In-Service Education and Training for teachers of mathematics with limited qualifications and experience

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In-Service Education and Training for Teachers of Mathematics with Limited Qualifications and Experience

by


A Doctoral Thesis submitted in partial fulfilment of the requirements for the award of Doctor of Philosophy of the Loughborough University of Technology.

1990

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ABSTRACT

The author has been working in the field of Mathematical Education, with special interest in In-Service Education and Training, for many years. This work, which is described in this thesis, has been used to develop a particular philosophy of Mathematical Education and strategies and techniques related to the provision of INSET for special groups of teachers.

The author has played a major role in a collaborative venture, between a local education authority and Loughborough University of Technology, to devise and provide a relevant and specialist scheme of in-service education and training for teachers of mathematics, who have limited qualifications and experience in the subject; the 'hidden' shortage in mathematics. The INSET scheme is the principal vehicle on which the research is based.

The research programme has investigated the design and development of INSET provision and has produced Case Studies, theories and models to provide description, explanation, evaluation and understanding of the processes involved. Although, the study includes aspects of Case Study Research and shares characteristics with Action Research, theory has not been neglected in favour of pure description.

Pluralistic research methods have been employed. The thesis discusses and analyses the suitability of these methods. Participant observation and interviewing play major roles, although data is gathered by other means, such as questionnaires and written material. The thesis considers in some depth the nature of educational research, in order to describe and justify the research perspective and methods adopted. The perspective is described as non-positivistic and interpretive.

A 'naturalistic' INSET model is constructed by analysis of the research data. Guidelines for action and implementation, in respect of the 'hidden' shortage of mathematics teachers are given, which are based on the data, theories and models of this research.

Key Words; Mathematical Education, INSET Models, 'Hidden' Shortage.
I should like to express my thanks to the following people, without whom this thesis would not have been written.

The members of the Loughborough Team, in particular my close colleague and friend Maureen Green, the Rurishire Mathematics Inspectorate and Advisory Team and the participant teachers of the RLPE INSET scheme.

My mentor and friend, Professor Avi Bajpai, who has not only guided and advised me in the pursuit of this research and in the production of this thesis, but also has encouraged, supported and inspired me throughout my career in Mathematical Education.

My dear wife and children Christine, Juliet and Steven, who have once again supported me, with unbelievable patience and love, as I have followed my academic interests.
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Chapter 1

INTRODUCTION

In July, 1986 the DES Consultative Document "Action on Teacher Supply in Mathematics, Physics and Technology" [Department of Education and Science, 1986b] identified a "hidden shortage: where tuition in a subject is given by teachers considered to be inadequately qualified in it or lacking the personal qualities required for effective teaching". Earlier in that year the initial stages of a related in-service scheme, a collaborative venture between a Local Education Authority and the Centre for Mathematical Education in Technology (CAMET), Loughborough University of Technology, had commenced. The venture ultimately evolved into the development of a relevant and specialist scheme of in-service education and training for teachers of mathematics with limited qualifications and experience in the subject. In order to preserve anonymity and to respect privacy and confidentiality the Local Education Authority concerned will be referred to as Rurishire throughout this thesis and the specialist INSET scheme will be called the Rurishire/Loughborough 'Pilot' Experiment: In-Service Education and Training Scheme For Teachers of Mathematics (abbreviated, henceforth, to the RLPE INSET scheme).

For a number of years previously the author had been involved with the development of schemes of in-service education for teachers of mathematics. By the time the initial stages of the RLPE INSET scheme began the author's experience had prepared him to undertake a programme of research into INSET provision, since he had been able to formulate candidate models of design and development based on the data which he had gathered as a developer and participant observer. The work had also provided opportunities (i) to investigate the potentials of a variety of methods and approaches and to evaluate their suitability to meet the INSET needs of different groups of teachers, (ii) to refine methods and techniques of gathering and analysing data and (iii) to judge research approaches and to choose a preferred and appropriate research perspective. Thus, the RLPE INSET scheme presented an ideal vehicle on which to base the research programme, which was to become a culmination of this earlier work.
This research programme comprises an in-depth study of a particular INSET scheme, which provides models and theory to describe, explain and enhance the understanding of INSET design and development. The research study also investigates the nature and problems of a group of teachers of mathematics with limited qualifications and experience of the subject and, hence, illuminates and interprets the 'hidden' shortage in mathematics. Indeed the common definitions of the 'hidden' shortage of mathematics teachers are re-examined and alternative descriptions and explanations are suggested.

Although the title of the RLPE INSET scheme refers to 'experiment', this should not be construed to suggest that the research adopted a normative perspective or that the methodology included 'scientific experiment' or 'quasi-experiment'. The model/theory of INSET design and development which emerged, as the research data was analysed, is described as 'naturalistic'. The data is mainly qualitative and gathered, for the most part, by non-positivistic methods. Nevertheless, this research also emphasises a flexible, informed, eclectic approach and eschews those entrenched attitudes which characterise a number of camps of educational research [vide infra 2.2]. Consequently, the author considers it extremely important to discuss and justify the research perspective which he has adopted and Chapter 2 is devoted entirely to these ends. That chapter discusses the nature of research in general and, in particular, the characteristics of educational research. It develops and describes a 'model view' of research, which it suggests may address some of the criticisms which are often levelled against educational research programmes. The 'model view', it is argued, also provides remedies for the deficiencies which critics identify in educational research.

At this stage it is, perhaps important to stress that the programme sought to avoid the traps which ensnare much qualitative research. Although this research does not endeavour to refine prediction or to establish rigid relations between causes and effects, it does attempt to provide description, explanation and understanding. It does not, however, concentrate solely on description, or on methodology, at the expense of theory. The adjectives interpretive, qualitative, illuminative, naturalistic and non-positivistic are all appropriate to this research but this does not imply a neglect of theoretical
In this programme the nature of the subject matter and the preferred research perspective made it necessary to employ the processes, which are described in sociological research as theoretical sampling and progressive focusing [vide infra 2.1 and 8.24]. Although these processes select and identify pertinent matters for study, they do not necessarily reduce the number of research methods required to match situations which are numerous and varied. In the case of this research programme this meant that the methods were necessarily pluralistic and varied. Chapter 3 describes and discusses these methods. There are dangers in adopting such a pluralistic and eclectic approach [Boring, 1950], which this research recognised. In order to avoid these dangers, methods were carefully chosen to match the relevant research problems and to be compatible with the overall perspective of the research programme.

Chapter 3 also discusses the question of validity and reliability. It discusses why research, which adopts a non-positivistic perspective, can justify its claim to have high validity and, at the same time, maintain reliability. It describes how the pluralistic approach provides the important triangulation which, enhances reliability and enables the latter to be evaluated.

The 'naturalistic' INSET model, which is developed by analysing this research data, introduces the notions of near and far influences which act on developers and which must be taken into account in any theoretical discussion of INSET design and development. It is with these notions in mind that Chapter 4 describes work which the author had undertaken in the area of in-service education and training of teachers over the preceding decade. In doing this, other models of curriculum and INSET design and development are discussed. These other models, by acting as exemplars and directional indicators, have been influential in the comparative analysis of this research data and in the formulation of new models and theories.

In certain respects Chapter 4 may be regarded as the first of a set of Case Studies. This set (Chapters 4, 5, 6 and 7) constitutes both data and substantive theory, or what Stenhouse calls a second stage 'presentation', in which "data is organised in order to present to the reader an interpretation of its significance in relation to some topic issue or problem"
In this thesis presentation includes a description and discussion of the research study, together with analysis and theoretical interpretation. The programme recognises that reactivity \[\text{vide infra 2.7}\] is a matter which researchers must address and to diminish its effects this report provides sufficient information for the reader "to feel confident that the results obtained are reasonable under the circumstances" [Parlett et al., 1972]. Therefore the presentation includes what the author believes is sufficient and necessary data to enable the reader to evaluate the interpretation, the analysis, the models and the theory of this research and, hence, to provide both reflexivity and indexicality \[\text{vide infra 3.10}\]. Once again, in order to preserve anonymity and confidentiality, names of individuals included in these Case Studies, with the exception of members of CAMET, have been changed throughout.

It is important to state that the research documentation also includes materials (The Case Data) collected and assembled by the author in conducting the programme and an "edited primary source" (The Case Record) \[\text{vide infra 8.1}\]. Stenhouse refers to this research documentation as the first stage 'representation'. In this research programme the first stage representation includes field-notes and diaries, resource material, INSET programmes, school brochures, LEA documents, letters, questionnaires, audio-tapes, interview transcriptions and photographs. This first stage representation, although voluminous, is available for inspection (as far as considerations of anonymity and confidentiality allow) to facilitate and support interpretation.

Chapter 5 is an in-depth Case Study of the first stages of the RLPE INSET scheme. The study commences with a description and interpretation of the scheme from its inception. The activities and roles of the principal developers are studied during the early phases of investigation, analysis and planning and as the scheme was implemented and developed. The Case Study goes on to describe how 21 teachers of mathematics, in Rurishire secondary schools, were identified and invited to join the RLPE INSET scheme. Description and interpretation are supported by data collected by participant observation as the scheme was implemented and by selected extracts from conversations, interviews and written correspondence.
It is worth noting that, the first stages of the implementation of the scheme were unusual in that a team from the Departments of Engineering Mathematics and Education, travelled to the Mathematics Centre, Midchester (a distance of 75 miles), on 19 occasions over a period from February to July, 1987 to conduct INSET sessions with the teachers. Since Rurishire is a large rural county, the teachers themselves travelled considerable distances to attend the Midchester sessions. Consequently the RLPE INSET scheme was rather different from many agency-provided INSET schemes and, although it shared certain characteristics with area-based INSET, it also differed from school-based and school-focused INSET provisions. In the early stages of implementation the venue was regarded by all parties as neutral ground but, as time passed, those involved came to identify it as a meeting place to which they belonged. The location and timing were in fact extremely important to the design, development and implementation of the scheme. The Case Study acknowledges this in its description and interpretation. The progressive development [vide infra 9.34] of the RLPE INSET scheme, however, led to a residential element being included in the provision. Consequently, following the Midchester sessions, the teachers spent a residential weekend at Loughborough University as part of the RLPE INSET scheme. A description and interpretation of that residential element concludes the Case Study of Chapter 5.

Chapter 6 is a 'naturalistic' study of the continuing INSET programme. It investigates the perturbations and constraints, which act on a continuing INSET scheme, as a providing agency attempts to change its role so that the main responsibility for development transfers to the local authority (its advisory service and schools) and to the participants themselves. The chapter includes two particular Case Studies of participant teachers, who emerged as 'key' persons. These teachers were observed and interviewed in their schools and classrooms in some depth. Both had changed their classroom practices, after attending the RLPE INSET scheme, and both had adopted a more practical approach based on a resource package prepared by CAMET. The background histories and attitudes of these two teachers are studied, as well as their roles and positions within their schools. The attempts to initiate 'follow-up' INSET activities and to maintain the on-going INSET provision, which were undertaken by these two teachers, form
important aspects of the respective Case Studies.

Chapter 7 is a study of all 21 participant teachers of the RLPE INSET scheme. It is based on data collected by questionnaires, participant observation and interviews. Qualifications, experience and background histories are investigated and interpreted. An important aspect of this study, which emerged as the data was analysed, involves the relationships which exist in the schools and departments of the participant teachers. This aspect has implications for the roles of Heads of Mathematics Departments and for future INSET provision for teachers of mathematics with limited qualifications and experience in the subject. These implications are discussed and analysed in the light of the current debate on school-based and school-focused INSET provision.

Chapter 8 is concerned with Analysis and Theory in an educational research programme. It begins by discussing and developing a structure to facilitate the presentation and representation of research data and theory. Techniques of data analysis which have been influential in formulating the models and theory of this research are discussed and criticised, with reference to Chapters 2 and 3 (which deal with the nature of educational research and its methods). A selective study of these techniques established the guidelines which assisted the author to analyse this research data.

Chapter 9 presents a model and theory of In-Service Education and Training which has been developed using the techniques of analysis described in Chapter 8. The presentation is in two parts. Firstly a 'naturalistic' model of INSET design and development is formulated and discussed. The second part develops a 'naturalistic' model of the INSET evaluation process. This model takes the form of an Evaluation Structure. Later in the chapter the two parts are combined to form an Overall 'Naturalistic' INSET Model. The author suggests that this model contributes to the body of educational knowledge and thought by extending and unifying theoretical aspects of design, development and evaluation. It does so in a manner which those who insist in adopting entrenched positions might not discover, or perhaps appreciate.

Chapter 10 summarises the research programme and suggests guidelines for action and further research. It argues that this research "through the
refinement of judgement, not the refinement of prediction" has provided guidelines which should assist other INSET providers, designers and developers by "strengthening individual judgement where it can not be superseded" [Stenhouse, 1979] and by enhancing description, explanation and understanding.

A set of guidelines for INSET design and development are given, in the form of retrospective generalisations. These guidelines are constructed from the Case Data, Case Records, Case Studies, theories and models of this research and they utilise and reflect the 'Naturalistic' INSET Model, which has been developed as a result of this research programme [vide infra 9.5].

Suggestions are then made for action and implementation with respect to the INSET provision for the 'hidden' shortage of mathematics teachers. These suggestions are based on the research findings of the RLPE INSET scheme and other INSET provisions, which the author has helped to design and develop. They call for innovative INSET schemes, which match the needs and problems of the 'hidden' shortage, and which do not simply follow dogma, fashion and rhetoric [vide infra 10.3]. A plea is made for support, in terms of goodwill and resources rather than unfulfilled promises by Government, to meet the INSET demands of the 'hidden' shortage of mathematics teachers.

More specific guidelines constitute a model for the design and development of a suitable INSET scheme, directed at the 'hidden' shortage in mathematics. Particular attention is paid to ensuring support for a continuing INSET provision. It is suggested that the scheme should involve, in addition to an external agency, Heads of Mathematics Departments and members of the Local Authority Advisory Service as designers, developers, participants and contributors.

The perspectives and methods of this research programme are reviewed and, in the light of this, open research problems are identified, selected and described.

A postscript repeats and emphasise the plea for suitable, sufficient and adequately supported INSET provision for the 'hidden' shortage in order to enhance the mathematics learning and experiences of children in schools.
Chapter 2

THE NATURE OF THE RESEARCH

2.1 Introduction

"The nature of educational research is much more difficult to describe than many educators would seem to appreciate. One of the problems is the diversity of techniques and approaches that are employed in the study of educational phenomena."


