me from either the authors' 'results' or their 'conclusions' as summarised at the beginning of their article (sometimes with reference to the main text as well), except in the papers by Newton and Newton, and by Plewis, where the authors had themselves expressed their results in this form.

(a) Examples of Papers where the Authors give Scientific Generalisations (authors' scientific generalisations in italics)

Bryant, Devine, Ledward and Nunes (1997) Spelling with apostrophes and understanding possession.

Synopsis (MB) Two experiments with experimental and control groups were carried out as intervention studies into teaching the use of the apostrophe (75 children in a London school and 42 children in a Stoke-on-Trent school, aged 9–11).

Results (authors) We found (1) that children of this age have striking difficulties over the use of the apostrophe in genitive words, (2) that it is possible to improve the children's use of apostrophes, and (3) that there is a connection between children's grammatical awareness and the use of apostrophes.

Conclusion (authors) We conclude that *there are two main constraints on children's learning about apostrophes: (1) the extent of their explicit knowledge of grammar, and (2) the emphasis that is put on this aspect of spelling at school* [7].

Fuzzy prediction (MB) Children aged 9–11 may have considerable difficulties over the use of the apostrophe in genitive words dependent on: (1) the extent of their explicit knowledge of grammar, and (2) the emphasis that is put on this aspect of spelling at school. It is usually possible to reduce these difficulties by appropriate teaching.

Mynard and Joseph (1977) Bully/victim problems and their association with Eysenck's personality dimensions in 8 to 13 year-olds.

Synopsis (MB) Four published instruments were completed by 179 children aged from 8 to 13.

Results (authors) Forty-nine per cent of children were classified as involved in bullying either as bullies (11%), victims (20%), or bully/victims (18%).

Bullies scored lower on the lie scale, victims scored lower on the extraversion scale, and bully/victims scored higher on the neuroticism and psychoticism scales than children who were classified as not involved in bullying [8].

Conclusion (authors) These data provide evidence that *bully/victims are a distinct group from either bullies or victims* and that they may be the group of children who are most readily distinguished in terms of personality.

Fuzzy prediction (MB) In addition to identifiable bullies and victims there may be a third category of bully/victims and it is likely that they can be readily distinguished by personality tests.

(b) Examples of Papers where the Authors give Recommendations (authors' recommendations in italics)

Hall, Hall and Abaci (1997) The effects of human relations training on reported teacher stress, pupil control ideology and locus of control.

Synopsis (MB) Three published instruments were used in an experimental

study of a masters' programme in human relations taken by 42 experienced teachers with a demographically similar control group of 42, plus semi-structured interviews.

Results (authors) The results indicated that, following the training, there was a reduction in reported stress, indications of a more humanistic orientation toward pupil control and an increase in a sense of an internal locus of control. The quantitative data were confirmed by qualitative data generated from semi-structured interviews, which involved substantial reports of applications of the training in their professional and personal lives.

Conclusion (authors) *These results provide support for including experiential human relations training as part of both the in-service and initial teacher training programmes.*

Fuzzy prediction (MB) Courses for teachers like this which include experiential human relations training may reduce stress and encourage a more humanistic orientation towards pupil control.

Duff (1997) A note on the reliability and validity of a 30-item version of Entwistle and Tait's Revised Approaches to Studying Inventory.

Synopsis (MB) An instrument (shorter RASI) was given to 356 undergraduates in a university faculty of business.

Results (author) Evidence of moderate to high internal consistency, reliability and satisfactory construct validity.

Conclusions (author) *This short-version of the RASI can be recommended to researchers, staff developers and teachers as a useful instrument to measure approaches to learning.*

Fuzzy prediction (MB) The shorter RASI may be a useful instrument for trying to measure students' approaches to learning.

(c) Examples of Papers where the Authors give Fuzzy Predictions (authors' fuzzy predictions in italics)

Newton and Newton (1997) Teachers' conceptions of understanding historical and scientific events.

Synopsis (MB) A new instrument was completed by 178 primary school teachers (one-third with science degrees, one-third with history degrees, one-third with other degrees) about the relevance of 36 statements to understanding historical and scientific events.