In attempting to describe the nature of a particular research programme one is aware that the nature of research, in general, has changed dramatically in the last two decades and continues to change. The roles and purposes of research in many fields have been questioned and subsequently revised. Methodological advance has been rapid. This flux has had a significant and spectacular effect in the field of education, where research has been influenced by the philosophy and thought of many disciplines. This has resulted in educational research adopting many, and varied, research methods. The research described here reflects this change and, as a result, its nature fits uneasily into simple patterns and does not subscribe to a single paradigm. Indeed, McNamara [1979] has pointed out the dangers that use of the term paradigm holds for educational research. Setting aside, until later [vide infra 2.6], his argument that natural science uses the term in a way which would be inappropriate in educational research, McNamara makes an important observation, with which the author agrees, that;

"..........paradigm debates (arguments) force people into camps, place too much emphasis on method in educational research and constrain our thinking about the research endeavour."

D.R McNamara, 1979.

In the light of the observations above it has been decided that; (i) to describe this research in terms of a paradigm would be inappropriate, (ii) to describe the programme only in terms of its methods would be restrictive and (iii) to
subscribe to a single school of thought would be undesirable. These decisions were taken because the research perspectives and the methods which have been used in this research have been selected to match the situations under study and not to support the stances taken by particular camps. It follows that a variety of approaches and methods have been adopted, as appropriate, and this complicates the task of describing the nature of the research. To meet this task it has been decided to devote this chapter to a general description and discussion of the nature of this research and to refer more specifically to methodology in the following chapter. This structure has been chosen to counteract the criticism that educational research, far too frequently, concentrates only on methodology.

"Methodology ought to be the underlabourer in the research enterprise.......in teaching and research, debates about methodology should not become discussions about what is best but what is appropriate."

D.R. McNamara, 1979.

Throughout this thesis, however, every opportunity will be taken to relate research perspectives, methods, subject material, analysis of data and theory. This will be undertaken as an intrinsic aspect of this and all subsequent chapters. The necessity for this is illustrated by the manner in which the subject matter evolved.

A theme, which will be developed later [vide infra 2.4 and 2.5], is that the natural and social worlds have a such degree of complexity that a major feature of the research act is necessarily an exercise in selection from a multiplicity of happenings and phenomena. This selection may be guided by procedures such as the search for non-random patterns and the identification of problems associated with these. In this way certain happenings and phenomena constitute situations or subject matters for research but, since selection is a dynamic process, these cannot be regarded as static entities. As this particular research progressed the selection, collection and analysis of data were found to be mutually dependent and consequently the subject matter changed, in a manner bearing some similarities to the process of theoretical sampling, which has been described by researchers such as Glaser and Strauss [1967]. A constant examination of data suggested new directions and further
sampling. This tended to make the data more extensive but, perhaps paradoxically, resulted in a selective sampling process which focused and narrowed the research so that particular aspects of the subject matter were studied in greater depth and compared against each other.

Consequently, although the subject which prompted this research was a scheme of in-service education and training, the dynamics of selection ensured that the programme of study as a whole became much wider. The in-service scheme remained at the hub of the research, but since this was designed and developed following work with a number of such schemes over many years, these earlier schemes became part of the subject matter. Parallel work, with which the author was involved, also evolved as subject matter, since it became essential to gather indexical data to support theory. On the other hand, although data was gathered from an increasingly wide variety of situations through theoretical sampling, progressive focusing lead to in-depth studies of certain aspects. For example the evolving research required that two participant teachers became the subjects of closer study [vide infra 6.4 and 6.7].

The author considers it important to state at this stage that he does not regard the programme as pure social research. The theoretical sampling tended to incline the programme in the direction of sociology but the diversity of the subject matter, which evolved, demanded a perspective rather wider than social research could offer. It is true that, at all stages of the research programme, data was collected essentially by systematically studying the recipients (serving mathematics teachers) and the providers (university lecturers/ teacher trainers) of in-service schemes but it also studied the processes of INSET design and development in the context of mathematical education.

Cohen and Manion [1985] suggest that social research is;

"the systematic and scholarly application of the principles of the science of behaviour to the problems of man in his social context;"

and that educational research is;

"the application of the very same principles to the problems of teaching"
and learning within the formal educational framework."

One needs to exercise a little caution in accepting the above, since it may appear to suggest that educational research is simply a sub-branch of sociology. Critics often suggest that;

".....to many teachers educational research appears irrelevant..."  
Peter Woods, 1986.

The traditional approach to educational research seemed irrelevant to many teachers because it was often conducted by experiments, which were not related to life in the classroom and which relied too heavily on psychometrics and scientific methods. A radical approach, based on the methods of sociology, with its many divisions and extensive, esoteric terminology, may also appear irrelevant to teachers and to the clients and providers of in-service education.

The author contends that the problems and subject matter of educational research do not necessarily always match those of sociology. For these reasons the nature of this research is more pluralistic than a description such as social research would indicate. In order to reflect this the research programme is described as educational research in the context of mathematical education. This is not intended to deny that the research has been influenced by social research and in particular the more radical approaches. Nevertheless, although this research tends to favour the approach to research promoted by radical movements in sociology it does not identify with any particular school of sociology, or with sociology itself, and reserves the right to choose approaches and methods as appropriate.

2.2 Classification, Terminology and Entrenchment

Traditional and radical sociology are each divided into a number of factions. This presents a pervasive problem to the pluralistic educational researcher, since the literature of sociology is rich in terminology and this is not always used consistently across factions. To the outsider much of this terminology may appear to be unnecessarily esoteric and, indeed, simply jargon. It might be argued that many teachers conclude that educational research has little to offer them, not because it is irrelevant, but because it fails to communicate
its findings through its terminology. Nevertheless, terminology is a nettle which must be grasped if the nature of research is to be described and this chapter attempts to do just this. It is impossible to dispense with terminology, since analysis and classification, which are important characteristics of research, demand terms and often encourage their proliferation, but here only terms which are in common usage have been selected and their meanings are discussed as they occur.

The processes of analysis and classification have inherent dangers other than their tendency to proliferate terms. They are often accompanied by the creation of entrenched positions. This danger is recognised by a number of commentators. Reviewing the characteristics of educational research Eggleston stated;

"It would seem that research in education will benefit from a multidisciplinary attack on major problems. Internecine warfare between rival methodologies is unhelpful. The only grounds for rejecting the application of any discipline to educational problems are that it fails to contribute to educational theory or that it fails to provide useful data and concepts."


The above comments are welcome since they support the view, shared by the author, that research requires a variety of perspectives, approaches and methods and that entrenchment should be avoided.

Norman Williams, Principal Research Officer of the Schools Council, also supported a multidisciplinary approach in evaluation research. In 1981, he called for an "eclectic approach to evaluation." His fear was that evaluators, in an over-reaction to psychometric methods, were detrimentally restricting their range of techniques and "making generalised statements about appropriate methods which would be applicable to all cases". There is obvious merit in Williams argument but it must be remembered that Boring [1950] has accused some researchers, mainly in psychology, of "eclectic laziness". Atkinson and Delamont [1985], in a rather harsh and belligerent criticism have also suggested that case-study practitioners advocate an eclectic approach because they are not committed to any form of
"methodological purism" and lack "methodological sophistication". These accusations and criticisms must be taken seriously, since they have some validity, but, on the other hand, they might be considered contradictions in terms, if one accepts that to be eclectic one chooses the best out of everything.

Mindful of the advantages and disadvantages of eclecticism this research endeavoured to select the most appropriate perspectives and methods from a number of movements, mainly within social science, to match prevailing situations. In doing this certain approaches were favoured at the expense of others. This did not mean that the latter were rejected, because to do so would have placed the research in an entrenched position. It was the intention to avoid joining camps. Nevertheless, a decision was made to incline the research towards, what might be called, a non-positivistic perspective since this appeared to be most appropriate for the subject of the research. The term non-positivistic was preferred to the more usual anti-positivistic, since the use of the latter would suggest that an entrenched position had been adopted.

The thorny problem of terminology is now evident. If this research is to be described as non-positivistic, it is necessary to consider what might be meant by a positivism in social science. This almost certainly requires a discussion of what might be meant by the scientific method. This presents no easy challenge since, as Eggleston [1979] observes the scientific method covers many varied specific procedures. He indicated that this is not always appreciated when, after reviewing the work of many authors on the subject of educational research, he wrote;

"Impressions left on the mind suggest that there is a widespread belief that physical and biological sciences employ research methods involving only critical tests of hypotheses against observations in the 'observable world'."

To meet the challenge the author proposes to develop a model view to describe how natural and social sciences develop and how research is conducted in these sciences. It is hoped that the model view will avoid the "epistemological alchemy", which Eggleston suggests that writers engage in when they attempt to unravel the essential operations of scientific thinking.
The model view should also discourage entrenchment by demonstrating that different fields of research need not be regarded as absolute, incompatible entities but as regions of the same continuous spectrum. It should demonstrate that all researchers are involved with the production of models of the world. It is argued that the differences between different schools of thought and research perspectives lie in the manner in which the processes of modelling are employed and in the ways these processes are interpreted. If this is recognised it might be possible to pull down some of the fortifications and barriers which rival camps erect when research perspectives are discussed. Incidentally, as a bonus, the model view will allow epistemological and metaphysical aspects of educational research to be considered so that the notion of theory may be examined and so that philosophical and psychological aspects may be related to the nature of the research. It also enables the educational researcher to justify the choice of methods to match situations.

Before developing the model view it is convenient to present a brief introductory outline of positivism and the scientific method.

2.3 Positivism and the Scientific Method.

Positivism is a term which is associated historically with the philosopher Auguste Comte. In the last one hundred years it has been used in a variety of ways by social scientists. Here it is used to describe a research approach in social science which employs traditional methods, usually associated with the physical and natural sciences, and which is described by the generic term the scientific method. In keeping with traditional physical science, positivism regards the researcher as an objective observer. It is also concerned with developing general models and discovering universal laws of social behaviour. However, to describe positivism or, for that matter, of the physical and natural sciences, in such simple terms denies their complexity.

Cohen and Manion [1985] are more comprehensive when they describe a sequence of stages in the development of science;

1. Definition of the science and identification of the phenomena that are to be subsumed under it.
2. Observational stage at which the relevant factors, variables or items are
identified and labelled; and at which categories and taxonomies are 
developed.

3. Correlation research in which variables and parameters are related to 
one another and information is systematically integrated as theories 
begin to develop.

4. The systematic and controlled manipulation of variables to see if 
experiments will produce expected results, thus moving from correlation 
to causality.

5. The firm establishment of a body of theory as the outcomes of the early 
stages are accumulated. Depending on the nature of the phenomena 
under scrutiny, laws may be formulated and systematised.

6. The use of the established body of theory in the resolution of problems 
or as a source of further hypotheses.

The list above begs a number of questions, which Cohen and Manion deal 
with at some length. It would be inappropriate to reproduce their answers 
and arguments here. Instead it is proposed to identify and consider these 
questions in terms of the model view. This will enable us to expand on this 
introductory outline and to justify the decision to incline this research away 
from the traditions of positivism and the scientific method

2.4 The Model View

Since the term model itself is often regarded as yet another example of 
esoteric terminology it is essential to explain what it might mean in this 
context. A useful starting point to the model concept, as applied to scientific 
thinking and research, is Harré's [1976] contention that a model is a 
representative device which may also be used in a creative role. He uses 
the notion of the model to argue that the traditional (positivistic) programme 
has limited creative scientific thinking. He recommends that thinking in 
natural science and in social science (including educational research) 
should be developed through imaginative processes and not by 
conceptualising exclusively from formal logic.

Although Harré does not say so, explicitly, his ideas might be thought to 
suggest that the ultimate, but idealistic, goal of the natural and social 
sciences would be to describe and explain, in a complete sense, the 
happenings and phenomena of the world and to make precise predictions
about them. As we shall see later, not all informed comment would accept this as an ultimate aim, especially since the complexity of the natural and social worlds would ensure it was unachievable [vide infra 2.5, Kuhn, 1970]. However, accepting for the moment the goal suggested by Harré's ideas, such description, explanation and prediction could be provided by a set of sentences about the world. Harré calls such a set a *sentential model*.

Acknowledging the complexity of the world Harré extends the notion of the model to suggest that a second, more manageable set of sentences must be found which corresponds to the first. This is done by applying constraints through a systematic process of selection. Firstly researchers need to select aspects (subject matter) of the world which will be studied and modelled.

Of course, selection involves more than choosing subjects of study. Harré suggests that the process of selection could be continued by constructing an *iconic model*. This would consist of icons (objects, things, structures or processes; real or imaginary) in some kind of correspondence with the things, structures or processes of the subject matter. A set of sentences (*sentential model II*) could then be constructed about this *iconic model*. This set of sentences would then be a model of the infinite, and idealistic, set of sentences (*sentential model I*) describing the subject matter. The following is an adaptation of Harré's diagrammatic representation of his ideas.

```
<table>
<thead>
<tr>
<th>Sentential Set I</th>
<th>corresponds to</th>
<th>Sentential Set II</th>
</tr>
</thead>
<tbody>
<tr>
<td>is about Subject Matter</td>
<td>corresponds to</td>
<td>is about The Iconic Model</td>
</tr>
</tbody>
</table>
```

It is not intended to follow Harré's arguments further since he develops his ideas in an interesting but debatable manner to argue the case for *ethogenic* methods in social research and those particular methods have not been employed in this research. Nevertheless, it must be stressed that the term *model* is used in this thesis in the sense that Harré uses it. In addition, it is explained in the next section [vide infra 2.5] that this thesis relates the concept of the *model* to that of *theory* in much the same way as Harré. It is important to stress this, because models which have not been constructed in the manner described above may be useful but may not necessarily constitute theory. Nevertheless, although all models are not
theories, all theories are models.

2.5 Models, Theories, Paradigms and Scientific Research

Cohen and Manion's six stages in the development of science [vide supra 2.3] might be thought to suggest that science is developed linearly. In fact history suggests that science is not normally developed in an ordered, linear fashion [Kuhn, 1970]. Indeed Cohen and Manion acknowledge this before listing their six stages. It is far more likely to be developed in a cyclic, iterative process akin to "parallel processing". The model view allows us to imagine initial stages in the development of a particular area of science when a number of scientists 'observe' the world. From their observations they identify non-random patterns. In order to study these patterns more easily it would be necessary for the observers to select what they considered to be relevant elements, relations, happenings and phenomena. Observations would be repeated and selections modified in order to acquire information about the patterns and, perhaps to make "theories" about them. These early activities in the development of a science may not be as systematic as many would care to believe. Indeed Kuhn suggests it is a "far more really random activity" [Kuhn, 1970].

Now the term theory is contentious and is used in many different senses. In the early stages of the development of a science it may be more advisable to think in terms of the scientists constructing models. As data is gathered and patterns become more sharply focused, relevant elements and relations in these patterns emerge. If these are placed in some form of correspondence with icons, of the type Harré describes, the scientists build iconic models and subsequently sentential models. It would then be possible to label icons and then to classify and categorise.