Results (authors) Teachers generally discriminated between the relevance of the statements for understanding these events. At the same time, teachers with different subject degrees also disagreed about the level of relevance for understanding of a number of statements. Differences in the balance of subject experience could account for this.

Conclusions (authors) *Differences in academic backgrounds can affect conceptions of understanding of a subject: this could have consequences for the support for understanding that teachers provide.*

Fuzzy prediction (MB = development of authors' conclusions) Differences in the academic subject backgrounds of primary school teachers can affect their conceptions of a subject: this could have consequences for the support for understanding that they provide.

Plewis (1997) Inferences about teacher expectations from national assessment at key stage one.

Synopsis (MB) National assessment data (teacher assessments and standardised assessment tasks) were analysed from 6–7000 key stage one pupils in England.

Results (author) No evidence of systematic individual mismatch but some evidence of group mismatch by gender and ethnic group. The results for bias suggest that *teachers might [9] have expectations for boys, ethnic minority pupils and pupils from less advantaged backgrounds which are too low.*

Conclusions (author) Care is needed in defining aspects of mismatch and bias when studying teacher expectations. Possible teacher biases against some groups of pupils merit further investigation.

Fuzzy prediction (MB = part of author's results): At key stage one teachers may have expectations for boys, ethnic minority pupils and pupils from less advantaged backgrounds which are low.

VI(B). EXAMPLES OF FUZZY PREDICTIONS IN A REVIEW OF RESEARCH

There are at least three kinds of reviews of research. *Annotated bibliographies* list the research publications in a field of enquiry, sometimes in logical sections, and give a very brief and uncritical synopsis of each publication. *Academic reviews* describe and analyse the research publications in a field, try to assess their trustworthiness, try to map the conceptual structure of the field, and indicate gaps in understanding which deserve future research. *User reviews* (a recent phenomenon) are written for a specific audience and aim to show how existing research can illuminate the work of practitioners or policy-makers.

Hallam and Cowan prepared in 1998 an academic review entitled 'What do we know about homework?'. They reviewed nearly 200 studies (many from the USA) and wrote a 27-page report. Subsequently they prepared a user review entitled 'Perceived purposes, advantages and disadvantages of homework'. This is a one page document—with 33 fuzzy predictions. It was reproduced by Nottinghamshire LEA in a document circulated to its 500 primary schools (and no doubt some other LEAs did the same).

These are some examples of the fuzzy predictions [10]:

Homework can promote academic learning by:

- increasing the amount of time students spend studying;
- providing opportunities for practice, preparation and extension work.

Homework can assist in the development of generic skills by:

- providing opportunities for individualised work;
- fostering initiative and independence;
- developing skills in using libraries and other learning resources;
- training pupils in planning and organising time;

- encouraging ownership and responsibility for learning.

Homework can act to the disadvantage of schools when:

- it increases negative attitudes;
- parents pressure children too much;
- parents create confusion in explaining material;
- the differences between high and low achievers are increased.

Homework can have a negative impact on the family when it:

- disrupts family life;
- causes friction within the family.

Homework can be detrimental to the individual when it:

- causes anxiety;
- reduces motivation to learn;
- creates boredom, fatigue and emotional exhaustion;
- reduces time for leisure activities.

Homework can have a negative impact on society when it:

- polarises the opportunities for children from different economic circumstances because some have better facilities and resources than others.

The above example shows the potential power of a user review expressed in fuzzy predictions. Taken individually, many of these statements suggest rather trivial research studies which come to obvious conclusions; but put together they provide a research-based overview which challenges any teacher, or school, to reflect on their practice with regard to setting homework. These statements also are a challenge to the present Secretary of State, judging by this report in the *Daily Telegraph*:

> David Blunkett, the Education Secretary, has made the marking and setting of homework a major plank of his school improvement policy. Launching his regime last April, he said that research evidence proved that it led to improved exam and test results. (Liz Lightfoot, 18 September 1998)

Dare we hope that one day even politicians will come to recognise the value of fuzziness?