Since any model may be refined and because the most distinctive characteristic of science is its empirical nature it is normal practice for the modelling process to continue in a cyclic fashion for some time, before models emerge which have some degree of acceptability in the scientific community. This cyclic process proceeds by using the sentential models to produce explanations, descriptions and predictions of the world which are tested through observation. As the models are refined the process becomes
more systematic and begins to take on the nature of research.

"Research is best conceived as the process of arriving at dependable solutions to problems through the planned and systematic collection, analysis and interpretation of data."


The process might be illustrated diagrammatically as follows.

Thus far, the model view provides a description of the processes which characterise the early stages of the scientific method. These early modelling activities may be regarded as attempts to supply a foundation on which a particular scientific community will base its further practice. If the history of any field of science is examined it will be evident that before such a foundation is chosen many candidate models are developed and championed by many thinkers and researchers. Historically many of these candidate models have been termed theories. In the early eighteenth century there were many models of electricity which were called theories.

Now, the decision to call a model a theory may be extremely contentious. To throw light on the use of the term theory it is necessary to consider the epistemological concepts of plausibility, adequacy and establishment. These terms, themselves are rather arbitrary and are not "capable of reductive analysis in 'truth' ......" [Harré, 1976]. Nevertheless they will be useful in this discussion.

A model may be thought to be adequate if it explains, predicts and describes
the limited selection of phenomena and happenings, which are its subject matter, to some "acceptable" level. A model is plausible if it fits in with predominant conceptions of science which appertain when it is formulated. Now if the modelling process is continued, for example by relaxing the constraints of selecting the happenings and phenomena which are its subject matter, the adequacy and plausibility of a model may increase to such an extent that it is commonly called a theory.

Since there are usually many models which are honoured, perhaps prematurely, with the title of theory, the modelling process is continued until one particular theory, or a modified version of it in the light of other theories, acquires much higher degrees of adequacy and plausibility than the other candidates. This model/theory is then adopted as the foundation and is called a grand theory or paradigm [Kuhn, 1970]. It is not always the case that the chosen paradigm has universal adequacy (or for that matter plausibility). For example, Franklin's theory, suitably modified, provided a paradigm for eighteenth century electricity but it failed to account for some important effects. What is important about a paradigm is its potential for guiding research and generating further theory.

It is, really, only at the paradigm stage of modelling that a definition of scientific research such as the following would be appropriate

"Scientific research is systematic, controlled, empirical and critical investigation of hypothetical propositions about the presumed relations among natural phenomena."


Logical deduction, hypotheses and experiment might be involved at earlier stages but a systematic approach might not be entirely evident. However, once a paradigm has been elected, scientific research normally takes place as Kerlinger suggests. The paradigm suggests which happenings and phenomena are worth investigating further and how this might be achieved. This continuing process is, of course, modelling. Through modelling new data is gathered, hypotheses are formulated, tested experimentally, accepted or rejected and new theory is developed and cumulated. Thus the model or paradigm grows and becomes established.
It has been suggested that a paradigm may be acceptable as a foundation, despite the fact that it may not be universally adequate. However, as the process of cumulation is continued it may be found that a paradigm becomes unacceptably inadequate. When theory and nature cannot be reconciled a non-cumulative "scientific revolution" [Kuhn, 1970] occurs and another paradigm is elected to replace the one which is no longer sufficiently adequate (for example, Wave Mechanics replaced Wave Theory, which replaced Newton's Corpuscular Theory of Light). The model view of the development of science seems to suggest that the ultimate aim of science is, not simply to develop theory; it is to develop theories, to elect paradigms, to test paradigms to destruction and to elect new paradigms in a never ending, cyclic process called modelling. Usually the old paradigms which have been replaced are not discarded. They are simply regarded as models to be used whenever they are useful.

2.6 Models, Theories, Paradigms and Educational Research

In many ways it is unfortunate that Kuhn chose to use the word paradigm as he did, since he appears to have placed a restriction on an English word which has a more general meaning. In fact seven years after first publishing The Structure of Scientific Revolutions, in a postscript, he admitted that he used the word in two different senses. A sympathetic reader had informed him that the term is used in twenty two different ways. The first sense describes "the beliefs, values, techniques and so on shared by members" of a scientific community. The second sense is as a model selected from candidate theories to provide a foundation for further research and development of the science.

McNamara has criticised educational researchers for using paradigm to describe their research because they do not reflect the two senses in which Kuhn uses the term. He argues that much educational research (particularly evaluation research) differs from 'normal' scientific research because it does not work within, or from, a paradigm (theoretical framework). Furthermore, he claims "there is hardly ever (never?) a sustained endeavour by a community of researchers (educational) investigating a specific issue within the context of a dominant theoretical perspective" [McNamara, 1979]. Consequently he suggests that paradigm is an unsuitable term for describing educational research.
Earlier we noted McNamara's contention that the use of the term *paradigm* by educational researchers, and debates about it, force people into camps [vide supra 2.1]. Although McNamara may be thought to be guilty of encouraging entrenchment himself, his observations are extremely valuable in highlighting important characteristics of educational research. The model view of research illustrates these characteristics even more clearly and indicates that there are important differences between 'normal' scientific research and educational research, as McNamara claims. On the other hand, the model view suggests that the development of 'normal' science and the social science of education are not as different as many think. Both of these sciences develop by constructing and refining models in a "to and fro", cyclic manner. As Kuhn intimates, this process, in either science, is not as systematic as many commonly suppose. Educational research is conducted in the context of an emerging science and thus bears a close resemblance to the initial modelling stages of the development of 'normal' science. Since no dominant theory has emerged educational science is necessarily different from that 'normal' scientific research, which takes place well into the lifetime of an established science. Because of this and, more importantly, for metaphysical reasons, educational research often chooses to eschew methods based on the deduction of hypotheses from theory. This does not make it incapable of developing and cumulating theory. Educational research may not be 'normally' conducted after a foundation of plausible, adequate and established theory (paradigm) has been chosen by a community of educationists. It may not 'normally' be conducted by formulating hypotheses from such a foundation and conducting experiments. However, it does construct models, in a "to and fro" cyclic fashion, and these are subject to the epistemological criteria of adequacy and plausibility and they are capable of becoming established and accepted as theory.

In educational research it is dangerous to discuss *verification* of theory in terms of replicating experiments and *cumulation* in terms of testing hypotheses, which are formulated by logical deduction from paradigms.

"*In* systematic study *data* are either treated as *timeless*........and hence *replicable* or as embedded in time.............and hence not replicable"

The subject matter of educational research tend to be cases embedded in time. The data collected from these cases are embedded in time and the models formulated from them are not capable of verification by forward prediction or by replicating events. Stenhouse suggests that verification in educational research depends upon critical discussion of the evidence and, if this is to take place, it is necessary for evidence to be readily available and for that evidence to be sufficiently comprehensive and illuminative.

Furthermore, Stenhouse has argued that a case is an instance not, like a sample, a representative of a class and, as such, a case cannot be related to a target population by statistical means and the variables of a case cannot be abstracted out of context. He suggests that such "abstraction starves judgement" which is essential for case study [Stenhouse, 1982]. The models/theory of educational research may not be developed in an hypothetical-deductive manner which builds on a theoretical framework or paradigm. Nevertheless, the models can provide a basis for cumulation since, although they do not allow predictive generalisation, they may be developed into retrospective generalisations.

2.7 Reality and the Subjective-Objective Dimension

The nature of this educational research must be discussed and justified in the light of certain metaphysical issues which are highlighted by the model view. These concern the views of physical, social and human reality which are taken by the researcher and the community of scholars, to whom the research will be open. The main issues are existence and causal production and they are related to conceptions of objectivity and subjectivity. All of these hinge on the nature of the correspondence, which Harré [1970] suggests must be established between the subject matter and the model.

An extreme stance might envisage this correspondence in mathematical
terms. This would regard the model as a set of elements $S_1$, with a set of relations $R_1$ between its elements, and the subject matter as a set of elements $S_2$, with a set of relations $R_2$ between its elements. The correspondence would be $a \rightarrow \alpha$, $b \rightarrow \beta$ (where $a$ and $b$ belong to $S_1$ and $\alpha$ and $\beta$ belong to $S_2$), $r \rightarrow \rho$ (where $r$ belongs to $R_1$ and $\rho$ belongs to $R_2$) such that if $a$ and $b$ are in relation $r$ in $S_1$ then $\alpha$ and $\beta$ are in relation $\rho$ in $S_2$ [compare Griffiths et al., 1974, page 291]. The correspondence would usually be 'into' and probably 'one to many', because of selection and simplification, and, for the same reasons, quite unlike a mathematical structure, such as a function, isomorphism or homomorphism. In the early stages of the modelling process selection requires that many elements of the world must be ignored. The noise of the world must be "filtered out" if a workable model is to be constructed. The model must be a simplification of the world. Is this simplification always recognised and acknowledged?

Now, it is unlikely that such an extreme stance would be taken in educational research, where it is by no means certain that the happenings and phenomena constitute sets in a mathematical sense (in fact it is extremely likely that they do not). Even in physical science, assuming a set was an acceptable concept, an extreme stance would present difficulty since any correspondence is unlikely to be bijective or even injective. The concept of reactivity suggests that any research procedure tends to distort the model of "reality" [McCormick, 1983]. This raises questions about experimentation. If the correspondence is not 'one to one', how much belief can one have in experimental control and causal production. To what extent and precision does an experimenter know what is controlled? In educational research this question is of paramount importance. When are control groups and
psychometric methods justified? Are quasi-experiments justified? In this particular research, which deals with human beings in an INSET situation the belief in control and causal production is necessarily minimal and, therefore, interpretive and illuminative methods [vide infra 2.8] are preferred to the scientific method. Here, the situation or case is regarded as an instance, temporal and fixed in time, so that it cannot be replicated in the sense that an experiment, in the judgement of a "normal" scientist, can be replicated. The 'correspondence' between model and subject matter is constantly changing. Replication, in this research, follows the sense of Glaser and Strauss who write that "facts are replicated by comparative evidence, either internally (within a study), externally (outside a study), or both." This does not entail setting up experiments and controlling variables.

A consideration of the nature of the correspondence between subject matter and model also demands that a stance be taken on subjectivity and objectivity.

The classical absolutist conception of objectivity assumes that;

(i) the elements and relations of the subject matter under investigation can be made 'objectlike',
(ii) the researcher can eliminate the effects of herself/himself, as a person, by externalising research methods,
(iii) a world of reality exists (the noumenal world) and scientific methods can be devised which can discover this reality.

Alternatives to the absolutist conception of objectivity cover a wide spectrum and it would be impossible to discuss all of these here. However, they all subscribe in some way or other to the idea of subjectivity in the researcher and, in the case of social science, in the subjects. Kant held that a world of reality did exist but that the researcher, in perceiving it would interpret it idiosyncratically [Greenfield, 1975]. This fits in nicely with the model view of research and with cognitive field learning theory. Models are not the world of reality and must not be confused with it. Models are human invention. The world exists but different people construe it in different ways by constructing different models.

It has been decided in this research to favour a subjectivist approach rather
than an objectivist perspective, since the subject matter consists mainly of people acting individually or together (rather than as an object/organisation waiting to be discovered). Individual interpretations are the basis of much of the modelling. The models sought are not quantitative but represent the world as it is perceived by the researcher and the people researched. It is recognised that the researcher will have an effect on the data and on the models which are built. The researcher cannot be regarded as a detached observer.

2.8 Educational Research Perspectives

This chapter commenced by recognising the difficult task of describing the nature of educational research. Faced with a multitude of research perspectives, classifications and categories how does one describe the nature of a pluralistic and eclectic research programme? This would appear not to be a unique problem [Sharp et al., 1975; Hargreaves, D.H., 1978]. It would be convenient, and heaven sent, if an educational research programme of this kind could be accurately described by ascribing to it a set of labels. A review of research activity in education will uncover a wealth of candidate labels, many borrowed from social research. Unfortunately, such a review will also suggest that rigid labelling encourages the entrenchment and internecine warfare which is counterproductive in the overall educational research endeavour. This research has attempted not to become identified with a particular camp since the author believes that the model view [vide supra 2.4] supports the argument that different research perspectives are not quite as distinct as many of their followers, or their labels, would have us believe.

If forced to do so the author would label this research 'non-positivistic, subjectivist, interpretive and illuminative' but this would indicate its inclination rather than provide a complete description. Furthermore these labels have somewhat loose and complicated definitions and they are used in diverse ways. For instance, non-positivistic is an adjective which might be applied to a very wide field, and the notions of research and theory vary considerably across that field. Even the more conventional classifications of positivistic and anti-positivistic suggest a dichotomy which in practice is not entirely evident. The same observation could be made about other well-known and much used classifications such as interpretive. For example
Thomas Wilson [1974] introduced two generic terms to describe contrasting research perspectives in sociology. These were the normative paradigm and the interpretive paradigm. This is a reasonable working classification but it is somewhat limited since Wilson fails to include a number of important approaches in his classification. It is perhaps more useful to regard interpretive as a generic description of a variety of approaches with a number of strands (e.g. phenomenology/ethnomethodology, symbolic interactionism). These concentrate on the micro-level of social life and argue that society is the end result of interaction between humans who choose roles and actions purposefully in the light of their perceptions [Halfpenny, 1979]. They contrast with structuralist approaches which concern the macro-level of social life and considers that cultural rules and/or forces determine behaviour. Structuralism also has a number of strands (for example, functionalism, Marxism) [Jones, 1985]. This terminology represents something of a jungle and is further complicated since all structuralists cannot be described as positivists and the interpretivists and the anti-positivists are not identical sets. To describe a research programme as interpretivist begs many questions.

The main subject matter of this research is a curriculum development in the form of an INSET scheme related to the 'hidden' shortage of teachers of mathematics. As data was gathered, and theoretical sampling took place, it became evident that the study needed to include micro and macro level aspects. Other researchers have recognised that both these levels are relevant to their programmes and have attempted to marry these levels, with varied success. A notable example is Paul Willis who uses both levels in a study of the transition from school to work of non-academic working class boys [Willis, 1977]. Such research has been advocated and supported by many leading researchers [Hargreaves, A., 1978, Hargreaves, D.H., 1978, Woods, 1988]. Others have been critical of attempts to merge macro and micro levels. Willis and Woods, are adversely criticised by Sara Delamont [1981] for "writing in vacua". Hammersley [1983, 1984] describes projects which attempt to "link macro and micro levels in a grand synthesis" as misguided. This presented a dilemma in this research, since the design and development of the INSET scheme was influenced at a macro-level by events, perturbations and forces at national, county, school and university levels. However, theoretical sampling also indicated that the study should be conducted at micro-level since the experience, beliefs, preferences,
prejudices and attitudes of providers, clients and recipients of the INSET provision constituted data which could not be ignored in a naturalistic curriculum study. A study of an INSET scheme related to the 'hidden' shortage of mathematics teachers tends intrinsically to utilise data at the micro level in preference to macro level data but the latter are still in evidence. The manner in which this dilemma was resolved is described in Chapter 9 [vide infra 9.31].