VII. A PROPOSAL FOR USING THE HEADING 'PREDICTIONS' INSTEAD OF 'CONCLUSIONS' IN BOTH PROFESSIONAL AND ACADEMIC PAPERS

Confusion about Outcomes

There are a variety of practices adopted in empirical research papers for discussing the outcomes. The headings 'results', 'findings', 'discussion' and 'conclusions' are variously used.

'Results' and 'findings' usually refer to the outcomes of the particular investigation—with the former tending to refer to the collation of raw data and the latter tending to involve analysis of this data. Sometimes the form of words used seems to deny the sampled nature of the investigation. For example Newton and Newton (1987) (see above) under the heading of 'results' write: 'Teachers generally discriminated between the relevance of the statements for understanding these events.' I would rewrite this as

'*The* teachers generally discriminated …' in order to make quite clear that at that stage the result refers to the 178 teachers in the study.

'Discussion' may relate the findings to other work reported in the literature, give a critique of the methods used, express the author's opinions, analyse the findings further, or give conclusions and so avoid the separate use of such a heading.

The greatest variety is found under the heading of 'conclusions'. As noted above conclusions may entail general statements, predictions, recommendations for practice, pleas for more research, and so on.

From the perspective of writers, a plethora of forms of outcome may seem legitimate and appropriate, but from the perspective of readers of research, it is confusing. My contention is that formulating the conclusion of a paper in the form of a carefully worded prediction is likely to be the most useful form of conclusion for many readers.

Informing Action and Informing Understanding

I have argued elsewhere (Bassey, 1995), that there are two main kinds of writing about research in education: writing which aims to inform the actions of educational policy-makers and practitioners, and writing which aims to inform understanding of social or psychological phenomena, or historical insights, or philosophical concepts, in educational settings. Of course understanding of phenomena, for example, is needed in order to inform action, but when writing for an audience of, say, sociologists, a researcher writes in quite a different way to when writing for an audience of teachers. The sociologist seeks theoretical insight based on methodological probity: the teacher seeks practical guidance based on credible evidence.

Good Practice in Educational Research Writing (British Educational Research Association (BERA), 2000) recommends researchers, when writing, to make clear for whom they are writing. Is the intended audience one of other researchers, or practitioners, or policy-makers?

If the audience is to be professionals, ie practitioners or policy-makers, it seems to me that to end the paper with a fuzzy prediction is to give the practical guidance which is sought, while the rest of the paper should set out the context in which that prediction is made and the credible evidence for it.

If the audience is to be other researchers, it seems to me that if it is possible to give a fuzzy prediction this should be done. Academic papers usually give a rigorous account of how the findings were arrived at, discuss them in the context of what has already been written about the subject, and set parameters for future enquiry. If fuzzy predictions are also given they can give cumulative coherence to the field of investigation. In other words if a paper says 'x may lead in y circumstances to z', a subsequent paper can build on this by saying 'x may lead in y circumstances to z if w applies'. This suggests how the concept of fuzzy prediction may contribute to theory building. Some authors—but not many—do this at present.

Fuzzy 'Predictions'

I suggest that, wherever possible, the outcome of empirical educational research should include fuzzy predictions. The *findings* (or results) give an empirical statement of what has been found out about the actual people-events-situation under study. The *prediction* is a fuzzy generalisation which extrapolates the findings to similar people-events-situations and suggests that similar findings may be discovered elsewhere. The following

extracts from papers in the *British Educational Research Journal* illustrate what I am advocating. (There is a slight revision of the authors' actual words and the introduction of the headings 'findings' and 'prediction'.)

West A, Noden P, Edge A and David M (1998) Parental involvement in education in and out of school.

Synopsis (MB): Interviews were carried out with the families of 107 London children aged 10–11 sampled in terms of social and ethnic composition, geographical spread and state/private school.

Extract from ***Findings*** (authors): We found no statistically significant differences between the parents' involvement in their children's education in terms of social background.... We did find differences in relation to the mother's educational level. When we focused on the children in the state sector, we found that a mother's level of educational qualifications was associated with who attends open evenings and who has informal discussions with teachers. We also found that the children with more highly qualified mothers were significantly more likely to have used workbooks at home and to have had private tuition than the children of mothers with lower levels of educational qualifications.