It was suggested above that the labels 'interpretive' and 'illuminative' might indicate the inclination of this research. The term 'illuminative' is often associated with the curriculum evaluation work of Parlett and Hamilton [1972] but commentators, many of whom criticise these two evaluators adversely, have pointed out that social scientists, described as interpretivist, have been advocating illuminative methods in research for many decades [Shipman, 1981; Spindler, 1982]. This is indicative of the potential which these two terms ('interpretive' and 'illuminative') possess to promote the internecine warfare which the author would rather avoid. As an example, although they state that their own research "was closest in style to a variety of educational evaluation variously known as 'illuminative', 'naturalistic', 'holistic', 'responsive' or 'case study' research", Atkinson and Delamont [1985] are extremely and adversely critical of 'illuminative evaluators' and 'case-study practitioners'. Furthermore, Delamont's plea that "sociologists of education must completely dissociate themselves from researchers at CARE" and her apparent belief that only sociologists, and not practitioners (teachers, advisers, etc.) are capable of conducting research in schools are disturbingly extreme [Delamont, 1981]. The author would not support such criticism and believes that CARE (Centre for Applied Research in Education, University of East Anglia) the "invisible college" of educational evaluators, which Helen Simons [1987] suggests was founded at Churchill College, Cambridge, in 1972, and the work of Laurence Stenhouse have as much to offer as ethnographers and anthropologists who have the approval of Atkinson and Delamont.

In 'normal' scientific research, models are constructed to describe and explain phenomena and to make predictions (which will usually be tested) about future events. The educational research of this thesis may be described as a process in which models are constructed to represent both a social world (the 'hidden' shortage) and a curriculum (an INSET
These models do not attempt to predict future events. They describe events and phenomena so that the world may be illuminated, interpreted and given meaning. They suggest what the consequences of action might be in order to assist decision making but, as Lawrence Stenhouse has argued, they do not "supersede individual judgement" [Stenhouse, 1978]. To construct such models it was necessary, not only to use interpretive techniques to "make sense of the world from the perspective of the participants" [Eisenhart, 1988], but also to study wider influences which acted on those participants. Unlike purely sociological research the model must also describe a curriculum process, including its content, design, implementation and evaluation.

This thesis takes the view that the reader must be provided with necessary and sufficient evidence to be able to judge the worth of the writer's interpretations and to make interpretations. Consequently, if the adjective interpretive applies to the research so does illuminative. It is suggested that models which only interpret, without illumination, are unlikely to meet the criteria of plausibility or adequacy, and will be unacceptable as theory.

2.9 Summary

This chapter has been devoted to the general nature of this research and has necessarily involved discussion and comparison of various thoughts in science and sociology. The roots of this research, however, are embedded in education and not in science or sociology consequently its theory, which consists of sets of models, is not constrained by those fields and neither are its techniques of analysis. It will be necessary to return to this theme later [vide infra Chapter 9] but it is proposed to do so after describing and discussing the methods which the research adopted to gather its data and after the main presentation of the study.
Chapter 3

METHODOLOGY

3.1 Introduction

It was suggested in the previous chapter that a criticism, which is often justifiably levelled at many educational researchers, is that they concentrate too heavily, or solely, on methodology. They often do this at the expense of analysis and theory and fail to describe adequately the nature of their research; ignoring underlying philosophies and paradigms. In many cases the term paradigm is used by educational researchers to describe methodology and does not refer to a plausible, established body of theory. The model view developed in the last chapter explained that in the early developmental stages of a relatively new field, such as educational research, it would be unlikely that a grand theory would emerge. Such fields would lack a paradigm from which, by deductive processes, hypotheses could be formulated and tested in the manner of traditional science. However, the model view also suggested that traditional sciences, in their early stages, may not develop in the hypothetical-deductive manner which many critics of educational research imagine. It may be the case that many 'mainstream' sociologists who criticise, for example, the 'curriculum evaluators', delude themselves that they have a paradigm or established theory from which to deduce hypotheses and, hence, to cumulate theory. They also might be accused of confusing methodology and theory.

In adopting the model view, this thesis identifies and recognises the danger of confusing theory and methodology but it also recognises that theory and methodology are not disjoint. For that reason many points which were raised in the previous chapter, which discussed the nature of this research, must be related to the methods which were employed to collect data.

It must also be recognised that theory building and data collection are dependent. Analysis and the generation of theory guide the researcher to seek data from other sources than those which have already provided information. In this process of theoretical sampling new subject matter must
be matched to suitable data collecting methods. Of course, as analysis is used to refine categories/theories/models, progressive focusing may occur so that identifiably relevant subject matter may become increasingly limited. In some types of research (for example, in small scale sociological programmes) theoretical sampling and progressive focusing may reduce the number of research methods. This was not the case in this particular research. Particular aspects employed progressive focusing (for example, the investigation of the nature of the hidden shortage) but overall theoretical sampling extended the field of exploration and demanded that a variety of methods were used. In many ways this was a direct result of regarding theory as a set of models. The modelling process, by its cyclic nature, requires that information is selected and gathered by a variety of appropriate means and that this data is compared so that models may be improved, accepted, stored or rejected. Triangulation is a basic feature of modelling. The pluralistic methodology of this research not only reflected the wide research perspective, which was described in the previous chapter, it was demanded by the situations, events and groups which theoretical sampling identified as relevant subject matter. It could be argued that modelling encourages that "spiral of understanding" in educational research, which Lacey [1976] suggests can only be provided by a variety of data collecting methods and analytical techniques.

Unfortunately it is not only in research perspectives that entrenched positions are adopted. Dogmatism is also a feature of the debate on methodology. For example survey techniques are often eschewed by researchers who rely solely on participant observation, on the grounds that the two techniques belong to diametrically opposed research perspectives. Fortunately many researchers, including the author, are now coming to regard observational techniques and questionnaires as members of the same spectrum of research methods; well separated but not constituting a dichotomy. Even in the illuminative research tradition Stenhouse [1979b, p32] recognised that there was "a lot of room in case study for a quantitative ingredient which is at present too much neglected............The issue is not qualitative versus quantitative, but samples versus cases, and results against judgements". Stenhouse remained suspicious of the sampling procedures associate with, what he called, the 'statistical-experimental paradigm' of research but admitted the worth of quantitative data in enhancing judgement. In this research quantitative data, some collected
through survey techniques, is used to provide illumination and to assist interpretation.

3.2 Evaluation and Research

Before describing the particular methods which are employed in this research, it is necessary to consider and analyse a contentious debate regarding the relationship between evaluation and research. Strangely two camps, which might be thought to occupy entrenched positions at opposite ends of a spectrum ranging from the scientific method and positivism to naturalistic and illuminative traditions, take the same view that research and evaluation should be regarded as different processes. Henderson [1978] compares and differentiates between research and evaluation by adopting a limited view of research, as a hypothetical deductive process, while MacDonald and Walker [1974] of CARE, from an illuminative perspective, distinguish 'pure academic research' and 'applied evaluation'. The latter distinction is described as "spurious" and "crudely stereotyped" by Atkinson and Delamont [1985] who accuse 'professional evaluators', presumably members of CARE, of seeking absolution from the theoretical and methodological constraints of the 'researcher'.

The author, while not accepting that the above criticism of MacDonald and Walker is entirely justified, argues that to distinguish between evaluation and research is unhelpful and unnecessary. Some evaluation is intrinsic to any research involving INSET provision. This will usually be, what Scriven [1967] describes as, formative evaluation; used to provide feedback and 'mid-course' modifications to programmes. In the research described in this thesis the evaluation was regarded as formative at all stages. Although evaluation continued after the first 19 week phase of the RLPE INSET programme had been completed this was not summative, since the provision was intended to be on-going. On the other hand INSET provision necessarily involves research problems, which usually emerge as the programme is implemented. In order to solve these problems perspectives and methods must be adopted which inevitably lead to analysis of data and the construction of theory. Such was the case in this research, which not only sought to evaluate and research a 'curriculum development' but also involved itself with a theoretical study participants.
The RLPE INSET programme has consciously been described as a 'curriculum development' because, in this research, INSET is regarded as part and parcel of the general curriculum. This includes not only schools but all sectors, phases and aspects of education in this country. There exists a disturbing tendency to compartmentalise, so that research in which the subject matter is identified as classrooms and/or pupils is divorced from that in which the subject is INSET provision and/or teachers. This research rejects such compartmentalisation and, accepting that INSET affects not only teachers but also classrooms and pupils, it has conducted its business inside and outside classrooms. With this in mind consider a useful diagram [Fig. 1(3)] given by Davis [1981] to relate and compare significant aspects of curriculum evaluation.

![Fig. 1(3)](EMPHASIS ON HUMAN PERFORMANCE

1. Testing (for selection and certification)

3. Psychological research (into learning, motivation and child development)

EMPHASIS ON QUALITY CONTROL AND ACCOUNTABILITY

2. School Inspections (preview of materials and resources by 'experts' away from the schools)

EMPHASIS ON EXPLANATIONS AND FURTHERING UNDERSTANDING

4. Within school evaluation (observing, monitoring, describing, documenting)

EMPHASIS ON EDUCATIONAL PROVISION

If the wider perspective of the curriculum is taken, which includes INSET provision, the evaluation aspects of this research programme arguably belongs to the fourth quadrant of the diagram above. The RLPE INSET provision, which this research studied was evaluated but this was clearly distinguished from assessment, measurement and testing. The RLPE INSET programme was subject to quality control and accountability. The Local Authority Inspectorate were involved in this and its conclusions are reported in this thesis. Since the research also studied the nature of the 'hidden' shortage of mathematics teachers, it included some consideration of human performance but this is, perhaps, not closely related to psychological
research in the sense that Davis uses the description.

It must be emphasised that although evaluation forms part of the research programme described here it includes wider aspects. At face value Davis' diagram appears to relate only to 'applied evaluation' but explanation and understanding necessitate a research act through which theory will be produced. Such theory would, as Stenhouse suggests, assist judgement in educational provision and this is the view adopted by this research. Nevertheless, the methodology which is associated with the fourth quadrant of Davis' diagram (observing, monitoring, describing and documenting) are those mainly employed in this research. They are also those methods most closely associated with *ethnography* and it will be necessary, later, to discuss how this research is related to ethnography. However, at this juncture, it is, perhaps, more pertinent to discuss how the research methodology combines *explanations and understanding* with *educational provision* in the context of INSET. It is possible to do this by considering characteristics which this research shares with *action research*.

### 3.3 Action Research

Arguing that "*it might be better if less were made of the differences between evaluation and research*", Davis [1981] promotes the case "for placing some evaluation techniques at one end of a scale, with action-research somewhere in the middle and laboratory-type controlled experiments at the other end." Now, much has been written on *action-research* but the subject is often the source of confusion. This is usually the result of conflicting definitions and the many different contexts in which the term is employed.

Interestingly, and appropriately for this research, action research shares its origins with mathematical modelling. During and after World War II scientists, engineers, sociologists, anthropologists, psychologists and mathematicians worked together to solve problems which that conflict had highlighted and produced. For the first time these workers came to recognise that many of their techniques and approaches had a great deal in common. This recognised commonality and the advent of the computer combined to encourage the development and use of the mathematical model in many fields. At the same time, action research was being developed, often by the same groups, to study parallel problems. Rapoport [1970] identifies four
strands, from which action research developed; (i) The Tavistock experience which researched and treated social groups affected by war, (ii) Operations Research, (iii) Group Dynamics and (iv) Applied Anthropology. In its early days action research was often identified as an applied form of social research, distinguished from 'pure' research by the immediacy of the researcher to the action and by the existence of a client seeking a solution to a problem. Rapoport suggested alternative aims.

"Action Research aims to contribute both to the practical concerns of people in an immediate problematic situation and to the goals of social science by joint collaboration within a mutually acceptable ethical framework".


Stenhouse has extended the above and applied it to education by distinguishing between a research act, which is an action "to find something out", and a substantive act, which changes the world in a manner, "which is judged to be desirable". He argues that action research in education combines both acts so that "the act of finding out has to be undertaken with an obligation to benefit others than the research community" [Stenhouse, 1979c, pp56-58]. Stenhouse demands that research should guide teaching and teachers. In his view, the purpose of action research is not to provide teachers with practical ideas and social scientists with theory but to contribute to "a theory of education and teaching which is accessible to other teachers" [Stenhouse, 1979a].

Now, this research has been conducted to solve an immediate problem. The local authority, inspectorate and teachers were clients. The researcher was immediately involved in solving the problem and the solution was designed to benefit the clients, including the teachers and their schools. At the same time the research act sought to further an enquiry and to produce theory which would guide teachers and agencies involved in future INSET provision. For those reasons this research has many elements which might be described as action research but to apply that terminology to the programme as a whole would probably be too restrictive. In addition, in the UK and Australia action research in education is becoming increasingly associated with classroom research in which teachers themselves are the
researchers. Nevertheless, it will be seen later [vide infra 9.34] that an important phase of the design and planning of the RLPE INSET provision was conducted in a fashion which had many similarities to the modified forms of Lewin's spiral model for action research, which Kemmis and McTaggart [1988] have presented to teachers and school administrators in Australia and which Elliott has used in educational research in the UK [Elliott et al., 1976: Elliott, 1981].

Although this research will not be described strictly as action research it is suggested that future research which develops from it might well be inclined to what is being termed collaborative action research [Henry, 1987]. Elliott observed that teachers involved with the Ford Teaching Project [Elliott et al., 1976] were sometimes not free to change because of their working environments. This was certainly true of the teachers involved with the RLPE INSET provision of this research and this will constitute part of the reported research findings. The researcher collaborated with the Mathematics Inspectorate, the ESG Advisory Team and schools in an attempt to change the environment and effect change. This collaborative activity became part of the subject matter which this research studied. As the research progressed into the on-going RLPE INSET provision the researcher became more involved with teaching practices in schools and the research methodology (for example, participant observation) was adopted to accommodate this. In addition, aspects of the research could be regarded as emancipatory in the sense that a number of the teachers involved were assisted by it to move away from "the dictates and compulsions of tradition, precedent, habit coercion or self-deception" [Carr et al., 1986]. The data obtained from observations of teachers working in their schools are relevant in this respect [vide infra 6.71, 6.72]. It is suggested that future research could well assume many of the characteristics of collaborative and emancipatory research [Holly, 1987] in which the teachers themselves become participant researchers of their own practices, share research findings and control both the research and the resulting educational change. In this way an on-going INSET programme associated with research could well be supported by collaboration between Teachers, LEA and University [Dadds, 1986].