Prediction (authors): Mothers' education may be found to be more instructive in understanding educational involvement of 10–11 year old children than social class based on employment groups.

Boaler J (1997) Setting, Social Class and Survival of the Quickest.

Synopsis (MB): The research involved a longitudinal study of a year group of students in each of two schools as they moved from Year 9 to Year 11. The focus was on the day-to-day experiences of students in mathematics and included approximately 100 lessons in each school being observed and 40 students in each school being interviewed, and other data sources. Both schools were mixed 11–18 comprehensives in areas of social disadvantage. In mathematics both groups of students had learned mathematics through individualised SMP booklets for the 2 years prior to the research, but then Amber Hill had moved into sets and Phoenix Park to mixed ability groups.

Extract from ***Findings*** (author): At Amber Hill significant numbers of students experienced difficulties working at the pace of the class, resulting in disaffection and reported underachievement; students became disillusioned and demotivated by the limits placed upon their achievement within their sets; and some students responded badly to the pressure and competition of setted lessons, particularly girls and students in top sets. At Phoenix Park 3% of the year group attained A*/A grades compared with 0.5% at Amber Hill.

Predictions (author): Students of a similar 'ability', assessed via some test of performance, will not necessarily work at the same pace, respond in the same way to pressure or have similar preferences for ways of working.... Students who are most able to adapt to the demands of their set are most likely to be advantaged, or least disadvantaged, by setting.

These examples, coupled with the earlier ones from the *British Journal of Educational Psychology* show that it is possible (in at least most cases) to write fuzzy predictions from empirical studies and that some authors use them.

Fuzziness and Criteria of Quality

There is necessarily a measure of tentativeness in extrapolating the finding to other people-event-situations, but making a prediction of what *may be* the case elsewhere, is, I suggest, a proper outcome of research. It conveys to the professional reader, in terms which are framed by the researcher, guidance for action. It conveys to the academic reader a theoretical construct which can be tested and so supported, or refuted, or amended. This leads to two criteria of quality. Findings can be judged by their trustworthiness [11]. Predictions can be judged by the likelihood of general accuracy. The evidence on which such judgements will be based should be clearly set out in any paper.

A fuzzy generalisation in the form of a prediction is to a researcher what a sound-bite is to a politician. A pithy, memorable statement. But while the currency of a sound-bite depends as much on who said it as what it says, the credibility of a prediction depends upon the trustworthiness of the research findings which underpin it and the likelihood of those findings being generalisable. Thus the research paper must give a clear account of the context of the research study and a careful justification for the empirical findings on which the fuzzy prediction is based. The idea that it might also give a fuzzy measure of its generalisability is set out in the following section.

VIII. BEST ESTIMATE OF TRUSTWORTHINESS (BET)

The difficulty with the fuzzy prediction *if x happens in y circumstances, z may occur* is that logically it must also be true that *if x happens in y circumstances, z may* not *occur*. The potential user of such a research conclusion will want some idea of how likely it is that 'z may occur'. Rather tentatively I would like to put forward the following suggestion.

Suppose that the researchers, having worked on the topic and read the relevant literature, from their professional experience hazard a guess as to the likelihood of z occurring. Call this the best-estimate-of-trustworthiness, or BET, and give it in a fuzzy form or range. Thus if the researchers' insight leads them to believe z is likely to happen about 19 times in every 20, they might express this as a BET of 90–99%, whereas something of lower likelihood, say an expectation of about three times in every four, might be given a BET of 60–90%.

Such an approach would also allow for the meaning of *z may occur* which, conveyed by a hesitation in the spoken word, implies that it is a rare occurrence. The BET could be given as 1–10%, for example, meaning that, in the professional judgement of the researchers, in a 100 events they would expect it to occur between one and ten times.