3.4 Educational Ethnography

Illuminative evaluation, interpretive research, action research and
educational ethnography [Wilson, 1977] have many common characteristics and employ many of the same research methods (for example, unstructured observation, informant interviewing) and techniques (including, the use of field notes, anecdotes, documentation and background sources). They all tend to identify with a research perspective inclined away from positivism. Despite this commonality there are researchers, especially those with a background in anthropology, who are jealous of the description ethnography and who object to the proliferation of the term.

"Inevitably, any movement that rapidly acquires many followers has some of the qualities of a fad, and this is true of educational ethnography."

George Spindler, 1982.

The main source of contention is theory. 'Mainstream' anthroethnographers suggest that many researchers who call themselves ethnographers ignore theory. Those criticised argue that they do in fact produce theory but in a form likely to be of most use for practitioners and not necessarily for anthropology or social science. Much of this debate has been covered earlier in this chapter (and in the previous chapter) but, since the methodology of this research has a great deal in common with ethnography and action research the arguments must be kept in mind.

It was suggested in the last section [vide supra 3.3] that, although the research had many of the characteristics of action research, to apply that term as a general description would be restrictive. For similar reasons this research will not be described in general terms as ethnography, despite the facts that (i) it appears to meet the criteria which Spindler [1982] lists for "good ethnography" extremely well and (ii) many of the methods and techniques employed in this research are undoubtedly ethnographic. One reason for rejecting the description is that the methodology of this research is, perhaps, not as dependent on participant observation as are many programmes which are termed ethnography. Another important consideration is that ethnography, in its pure sense is concerned with developing theory about social systems which are relatively closed, but this research has rather wider interests. Because it concerns itself with teacher supply and the shortage in mathematics, this research necessarily takes into
account forces external to schools and INSET situations.

"Some critics of ethnography have claimed that it is hopelessly mired in situationalism and idealism. Again this may be true of some studies but by no means all."


It is hoped and suggested that this research falls into the latter category, by selecting judiciously from Ethnography, Marxism and Critical Theory [Carr et al., 1986], but without embracing any of these movements in a slavish and entrenched fashion.

3.5 Observation

Observation is a method which naturally assumes an important role in this research. The term observation is often used to include a wide combination of methods, which are conveniently sub-divided into two groups; direct observation and indirect observation. [McCormick, 1988] The latter group refers to the reconstruction of events, phenomena and behaviour from the accounts of participants and data is collected through questionnaires, interviews, diaries etc. These methods are employed in this research and they will be discussed and described individually in other sections of this chapter. The former section is the more common understanding of observation and it is this which will be considered here. Direct observation itself may be sub-divided into structured observation and unstructured observation. If the observation which is used in this research is described as unstructured it must be stressed that this is only done to distinguish it from those 'structured, systematic observations' which record behaviour against pre-specified categories and provide quantitative data. Many of the latter are based on Flanders' Interaction Analysis Categories [Flanders, 1970] which is, perhaps, more appropriate for the more formal classrooms of the USA than for studying INSET programmes or classrooms in this country.

The particular style of 'unstructured observation' employed in this research is described as participant observation. This description is used although, often, in ethnography it refers to a researcher who has chosen a social group as subject matter and has taken steps to become part of that group (or to become accepted by that group as a member). It could be argued that,
normally, this membership is extremely tentative and disputable and that it is extremely rare for the researcher to be regarded as a 'true' member in all respects. There is always a real danger of the researcher unwittingly 'invading the space' of the subjects. Because of this many researchers prefer not to completely immerse themselves in a sub-culture. There are indeed dangers in identifying too closely with a subject matter, since the researcher may lose that measure of detachment which facilitates appreciation, study and analysis. In this research the researcher was a provider, designer and tutor of the INSET programmes and in this sense was not a member of the group of teachers for whom the programmes were provided. Nevertheless, the teaching and social techniques employed by the researcher established close relationships with other participants of the INSET programmes to such an extent that it is considered appropriate to term the observational methods used participant observation. This is particularly true of the main vehicle of this research; the RLPE INSET programme for teachers with limited qualification and experience in mathematics. Woods has observed that in participant observation "the nature and degree of the participation might vary according to the aims of the research, the researcher, and the culture concerned" [Woods, 1986]. Such was the case in this research as the perceptions of roles, which all participants held, changed as the relevant programmes developed, proceeded and evolved. The role of the researcher changed during the programme from tutor (sometimes outside, 'university expert'), to advisor, colleague, fellow participant, friend, confidant, supporter, ally. This necessarily changed the degree and nature of the participant observation. For purposes related to indexicality and reflexivity [vide infra 3.10] these changing roles will be discussed alongside results and analysis.

3.6 Ethical Issues in Observation

In any research ethical questions must be of paramount importance. In observation these usually revolve around overt and covert research methods and techniques. This research attempted, at all times, to employ overt observational methods but as all researchers find, there are always occasions when information is obtained by unplanned covert means. The ethical dilemma is what to do with significant data obtained accidentally but covertly. To resolve this the following procedures were adopted.
In those data collecting situations which were likely to be ethically sensitive for personal reasons the subjects were well aware, by prior agreement, that they were being observed for research reasons. In fact, all participants from whom data was collected by participant observation, interview and questionnaire agreed that all the information gathered could be used for research purposes. In the case of the RLPE INSET programme, in nearly all instances, teachers indicated that they did not seek anonymity but, for ethical reasons, it has been decided, nevertheless, to preserve anonymity in this thesis. Such anonymity is not always affordable or acceptable in evaluation studies [Stenhouse, 1982] but, since any evaluation aspects of this programme were regarded as research, this was not a cause for concern.

The mutual trust between the researcher and subjects enabled the data to be gathered and in using this data the researcher has respected and maintained that trust. Non-participant, 'fly on the wall' techniques were avoided, as far as possible, even in those situations where classrooms and school activities were observed. Some non-sensitive data which was collected by non-participant observation has been used in this research. This is mainly connected with background data (for example the design and development of curricula, INSET programmes, syllabus content, pertinent influences, unobtrusive observations) and is strictly non-sensitive. There are, of course, occasions in the course of any research when significant but sensitive information is gathered incidentally and covertly by a non-participant observer. Certain information of this nature has been gathered and used in this research but it is only reported where anonymity can be strictly guaranteed. Where this is not the case the data has not been reported although it has necessarily been considered in the process of analysis, in order to maintain *indexicality* and *reflexivity*.

### 3.7 Insider/ Outsider Observation

Research which includes elements of evaluation faces another dilemma. An outside observer seeking research data may be accused of 'arrogance'. David McNamara has criticised participant observers in classrooms on this count [McNamara, 1980]. It is interesting to compare this criticism and a rebuttal by Martin Hammersley [Hammersley, 1981]. An inside evaluator may attract further criticism, possibly in respect to validity, from those who regard evaluation as an exercise in accountability. It must be stated that in
most observation situations of this research the researcher should be regarded as an insider.

The second 'horn of the dilemma' mentioned above is, perhaps the easier to deal with and this has been discussed in section 3.2. This programme does not distinguish between research and evaluation. Elements of the research which include evaluation are regarded as models of curriculum design; applied to and developed for INSET provision. Since these models are research models and in no sense objective models or means to ends devices they do not include assessment, testing or measurement. They are concerned primarily with the evolution of theory and the production of guidelines to assist curriculum improvement. Outside evaluation, in this instance, would have been inappropriate and would have diminished validity rather than enhancing it. Evaluation for accountability was the responsibility of the local authority inspectorate and this was carried out and is reported in this thesis; since it assists analysis and interpretation. The inspectorate's evaluation is not regarded as a direct observation by the researcher but constitutes important data.

David McNamara's accusation that outside observers exhibit a degree of arrogance in assuming that they "understand and appreciate the realities of classroom life as seen from the point of view of the practitioner" [McNamara, 1980] is directed at some ethnographic research in schools. For the most part this research was conducted by the practitioner in INSET situations. In collecting data from schools the researcher may be accused of arrogance but that data is not used to reconstruct the viewpoint of the practising teacher. It was gathered to support other research findings related to INSET provision and not to classroom practice.

3.8 Surveys and Questionnaires

It has been pointed out earlier that this research regards survey as a legitimate research technique to employ in a programme which, nevertheless, adopts a perspective inclined away from positivism and towards interpretation and illumination. It is simply one technique in a useful spectrum. In this research quantitative data are not utilised in a statistical-experimental manner; to relate samples to target populations and to make general inferences by calculation. Nevertheless, the quantitative data which
survey techniques supply are not denied, since these may enhance interpretation and analysis. Quantitative data were collected by questionnaires in this research and these data supplemented and complemented data collected by other techniques such as interviewing. This enabled a high degree of triangulation and the opportunity to compare and contrast data as part of the process of analysis.

Questionnaires are often regarded and treated as self-administered, structured interviews by researchers who adopt a statistical-experimental approach [Smith, 1981]. In this research the questionnaires might well be regarded as semi-structured interviews since, in the majority of cases, they were not completed at a distance. The subjects and the researcher were not remote and there was a great deal of interchange of information and interaction; which was regarded as part of the research process. The questionnaires were not used in isolation. Questionnaires and interviews complemented each other and allowed data to be cross-checked. The unstructured interviews were conducted after the questionnaires had been completed and analysed. In this way, additional and pertinent data was acquired. The research programme did not regard the matter of "questionnaires versus interviews" [Henderson, 1978] to be relevant. Consequently many requirements, which are essential for 'distance survey' or 'standardised' questionnaires/interviews, were able to be relaxed, modified or discarded as irrelevant. In doing this, respect was maintained for standards of design, organisation and implementation so that data were not impaired and design was based on a number of empirical studies of survey techniques [Kornhauser, 1976; Cohen et al., 1985].

The first questionnaire was originally intended to constitute part of an evaluation exercise related to the first phase of the RLPE INSET scheme. Its main purpose was to help the Loughborough team to design future INSET courses of a similar nature. This purpose was explained on the title page of the questionnaire itself, which was entitled an 'Evaluation Survey'. The design of the questionnaire was undertaken by the author and the other member of the Loughborough team who had been most closely associated with the design and implementation of the RLPE INSET scheme. It soon became apparent to these two designers that the questionnaire could not simply concern itself with obtaining the teachers' views regarding the
design, organisation and implementation of the RLPE INSET programme. In addition to such views, data was required concerning the academic and career backgrounds of the teachers. In fact evaluation and research issues could not be divorced. Indexicality [vide infra 3.10] was a necessary aspect of this survey exercise. The content of the questionnaire was chosen accordingly [vide Appendix 1].

The information sought presented problems in structuring the first questionnaire. Through participant observation during the RLPE INSET scheme and documentary evidence (for example, the application form for the RLPE INSET scheme, which the local authority inspectorate had required each member to complete, had been made available to the author) the designers were aware that many of the teachers concerned had changed schools frequently in the recent past and some were still in the process of doing so. These changes are, in fact, important data relevant to the nature of the 'hidden shortage'. Consequently it was decided to divide the questionnaire into a title page explaining the purpose of the questionnaire and giving brief essential instructions, a main section called 'Evaluation Survey', a section called 'Teaching Appointment 1' and a section called 'Teaching Appointment 2'. The third and fourth sections were identical, apart from their titles, and referred to teaching appointments held during the period September, 1986 to September, 1987. (The first phase of the RLPE INSET scheme covered a period from February, 1987 to July, 1987 and the residential weekend was in September 1987.) Any teacher who had held more than two teaching posts in that period, or whose teaching duties had changed drastically in a given post, was asked to complete additional sections identical to the third section.

Since the questionnaire was not designed for distance survey it was decided not to employ closed (fixed-alternative) items (questions) [Kidder, 1981]. The written instructions suggested that respondents should not allow the questions to restrict their answers. However, the items relating to teaching appointments sought data which was factual and non-subjective and, although they were free-answer questions [Kidder, 1981], they might be described as 'semi-closed'. These items were arranged to refer to the appointment itself, the school and the personal teaching timetable in that order. The main section included open and 'semi-closed' items and sought both subjective and non-subjective data. The structure of this section
presented more problems, but it was decided to order the items so that non-subjective items preceded subjective items, items became more open-ended as they were encountered by the respondent and later questions would 'build' logically and naturally on earlier question where necessary. The structure involved a minimum of routing and filtering [Henderson, 1978], which meant that the flow chart of the questionnaire was fairly simple and, except for one by-pass filter, linear.

Structuring the questionnaire involved a number of drafts which were edited and revised by the two designers. The items themselves were also subject to severe editing. This was done to eliminate ambiguities, esoteric or complex language, jargon, negative forms and expressions and terms which were judged to be potentially irritating and unacceptable to teachers. Such editing, although informed, constitutes a somewhat subjective selection process. This is necessarily a common feature of questionnaires and should be considered by those who use the technique in a positivistic fashion [vide supra 2.5].

Because of the subjective and open-ended nature of the questions it was decided to request the teacher to complete the questionnaire during the residential weekend when they would have access to the designers, other tutors and fellow teacher participants. This meant that written instructions could be reduced to a bare minimum. Respondents would be encouraged to consult tutors and each other. This reflected the perspective of the general research programme. No time limit would be specified but it was decided to encourage the teachers to complete the questionnaire during the residential weekend.

Favourable comment had been received from the participants during the RLPE INSET sessions at the Mathematics Centre, Midchester, regarding the presentation of course documents and resources. The mode of presentation was A4 white sheets, prepared by Macintosh Wordprocessor and Laser printer, using 12 point Helvetica font at 14 point spacing. It was decided to use the same style of presentation for the questionnaires.

Following severe editing by the designers, which not only considered individual items but also addressed the overall efficiency and length of the questionnaire, an advanced draft of the questionnaire was prepared. Other
tutors who had been involved with the RLPE INSET scheme were asked to comment on this draft. As a result of comments received from these tutors this draft was amended and a final version was prepared. Because this questionnaire was not designed to be a 'distance' survey and because the respondents were not regarded as a sample, from which general inferences would be made by calculation further piloting of this questionnaire was not undertaken. In fact to identify a representative pilot sample was not a feasible or appropriate proposition for the first questionnaire. However, in the event, the first questionnaire became a convenient pilot for the design of the second questionnaire.

The residential element of the RLPE INSET scheme was held at Loughborough University, commencing 2.00 p.m. on Friday 25 September and concluding at 10.45 a.m. on Sunday 27 September 1987 [vide infra 5.6]. Seventeen of the twenty one participant teachers attended the residential weekend. The first questionnaire was given to attenders at 4.15 p.m. on Friday so that they would have ample time to complete it during the weekend and sufficient opportunity to discuss it with tutors and other participants. The evaluation and research purposes of the questionnaire, together with instructions for its completion were described (in open session and individually) by the author and a colleague when the papers were distributed. These explanations and instructions were repeated as necessary during the remaining residential period. These instructions stressed that all information obtained from the questionnaires would be treated in strict confidence and any subsequent use of the data, in research and evaluation reports, would preserve anonymity. Most, but not all the participants, indicated that confidentiality and anonymity were not matters which concerned them. Nevertheless, the tutors assured the teachers that both elements would be maintained in reports and publications. The questionnaire itself did not include a request for names of individuals or schools but the designers recognised that the respondents and many of their career and personal details were so well known to them that completed questionnaires would easily be matched to individuals. For ethical reasons this was discussed with the teachers. In the discussions it was clear that the teachers also recognised this but they indicated that they did not regard this as a problem. It became clear that the manner in which the teachers completed the questionnaires preserved anonymity to the extent that individuals wished. Two teachers (Roy and Brenda) did not hand in
questionnaires during the residential weekend. Brenda returned her completed questionnaire by post, four weeks later. Roy never returned his questionnaire despite requests by letter, telephone and personal visit and despite his promises to do so. Data collected later by interview, the second questionnaire and informal conversations suggests that this negative response was the result of personal organisation, or other priorities, rather than a desire to preserve complete anonymity or because Roy did not trust the author.

It was decided to send the first questionnaire to the four teachers (Sheila, Lawrence, Bob and Steve) who had not attended the residential weekend. A questionnaire was taken to Steve by Wendy, who had attended the residential weekend. Wendy and Steve taught in neighbouring schools. Questionnaires were sent to Lawrence, Sheila and Bob by post. A covering letter and first class stamped, addressed envelope were sent to all four teachers. Since the questionnaire was, for those four teachers, a distance survey the covering letter emphasised purpose, confidentiality and encouraged a reply. Only one of these questionnaires was returned. Steve gave his completed questionnaire to the author during the interview. As the research progressed the author discovered that there were special and specific reasons why the remaining three questionnaires were not returned.

Bob, who had been on a temporary appointment during the first phase of the RLPE INSET scheme had failed to obtain another teaching post and had found other employment outside the profession. He had also changed his address and could not be contacted by the author, despite attempts to trace him. After approximately one term Sheila had been instrumental in obtaining him a temporary post at her own school, St. Benedict's RC School. The author subsequently interviewed Bob and Sheila at St Benedict's.

Sheila explained that she had not completed the questionnaire because she had been heavily committed to an Open University course, which she regarded as a priority. In fact, she had telephoned the author prior to the residential weekend to apologise for not being able to attend, because she was involved with this Open University course.

Lawrence had also telephoned the author, shortly before the residential
weekend, to offer his apologies for not attending. He explained that he had a prior family commitment. He telephoned the author again the day before the first RLPE INSET follow-up session to apologise for not attending. He gave the same reasons as before. He promised to return the first questionnaire and indicated that he was willing to complete the second questionnaire which the author had explained he would forward together with Lawrence's RLPE INSET Certificate. He was anxious to point out that any comments he had made, or would make, were not meant to be disapproving of the INSET provision. He had thought that the 'course' (most of the participants referred to the first phase of the RLPE INSET scheme as a course) had been extremely valuable to him. He thought that a written questionnaire would not truly reflect his own opinions and he hoped that his written comments would not be taken out of context. The author assured him that comments would not be taken out of context. Although, from this telephone conversation it appeared that Lawrence had already completed, or partially completed, the questionnaire he never returned it to the author. He did, however, return the second questionnaire.

In total 17 of the first questionnaires provided data for this research out of 21 questionnaires which were issued. Analysis of these questionnaires revealed that a great deal of pertinent and valuable data had been gathered by this technique. Nevertheless, the data was not regarded as sufficient. Four questionnaires had not been returned. A number of teachers had not responded to some of the more open-ended items. The information collected from some 'semi-closed' questions had not been comprehensive. Since the survey was regarded, not as a statistical exercise, but as one technique in a non-positivistic research programme the non-responses, in fact, provided a great deal of relevant and important data. These data were useful in the analysis and formulation of theory.

Although the first questionnaire had accumulated much valuable data its limitations were apparent as analysis commenced. This reinforced the author's opinion that questionnaires are not well suited to the type of research study involved. A questionnaire used as the sole research instrument, or in isolation from other techniques, would be virtually useless for such a study. Since it was never intended to use the first questionnaire in isolation it did prove extremely valuable. Its analysis, not only suggested that more data was required, it indicated new subject matter for research (that is,
it promoted theoretical sampling). It also acted as a pilot for a second questionnaire. Perhaps most importantly, by highlighting the limitations of questionnaire survey, it suggested that observational and interview techniques would be more suitable for collecting additional data and for checking the data already accumulated. However, a follow-up session of the RLPE INSET scheme had been arranged and this presented an ideal opportunity to employ a second questionnaire.

The author decided to use the second questionnaire to collect only non-subjective data. This would supplement and cross-check data collected from the first questionnaire. Because the data would not be subjective and because it was expected that the respondents would complete the survey at a 'distance' it was decided to use a mixture of closed (fixed-alternative) and 'semi-closed' (free-answer) items, but to use these with 'tick-boxes' [vide Appendix 2]. Preparation and editing followed the lines of the first questionnaire production. The nature, limited length and content of the questionnaire suggested that this version could be piloted and this was done by asking three teachers on MSc courses of the University to simulate the exercise and to comment. This provided valuable feedback from which minor modifications resulted.

19 copies of the second questionnaire, and a first class-stamped, addressed envelope, were given to the teachers who attended the RLPE INSET follow-up session at the Mathematics Centre, Midchester, on 26 November, 1987. As a result of the experience of using the previous questionnaire, space was provided on this questionnaire for the respondent's name. The teachers indicated that they had no objection to this and all who returned questionnaires wrote their name in the space provided. The author explained the research and evaluation purposes of the exercise and assured the teachers that all information given on the completed questionnaires would be treated as confidential and that anonymity would be preserved in any future reports or publications. Lawrence was absent but he had been sent a questionnaire and had been given full explanation and assurances by telephone the previous day. Bob was also absent but he was excluded from this exercise because, at that time, his whereabouts were unknown to the author. The questionnaires were returned by post, with the exception of Brenda's which was never returned.
Of the 21 members, 19 completed and returned the second questionnaire. The mixed 'closed' and 'semi-closed' items, with 'tick-boxes', appeared to have been suitable for the collection of the non-subjective data sought. The respondents completed the items efficiently. The author found collation of data easy and straightforward. Cross-checking previous data was expedient.

3.9 Interviewing

In order to justify the interviewing styles and techniques which were chosen in this research it is necessary to consider how interviews might be classified. There are a number of ways in which this might be done. One way is to imagine a continuum of types, with formal/structured interviews at one extreme and informal/unstructured interviews at the other. The former type would consist of set, ordered, pre-determined questions and would utilise standardised implementation and recording techniques; while the latter would be conducted with no pre-suppositions about the data to be collected and would be conducted in a conversational style. Between these extremes would lie many different varieties and compromises. For example, to produce semi-structuring, the order of questions might be modified as necessary during the course of the interview, additional questions might be added, wording might be changed or open-ended responses might be allowed and recorded. A focused interview [Powney et al., 1987] would eschew set questions in favour of guidelines. These would focus the responses of the interviewee; so that the furnished data would be relevant to pre-determined subject matter and would test pre-formulated hypotheses.

Another way in which interviews might be classified is based on the notion of control. In a directed interview the situation is controlled by the interviewer, whereas in a non-directive interview (a technique developed from the pioneering work of Sigmund Freud [Ford, 1963]) the interviewer takes a subordinate role and the interviewee is responsible for initiating and directing the situation.

Powney and Watts [1987] combine the notions of control and structure to distinguish two interview styles which they term (i) respondent and (ii) informant interviews. They suggest that all interviews are structured in some way, either tightly or loosely, but the important distinguishing feature relates to who determines and imposes the structure. Is it the interviewer or the
interviewee? In respondent interviews the interviewer retains control, imposes the structure, determines the set of questions and issues to be studied. In informant interviewing it is primarily the interviewee who imposes structure. The author suggests that, although the above is a neat way of classifying interviews, it does not reflect the dynamic nature of the interview situation. Control is not static. This is particularly true of interviews conducted in a conversational style.

The typologies described above are by no means exhaustive and would not adequately address the complexity of interviewing as a research technique. They do, however, allow the interviews used in this research to be described against a background which provides reference points rather than in a vacuum. The style chosen reflects the non-positivistic perspective of the research.

In each case the interviews involved only the interviewer and the interviewee. Each member of the RLPE INSET scheme was interviewed in depth. This involved 21 'full-scale, pre-arranged' interviews (supplemented by occasional 'ad hoc' conversations conducted as a natural part of the overall research programme). The interviews were conducted in a conversational style and in as informal a manner as possible. The environment in which each interview was conducted was chosen to enhance this informality and was one familiar to the interviewer. In fact the time and venue were always chosen by the interviewee. Locations were in the schools of the interviewees except in one instance when the interview was conducted in the home of the teacher concerned.

Before each interview commenced the author explained that the conversation would be used for the preparation of a research report and that strict confidentiality and anonymity would be maintained in that or any other report. This was a repeat of the explanation and assurances given by the author during the telephone call in which the teacher agreed to be interviewed and arrangements for the interview were made.

The interviews were focused to some extent, since the interviewer had a number of pre-determined issues on which data were sought. These issues had been identified following earlier observation and questionnaire based survey. Additional data connected with these issues were sought to cross-
check existing data and to support the formulation of that theory which was beginning to emerge. The issues were:

1. The background of the interviewee
description of the position held at the present school
relation to mathematics department
circumstances of becoming a teacher of mathematics
academic qualifications and perceived adequacy of these

2. Previous INSET opportunities
mathematics related
other

3. Reasons for joining the RLPE INSET programme
how did interviewee learn of the proposed programme
release pattern, supply cover
perceived needs

4. Comments on RLPE INSET programme
purpose
content
processes
organisation and administration
location, times, dates
effectiveness, suitability, match to needs
effects on personal teaching practices
effects on colleagues, pupils and school

5. Future INSET needs
on-going RLPE INSET provision
willingness to act as key-person in on-going provision
communication network
other

It is feasible and, perhaps superficially attractive to break down these issues into a set of formal questions. Indeed many of the possible questions had been covered by the questionnaire survey. Experience of using survey techniques suggested that, although a comprehensive set of responses might be obtained to such set of questions, presented in a formal, structured respondent interview, they would not necessarily be valid. Instead the list of issues was used as a general plan by the interviewer.
The issues were described, in very general terms, to the interviewee just prior to the interview. It was not intended that the interviewee should memorise these. The interviewer indicated that he would remind the teacher of the issues, if necessary, during the interview. This produced some loose structuring. In many instances the interviewee had asked what issues should be included in the conversation before the author had indicated that a set of issues existed. In other cases the interviewees requested the author to prompt and remind them of the issues during the conversation. By outlining issues and agreeing to prompt, the author gained the impression that he had alleviated mild anxieties in interviewees.

Because loose guidelines had been provided and because prompts and reminders were employed the conversation adopted some characteristics of a respondent interview. The interviewer retained a modicum of control, interrupting or prompting, when the direction of the conversation was veering towards the irrelevant, when inconsistencies were evident, when excessive repetition was occurring, when important issues had not been covered or, most importantly when the author detected that the interviewee sought assistance. Nevertheless, such interviewer control was employed only when essential. In fact, during the major part of the interview the author adopted a sub-ordinate role and allowed the interviewee to dominate the conversation. In most cases the interview followed and reflected the loose guidelines but the interviewer did not interfere when other directions were taken, as long as these furnished useful and relevant data. Indeed the technique of remaining silent was employed extensively by the interviewer and this almost always resulted in the interviewee adding usefully to the data. The conversation, therefore; had many characteristics of an informant interview and it is suggested that these balanced respondent characteristics to match the particular research situation.

The general aim of the interviewer was to join the ranks of those researchers who, according to Madge;

"wish to retain the good qualities of the non-directive technique and at the same time are keen to evolve a method that is economical and precise enough to leave a residue of results rather than merely a posse of cured souls"


51
The techniques which were used in the interviews conducted with teachers who had been members of the RLPE INSET programme had evolved following interviews with other teachers over many years using a variety of recording techniques. In the recent past pilot/practice interviews had been conducted with teachers who had been involved with the Loughborough University MSc in Mathematical Education and with the PEVE/INSET scheme [vide Chapter 4]. Those recent pilot interviews provided invaluable practice and feedback by which techniques were selected, modified and honed so that they became as economical and precise as possible.

Woods [1986] suggests that successful research interviews must possess a number of attributes. He points out that "people will not just talk to anyone". The interviews which were conducted with the members of the RLPE INSET scheme took place in the second year of the project, and in the on-going phase of that project. By this time the researcher had established close relationships with all the member teachers, so that each interview took place as a conversation between two friends and colleagues. (Note: there was a little residue from the early phases of the RLPE INSET provision, which meant that the researcher was still regarded somewhat as a tutor, advisor, source of external support, university expert, mathematician, but by the time the interviews took place this was minimal. Colleague implies 'fellow teacher'). Trust and rapport had been established and both parties to the interview had personal interest and respect for the project. The interviews had been arranged on a personal basis by telephone, when the purpose and estimated length of the interview (approximately 40 minutes) had been explained to the teacher by the researcher. In fact, the general purposes of the research had been discussed informally over the previous year so the explanation was not a difficult task. A number of researchers find difficulty negotiating access, when seeking interviews. Access was not a problem in this research since the teachers were, without exception, pleased to be interviewed. Also all interviewees were pleased to arrange times, venues and to clear the researcher's visit to the school with head teachers and departmental heads. (Note: the Local Authority Inspectorate had already agreed, and was involved with, the evaluation programme). The interviewees' contributions to the organisational details were beneficial, since they provided the teachers with even more sense of control and confidence. This was not as critical as in many research situations, since these qualities were already well established.
The on-going RLPE INSET programme was designed to support and encourage teachers and it was perceived by all concerned parties to be doing just that. Visits by the researcher to member schools were part of this process. In fact the research activity was enhanced because the interviewer had no need to adopt a special role as a researcher and there was little need to bridge a "middle ground culture" [Measor et al., 1984]. Both parties were naturally at ease and there was no necessity for the researcher to adopt those 'acting routines' favoured by some interviewers [Greer, 1983]. The interviews had many of the attributes which Woods suggests are required for such research, namely; trust, confidentiality, naturalness, curiosity, volition, reciprocity, sincerity and friendliness. These attributes allowed the researcher to gather much valuable and pertinent data. In fact for ethical reasons and to maintain confidentiality and trust some sensitive information is not reported in this thesis, despite the fact that the teachers declared that anything they said in interviews could be used as research data. The data which has been deemed too sensitive to use includes a little verbal data collected by interview but the bulk of sensitive data was gathered incidentally (and accidentally) prior to, during and after the interviews.