The stating of a best-estimate-of-trustworthiness would mean that researchers needed to put their heads above the parapet, but provided that it is recognised that this is an educated guess and not an empirical statement, and the idea of fuzziness is built into it by giving a range of the likelihood of the statement being accurate, this could be a valuable feature for those who seek to use fuzzy predictions. An indication of how this might serve the needs of policy makers at ministerial level and at school governing body level is published in a recent issue of BERA's *Research Intelligence* (Bassey, 2000).

This suggestion raises a number of issues, such as the basis of researchers 'professional judgement'.

IX. CONCLUSION

Educational research shares with research in the other social sciences the problem that, because it is social, i.e. about human beings, it inevitably embraces a multitude of variables. This precludes the making of scientific generalisation. However by invoking the principle of fuzziness, that there is a class of statements which are imprecisely probable, it is possible to develop the idea of fuzzy generalisation.

I believe that this idea offers a viable solution to the problem of generalisation in educational research and across the other social sciences. It suggests that formulating a generalisation can indeed be, in Usher's (1996, p. 10) phrase: 'the highest level of research', but whereas in the natural sciences generalisation is expected to be in the scientific form which leads to absolute prediction, or in the probabilistic form which leads to statistical prediction, in the social sciences the expectation can be for fuzzy generalisation leading to fuzzy prediction. At present only a few educational researchers give their conclusions in this form.

Fuzzy predictions with best-estimates-of-trustworthiness may provide a powerful tool for researchers to communicate with potential users of research and also to develop a cumulative approach to the creation of educational theory.

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NOTES

[1] The *Oxford Review of Education* paper was reprinted in an Open University reader (Bell *et al.*, 1984) and has been widely quoted.

[2] Looking back at my paper to the Classroom Action Research Network, I now realise that I stumbled on the notion of fuzzy prediction—but failed to recognise its importance. In that paper (Bassey, 1980) I took the example of a generalisation used by Ausubel and Robinson (1971, p. 64) in their then widely read undergraduate text entitled *School Learning: an introduction to educational psychology*. It is this: 'Crocodiles eat children'. I said: 'This is a curious statement in that thousands of children visit crocodiles all over the world in zoos every year, and yet reports of them being eaten are very rare. If the statement is to be a generalisation within the meaning … that it predicts future events, it needs to be expressed in a possible and not absolute sense, viz: crocodiles may eat children. The likelihood of a child being eaten depends upon whether the child comes within striking distance of the crocodile's jaws, whether the crocodile senses the child, whether the crocodile is hungry and how quick the child is!' This bizarre discussion had, of course, a vicious bite, for I concluded it by saying: 'In my view Ausubel and Robinson's example of a generalisation is peculiarly apt. I suspect that every general statement made about school learning has the same property of lack of certainty.'

[3] Explanatory notes can be tiresome, but the word 'empirical' seems to be used differently by different writers. I use it to refer to outcomes based on first-hand data collection, ie questions asked, observations made, and measurements taken, and entailing strict procedures, critical analysis and thoughtful interpretation.

[4] 'The principle that the momentum and position of a particle cannot both be precisely determined at the same time', *Concise Oxford Dictionary* 9th edition.
[5] For references see Bassey (1999).
[6] Eg 'all humans are mortal' (MB).
[7] This conclusion is clearly in the form of a scientific generalisation, ie 'there are two main constraints on children's learning about apostrophes'. Cynics will say that the second of these ('the emphasis that is put on this aspect of spelling at school') could be deduced logically without the need for studying 117 children, while empiricists will wonder about the legitimacy of extrapolating from 75 children in London and 42 in Stoke-on-Trent to all children.
[8] This is an example of a paper where there is unnecessary ambiguity in the style of reporting. To say 'Forty-nine per cent of *the* children …' would make clear that this is not intended as a scientific generalisation: as it stands it appears otherwise.
[9] Plewis uses 'might': in adapting this I have used 'may'. Does this distort his meaning?
[10] Hallam and Cowan (1998) are rare among reviewers of research in that their general statements are in the form of fuzzy predictions.
[11] See Lincoln and Guba (1985) or a simplified version of their system in Bassey (1999, pp. 74–77).

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