The trust which existed in these interview situations also meant that it was feasible to use an audio-tape recorder. The advantages of using such a recording device had become apparent in the earlier interview practice which the researcher had pursued over a long period of time. This practice had experimented with different recording techniques: including pen and paper, memory and post-interview notes and video recording. In the RLPE INSET interviews all interviewees agreed to the use of an audio-tape recorder. This was a small, portable, battery powered version. In each interview the researcher and the teacher sat comfortably, in armchairs, classroom chairs or laboratory stools, about one metre apart and at an angle to avoid a formal face to face situation. The recorder was positioned close to the parties in an unobtrusive location. The internal condenser microphone of the audio-recorder was usually used, although occasionally a small external microphone was found to be convenient). The recorder was seldom a source of embarrassment or disturbance and, on the rare occasions that it was, these problems quickly evaporated almost immediately the interview commenced. The recorded tapes themselves lend support to this conclusion.
A complete transcript was made of each recorded interview; using an electronic transcribing machine, with foot control unit, and a word processor. Data was supplemented by field notes, a log and documents such as school brochures. The field notes provided pre-interview and post-interview data (for example, conversations with other members of staff of the school) as well as brief notes about the interview which captured data missed by the audio recording (for example, raised eyebrows, grimaces, sideways glances). Hull [1985] in a paper which discusses the analysis of interview data refers to such data as a 'second record' which supported his interpretation of the 'first record' or 'documents of the case'.

The following extract from the transcript of the interview with Derek might serve to illustrate the nature of the interview and some of the techniques used. Derek had been responding to the guidelines when he requested that he should begin to talk about the RLPE INSET course at Midchester. In doing this he became involved in describing his attempts to do investigational work with his less able pupils.

Transcript Extract 1

Derek

I find a little bit of difficulty because...with the fourth year we were doing this athletics field....er....there's probably a few weeks' work there........But I think that if I allowed them to continue with that......although they were enthusiastic about this........at that time...and wanted to go on and do more........I think they'd have run into difficulties ..and then would've given up........So what I'm going to do is stop them as well....Do a little bit of work on circles ..and area.... and......scale drawing........scale drawing's involved in that. That's starting to come out now...........and then return to the......the investigation afterwards..........................and I find this is working out very well.....er...........................The difficulty out of the classes I have are the third year......the bottom group in the third year......they are poor....they are unbelievably poor......both in......er........(sigh).........understanding mathematics and writing and speaking.....Terribly, terribly poor........................................and I think that....er(sigh)..........I don't know, I don't know what the path is ....for those children........I have...............
was going to say, you should ...should have it off the record really, but...anyway ...leave it to you...discretion.................

(Derek now lowers his voice (not quite to a whisper) and turns his head to indicate that he does not want any one else to hear what he is about to reveal)

I have approached the Headmaster ...and...er... asked him what we can do with these children.....and he ...er...said to me, "Well, those children shouldn't be in this school. They should a in a special school".....and he ......tried his best to help....but I think he was.... as much at sea as I was..........er....admittedly he could stand back from it, a little bit....because he wasn't actually teaching the children.....and think that he.....if he was teaching the children would have the same difficulties ....knowing.....how low to go with those children to get something from them.

PKA

What sort of methods do you use with those children?

Derek

Well we are using the same sort of methods.....em..... I should have brought Mr. Johnson... Des Johnson......he's got a set of investigations....I can't remember who publishes them now, but it's cards and we are working through those. Now what I have to do, when I get round to it is to look at it very very carefully, because I tried it......the pig one... with them and they found that very difficult........ you know, just finding the square..... shape to cover the maximum area. They found that awfully difficult... and..... on top of that their concentration is so limited ...... if you go on for .... a quarter of an hour, twenty minutes.....and that's about the limit of it.

PKA

If you...

Derek

.....and then you have to change.

PKA

If you had some investigational work and practical work, which was directed to that type of child.....

Derek

Mmm (indicating agreement)

PKA

Is that what you really want?

Derek

I think so...... I think so
PKA
  And you would use that?
Derek
  Yes......Yes...... mmmm..... I've searched all round, you see........We had some visitors yesterday and I was hoping that....... ermm....... they were coming to help us, but in fact they were coming to look at what we were doing. So I got the wrong...... end of the stick there........And I'm searching all the time...... for help with that kind of child, who are........ well, you can't call them illiterate, they can write.... just about, and they can.....read..... with... er.....in inverted commas....er....orally they are not too bad except......... their vocabulary is extremely limited..... so we have got a very difficult group there.... Ehm ......and I don't think it's limited actually to that bottom class.....I think some of the other staff are experiencing these difficulties..............the oral and...er... the writing difficulties with.......with that......type of child.
  So I've only got six or seven of them ...probably the poorest in the school, but there are others in the other classes, who are not far above them. So what we can do about them I just don't know....em ...but I would like to see, personally,.........(school bell goes).................. some help for me... in.... dealing with those children...... Not from a behavioural point of view.......I know......they are not very well behaved but you can soon put a stop to that. .......er...... its from the work to give them, what to do with them.... the......I don't know it is probably like..... junior school work that we need for them. I don't know..... er.. I have no experience of that......you ..... I don't know what sort of work....

PKA
  It's something which....we need to look at?
Derek
  Ah, I think so.....I think so.......definitely.
has matched the transcription to the audio-tape, field-notes and memory. Necessarily, this transcription has been prepared with some degree of subjectivity. It is suggested that its form reflects the interview far more closely than a form obeying normal rules of punctuation and syntax.

3.10 Validity and Reliability

The concepts of validity and reliability are complex and each forms a set of variants. Any definitions tend to be simplistic and limited but the following constitute working definitions.

"Researchers are expected to demonstrate that the observations they actually record and analyse match what they purport to be recording and analysing. This is the concept of validity. Secondly, they need to ensure that random fluctuations in recorded observations are avoided. This is the concept of reliability."


"Reliability is the consistency of the results obtained when using a measure in research. .............................................................. We started with the simple definition that 'validity is the extent to which an indicator is a measure of what the researcher wishes to measure' (our emphasis). Later ...... you were told that, 'If a conclusion is properly deduced from the premises then we have a valid argument' (our emphasis)."


These working definitions appear to be applying the concepts not only to research methods but also to data, analysis, results and theory. In doing this they may appear to be in danger of (i) begging some of the issues discussed in a Chapter 2, such as reality and (ii) confusing validity with concepts such as verification, plausibility and establishment, which should be reserved for discussion of theory. The author has argued (in Chapter 2) that many positivistic researchers appear to be unaware of the first danger. It is, perhaps, to avoid both dangerous pitfalls that many researchers of the non-positivistic persuasion choose not to consider validity and reliability at all. Although this research is inclined towards a non-positivistic approach it has
chosen not to take the latter stance and not to eschew these concepts. However, it proposes to reduce confusion, and maintain consistency with the views expressed in Chapter 2, by applying the terms reliability and validity to data collecting methods only.

The author also considers that it is relevant to express certain reservations concerning the tendency to discuss non-positivistic research in terms of internal and external validity [Le Compte, 1982]. These concepts have their roots in experimental design where Campbell and Stanley distinguished internal validity and external validity in their classic exposition ‘Experimental and Quasi-Experimental Design for Research’ [Campbell et al., 1966]. Briefly; internal validity is the degree to which it can be shown that what is interpreted as the cause produces the observed effect, whereas external validity refers to the potential of generalising research results. Since it has been argued that the nature of this research would not lead to predictive theory or to consideration of causal effects [vide supra 2.6], it is not proposed to consider any variants subsumed under the notion of internal validity. Indeed these variants appear to be more appropriate to assessment than to non-positivistic research/evaluation.

The concept of external validity has been sub-divided into population validity and ecological validity by Bracht and Glass [1968] but, once again, in the context of experiments. Since this research does not employ statistical/experimental techniques and its subject matters are not regarded as samples from which generalisation can be made by calculation population validity is not a concern here. Some sources, however, link non-positivistic research with ecological validity. Sapsford and Evans [1981], for instance, suggests that an ethnographic research style would have 'high ecological validity'. This is a questionable suggestion because Bracht and Glass argue that ecological validity corresponds to a class, consisting of ten "threats to external validity", each of which refers to experiment. Bracht and Glass are proposing that the environmental conditions of experiment are fully described to ensure ecological validity, but they appear to be doing this to generalise and replicate experimental (or quasi-experimental) results. Stenhouse [1978] points out that the approaches to generalisation (and hence cumulation) and replication (and hence verification) in research which studies cases, rather than samples, should be different from those of experimental (quasi-experimental) research [vide supra 2.6].
Although the author chooses not to use the term ecological validity to refer to this research, the notion that validity can be enhanced by providing full descriptions of the environmental conditions under which data were collected is useful. Here validity is taken to be a concern with increasing the belief of the reader that the data collecting methods allow the data to be interpreted so that they match the observed phenomena. In order to achieve such belief prevailing conditions are described as comprehensively as possible; by establishing case data and case records and making these available for scrutiny. It is also achieved by including extracts from the data (for example, interview transcripts, letters, field notes etc.) in the thesis. This counteracts the tendency (reactivity [vide supra 2.7]) of the research methods to distort the relation between the interpretation of data (the model) and the subject matter.

In this research it has been recognised that a major source of reactivity is the researcher himself.

"Rather than engaging in futile attempts to eliminate the effects of the researcher, we should set about understanding them".


The plea contained in the quotation above is heeded in this research. The case records and case data treat the researcher as an important element of the subject matter and illuminate this element in an attempt to provide reflexivity and, hence, solve the problems of reactivity.

"Reflexivity demands that researchers constantly monitor, not only their own interactions with the groups being investigated, but also their own roles and reactions to what they observe. In other words they make a conscious effort to make explicit anything that could bias their interpretations of events."


Incidentally Hammersley and Atkinson [1983] argue that one reason for the lack of reflexivity in much ethnographic research is "the influence of naturalism, with its emphasis on 'capturing' the social world in description". This research has been influenced by naturalism [vide infra 9.2], but it is
argued that, in providing a comprehensive, illuminative description of events and referring extensively to case data and case studies, *reflexivity* is enhanced not discouraged. This is certainly justified if one agrees with the ethnomethodologists that all social data are *indexical*. In other words;

"........all actions, including the actions of describing, explaining, etc., are dependent for their meaningfulness or sense on the contexts within which they occur. That is, all actions (and contexts) are indexical, and the relation between actions and contexts is one of mutual constitution or reflexivity."

Peter Halfpenny, 1979.

Since this research employed a variety of methods to collect data it is possible to claim that methods were valid by demonstrating that relations between models and subject material were similar for each method. In other words *triangulation* was employed as an *indicator* of validity. (Note: Bloor's much quoted claim that "triangulation is itself beset with problems of validation" seems to revolve around his contention that methodologists equate validation and triangulation [Bloor, 1978]. The use of the term *indicator* emphasises that this author does not make this equation. Neither, unlike Bloor in his research, does he consider that some of the research methods furnished inferior data or were inappropriate).

Because Bloor's subject matter and methods were not suited to triangulation he relied heavily on the technique of *respondent validation*. This technique is appropriate when the subject matter consists of people who are asked to assent to, or disagree with the researcher's analysis. In this research the subject matter was wider and individuals were not really regarded as respondents. Consequently, and for ethical reasons, *respondent validation* was not employed in the sense that Bloor describes it. Aspects of the technique were used in that part of the research where teachers were interviewed and in informal conversations during the 'follow-up' INSET sessions, but these were not significant. A technique which was used to achieve similar validation was to ask a colleague and fellow tutor of the RLPE INSET scheme to assent to, or disagree with the analysis. Perhaps this exercise might be termed *parallel validation*.

It is generally accepted that research methods which gather qualitative data
face significant problems in establishing reliability [LeComte et al., 1982; Shimahara, 1988]. A non-positivistic research programme which takes a pluralistic approach to methodology and which does not distinguish research and evaluation faces magnified problems. It would be possible to consider each method used in isolation and to examine its "inter-judge reliability, which refers to the degree of agreement between two researchers in recording their observations of the same or similar phenomena" [McCormick et al., 1988]. To do this would not resolve the problems faced by this research in respect to reliability. It is likely that only the second questionnaire would have exhibited such reliability if treated in isolation.

The problems may be resolved by taking the methods as a whole and considering the "intra-judge reliability, which refers to the consistency of a researcher's observations on different occasions" [McCormick et al., 1988]. The Case Data and the Case Records [vide infra 8.1] will support the contention that the research methods used in this programme had a high degree of intra-judge reliability. This contention is supported in the Case Studies [vide infra Chapters 4, 5, 6, and 7] by the inclusion of extracts from the Case Data.

It is worth pointing out that many writers equate reliability with replicability in a special sense.

"The objective is to be sure that, if a later investigator followed exactly the same procedures as described by an earlier investigator and conducted the same case study all over again, the later investigator should arrive at the same findings and conclusions.....the emphasis is on doing the same case over again , not on 'replicating' the results of one case by doing another case study....the goal of reliability is to minimise the errors and biases in a study"


This concept of reliability appears to ignore the time-embedded nature of a case, together with a number of metaphysical issues [vide supra 2.6, 2.7]. It is not clear what is meant by "doing the same case study all over again" or exactly how one might attempt this. The author rejects this notion of reliability but sees great merit in Yin's suggestion that case studies should be well
documented as Stake suggests.

"To be fully understood, the educational program must be fully described and fully judged."


Stake was, in fact, referring to curriculum evaluation and did not clearly indicate who should be the judge. Since this research does not distinguish research and evaluation its theories/models might be regarded as judgements. However, by providing a full description of the programme it is suggested that the reader will also be able to make judgements and to examine the validity and reliability of the research methods in the light of this description.
Chapter 4

INFLUENCES ON INSET DESIGN AND DEVELOPMENT

4.1 Preparatory Work and Early Influences

The 'naturalistic' model of INSET design and development, which emerged from the data of this research, is described in detail in Chapter 9 of this thesis. That model introduces the notions of near and far influences [vide infra 9.2], which act on individual INSET developers. The former influences include current and recent interests/activities, professional responsibilities, beliefs, values, preferences and experiences. The latter influences result from professional demands, resource availability and the prevailing situations in systems of government, society and education [vide infra 9.3]. This chapter describes activities, in which the author has been involved, which have contributed to the influences acting on him. These have moulded his beliefs and values towards INSET design and development and provided him with the experience to make informed judgements about preferred INSET models, methods and approaches. The experience of undertaking these activities has, in fact, enabled the author to analyse and identify near and far influences, which acted on himself and on other participants in INSET development. This has been important in a research programme which emphasises interpretation [vide supra 2.8], since it provides that most important element of reflexivity, which non-positivistic researchers must include in their programmes to enhance validity [vide supra 3.10].

The activities described in this chapter should also enable the reader to relate the actions, statements, observations, comments and criticisms, included in later chapters, to the background situations and the social contexts of participants from whom the data was gathered [Cohen et al., 1985, Halfpenny, 1979]. This is the notion of indexicality which must also be an element of non-positivistic research reports [vide supra 3.10].

Perhaps most importantly, the activities described in this chapter constitute that part of the programme in which the initial research design was formulated over a number of years. In that lengthy period INSET models
were identified, used and evaluated. This involved an exercise in selectivity, whereby models were rejected, accepted or modified. Research methods were also subject to investigation and selection. Data collecting techniques, such as participant observation, survey and interview were refined and examined for suitability in a variety of situations. In non-positivistic research the process which is, perhaps, equivalent to 'experimental design' in the scientific method of research is one which requires experience and development stretching over a number of years. The author was in a fortunate position in this respect, since he was able to act as a developer and participant observer of several INSET schemes, from the early 1970's up to the commencement of the Rutlishire/Loughborough 'Pilot' Experiment in 1986. The latter INSET scheme became the main vehicle of this research, but its design depended heavily on the previous INSET provisions.

Furthermore, those earlier INSET schemes furnished invaluable research data, which have been added to the overall Case Data and which enhance the Case Records [vide infra 8.21]. The models and theory, which evolved from the RLPE INSET scheme, were compared with those earlier data to achieve the "retrospective generalisations", which Stenhouse [1978] argues "strengthen individual judgement". Through this comparison guidelines and models for INSET have been developed in this research programme to enhance such judgement [vide infra 9.2, 9.3, 9.4, 9.5].

4.2 The Growth of 'Near' Influences

4.21 INSET for Further Education Teachers

The author's beliefs, approaches and perspectives in regard to mature students, and in particular to teachers, have been influenced by his earlier experience as a lecturer in a large Further Education College. From 1973 to 1979 he had been a tutor of the City and Guilds of London Institute Further Education Teacher's Certificate (CGLI Course No.730). This work, together with a longer experience with a wide range of courses for adults, convinced the author of the importance of considering roles, and of establishing good relationships between participants, when designing and developing INSET provision. For instance he was aware that mature students do not appreciate threatening situations and that they often identify situations as such more readily than younger students. Perceptions of what is threatening change as
relationships with peers and tutors become more established. It was this awareness which influenced the author to delay observing RLPE INSET teachers in their classrooms until roles and relationships were firmly settled and trust was established on all sides.

The work with the CGLI 730 course also influenced the author to use a variety of pedagogic methods in that course and in subsequent INSET schemes. These methods included demonstration, investigation, problem solving, modelling, discussion groups, simulations, role playing, and practical work in order to provide opportunities for teachers to experience, as students, the strategies and techniques which they would use in their own classrooms, lecture theatres, workshops and laboratories. It also demonstrated to the author the benefits which seminars, workshops and residential courses could provide to INSET schemes. The experience convinced the author that organisational aspects and the availability of a wide range of resources and professionally produced materials were matters to which INSET designers and developers should address themselves.

In parallel with this work, the author was also a member of a group within the College charged with organising and tutoring activities related to Staff and Curriculum Development (the author was also a member of the College Academic Board and of its Standing Sub-Committee on Staff and Curriculum Development). This coincided with the publications of the Haycocks Reports (a Sub-Committee of the Advisory Committee on the Supply and Training of Teachers) [ACSTT, 1977 and 1978] on the 'Training of Teachers for Further Education' and on 'The Training of Adult and Part-Time Further Education Teachers' [ACSTT, 1978]. The recommendations of these Reports resulted in a re-examination of INSET activities in Further Education Colleges. This re-examination itself became an influence, which played its part in future INSET development by the author.

Work as a tutor of Staff Development activities certainly encouraged the author to examine the advantages and disadvantages of INSET activities which were college-based and to observe that a number of teachers resisted

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1 From 1974 the Advisory Committee on the Supply and Training of Teachers (ACSTT) had been attempting to produce guidelines for INSET development in all phases. Other ACSTT discussion papers were directed towards INSET in schools and were of greater concern to Colleges of Higher Education [Woodrow, 1977a, 1977b].
such provision or were 'hidden' from it. This proved to be useful comparative data in the analysis which led later to the formulation of a model of INSET provision for 'hidden' shortage teachers [vide infra 7.6].

Two particular elements of the author's work with the Staff and Curriculum Development Group were particularly influential and relevant to this research.

The first required the author to organise area meetings between schools and colleges to discuss responses to the Schools Council's N and F proposals [Schools Council 18+ Research Programme, 1977]. This involvement required the author to represent the Principal of the College at a Conference for Heads and Principals in Leicestershire. He was later invited, by the Director of Education for Leicestershire, to join a small team of senior teachers to advise officers in the County on the Authority's submission on N and F to Schools Council. This experience was a source of influence on the author's approach to curriculum development, since it involved work with teachers and officers at all levels and across the Secondary and Further Education Sectors.

The second element influenced the author in the selection of suitable models for INSET design and development. INSET provision was required in the College as a direct result of the introduction of Technician Education Council (TEC) courses [Technician Education Council, 1974]. Although the TEC were careful not to commit themselves to a particular prescriptive model of curriculum design their, 'Standard Units' were recognisably influenced by the 'Objectives' School of Curriculum Design and Development [Tyler, 1949] and by the work of Bloom on Behavioural Objectives [Bloom, 1956 and Krathwohl, 1964]. The fact that the FEU [Further Education Unit, 1981] employed what appeared to be an analytical-rational model in evaluating "TEC Programme Development" did not dispel the impression that a variant of the 'Objectives' model was an almost obligatory requirement for 'college-devised' units. Business Education Council (BEC) courses were introduced in the College later and, although these tended to employ less behaviouristic forms of objectives, the BEC National Awards Course Specifications included an overtly 'Objectives' model [vide Business Education Council, 1977: Introduction, page 3]. Since few college lecturers,
at that time, were familiar with the 'Objectives' model, INSET activities were established to meet perceived needs. The author was centrally involved with providing the relevant college-based INSET. In addition, he was personally devising college-devised TEC units using a variant of the 'Objectives' model. This experience, and that of implementing the devised TEC courses, enabled the author to judge the worth of the 'Objectives' model and to identify its advantages and disadvantages. It also enabled him to 'experiment with', and develop, more analytical models of curriculum design and to discuss these with teachers in INSET situations and with curriculum studies groups. His subsequent rejection of the 'Objectives' model [vide infra 9.1] was based on extensive use of variants of that model and on wide ranging observation of their implementation.

4.22 The AIMEC Project

In 1975 the author became associated, for the first time, with CAMET (Centre for Advancement of Mathematical Education in Technology) and thus began to be greatly influenced by the philosophies and ideas of the Director of that Centre, Professor Avi Bajpai. The approaches to Mathematical Education which Professor Bajpai developed and advocated constituted major near influences on the author's subsequent work. In 1979 the author was appointed to the Department of Engineering Mathematics, Loughborough University of Technology, and worked as Academic Tutor to a major INSET scheme under the Directorship of Professor Bajpai. That INSET scheme was the All India Mathematics Education at CAMET (AIMEC) Project [Bajpai, 1984]. The AIMEC Project, which the author helped to develop and implement over its life of six years from 1979 to 1985, was to become, perhaps, the most important influence on the author in the subsequent development of the RLPE INSET scheme.

Under the AIMEC Project 20 Mathematics teachers from State Boards and 3 from the Central Board for Secondary Education (CBSE) travelled from India to Loughborough, each year, to spend an academic session at CAMET. The author worked closely with Professor Bajpai to design and develop an INSET programme which would meet their needs. There were particular emphases on changing teacher attitudes and on improving competence in teaching methods. The teachers were provided with opportunities to learn about new topics in school Mathematics and to study new trends and
innovations in Mathematical Education in general. Relevance and applicability were important elements of the Mathematics which was included in this INSET provision.

From the outset, a design decision was made to include a wide variety of teaching/learning strategies, techniques and styles. In particular the author was able to develop the uses of role-playing, simulations, modelling and case-study work. All members used video and audio equipment and produced short video and audio presentations. The video resources were also used to enhance the role-playing exercises and to provide feedback in the regular teaching simulations, through which the members practised new methods and approaches.

An important design feature was a self-contained suite consisting of a classroom, seminar room, resource room, kitchen and offices. This suite was designed so that it could be easily rearranged as a workshop, Mathematics laboratory, computer room, video studio and social centre. Work with discussion groups of various sizes was easily accommodated. A well-equipped mathematical library was included and a wide range of mathematical equipment was available. A considerable investment was made in providing microcomputers and software. Members were introduced to Computer Based Learning and they investigated, used and produced Computer Assisted Learning resources. Field work was often undertaken and visits to other establishments were a regular feature of the INSET provision. External speakers also visited the AIMEC Project frequently and, in addition to a small team of two to three tutors who were based in the suite, a number of staff from the Department of Engineering Mathematics and from other Departments of the University provided specialist inputs. The Director organised regular meetings between himself and members, on a tutorial and counselling basis. Importantly he also insisted that social events should play a vital role. These were crucial in maintaining and raising affective levels and the author was influenced to include these in the RLPE INSET scheme [vide infra 5.5, 5.6, 6.3].

Other important elements of the AIMEC Project were regular visits (locally and nationally) to schools, colleges, teachers' centres, industry and cultural centres. These were part of the general attempt to increase awareness of new trends and innovations and to provide a sense of relevance to the
overall work of the Project. The members were able to observe learning and teaching in schools and colleges of England, Wales and Scotland and to converse with teachers, students and advisers from a wide background. Teachers and their classes also visited the AIMEC Project at Loughborough as external contributors and users of the available resources, particularly microcomputers.

A module was included in the programme, which was designed to give the teachers experience of how to run INSET programmes. This dealt with INSET provision from the viewpoint of tutor and participant. It was hoped that the teachers would act as 'key' persons on their return to India, where they would organise regional INSET programmes. A feature of the AIMEC Project was that each member was required to produce a package of learning resources during the year at Loughborough. This resulted in a wealth of well-prepared INSET material, which members used and tested later in India. A follow-up programme of workshops was developed to support the INSET work of the returned members. It was envisaged that, with the support of National and State Governments, a 'multiplier effect' would ensue, as CAMET trained teachers in turn trained other teachers. It is worth noting that the author attempted to influence Rurishire Local Education Authority to provide support for a similar on-going INSET provision [vide infra Chapter 6].

The situation, with which the author was familiar from the AIMEC Project, shared many common aspects with that which he discovered when he began to design and develop the RLPE INSET scheme. In particular, by a fortunate coincidence, the Midchester Mathematics Centre had almost identical facilities and layout as the AIMEC Project suite [vide infra 5.1]. Perhaps, more importantly the author was able to work with a team of tutors in both provisions and to rely on the support and advice of the same Director. In addition Maureen Green worked closely with the author on both projects. These factors were crucial influences on the RLPE INSET design and development.

Another vital influence, which acted on the author in developing the RLPE INSET scheme, was his experience of conducting INSET in India in the form of mathematical workshops. From 1979 to 1985 the author accompanied Professor Bajpai, on six occasions, in order to conduct these workshops throughout INDIA. Members of the AIMEC Project acted as 'key' persons at
the workshops. The experience was invaluable in subsequent INSET development. It persuaded the author that, rather than constructing inflexible plans based on 'means-ends' models, INSET should be designed and developed by (i) analysing situations carefully, (ii) becoming as familiar as possible with situations and problems, (iii) ensuring that organisation is of the highest possible standard, (iv) preparing good and professionally produced resources, which should be readily available when required and (v) being prepared to modify plans as situations change and as formative evaluation is conducted by the INSET team. If INSET provision is to be acceptable to all parties concerned, then roles, relationships and trust must be carefully established. Aims and objectives formulated in vacuo, methods used mechanistically and outcomes tested religiously, despite changing circumstances, would certainly have been disastrous as far as the mathematical workshops in India were concerned. The author was influenced to take similar views of INSET provision in Rurishire and elsewhere.

4.23 CAMET/Department of Engineering Mathematics

CAMET was administered by the Department of Engineering Mathematics at Loughborough University [Bajpai, 1984]. The author's membership of CAMET was crucial in formulating the near influences which came to bear on him in developing the RLPE INSET scheme. In addition to his work with the AIMEC Project the author also taught on the MSc course in Mathematical Education (a part-time course for serving teachers, lecturers and advisers), the BSc Honours course Education and Mathematics (a four year concurrent course of initial education and training for Mathematics teachers) and on a number of Engineering courses, which were serviced by the Department of Engineering Mathematics. This encouraged the author to develop an integrated approach to teaching Mathematics, which was a feature of the work of CAMET which Professor Avi Bajpai had promoted [Armstrong, Bajpai and Hunt, 1988].

The BSc Honours Education and Mathematics and the MSc in Mathematical Education courses, for which CAMET and the Department of Education shared responsibilities, enabled the author to maintain close contacts with teachers, schools and colleges in the Secondary and Further Education sectors. The former course required the author to teach undergraduate
Mathematics and to supervise teaching practice (school/college experience). The latter course brought the author into contact with experienced Mathematics teachers in both phases and with advisory teachers. This aspect increased in 1985 when he became Tutor of the MSc Course. Both courses provided opportunities to develop modules in Mathematical Modelling and the Use of Computers in Education [Armstrong, 1988b, 1989] and these in turn influenced the design and development of the RLPE INSET scheme, which reflected matters relevant to both modules.

In 1985 a new MSc Course in Computer Education was introduced at Loughborough University. This was a sister course to that in Mathematical Education but, in this case, with CAMET and the Department of Computer Studies sharing joint responsibilities. The author was deeply involved with the development of this course and, in particular, with designing the Education elements. He eventually designed and taught the modules 'Educational Issues' and 'Computers in Education' on that new course. The course not only widened the author's contacts with serving teachers (subject specialists from a wide spectrum), it strengthened a belief in cross-curricula INSET activities. This belief had long been held by the author, as a result of his wide ranging work with teachers in Further Education. He had supervised teaching practice in classrooms, laboratories, engineering workshops, photographic darkrooms, kitchens, nurses' training centres and evening institutes. The experience formed extremely strong near influences and was in tune with the philosophy of relevance, applicability and integration fostered by CAMET. The author suggests these influences are evident in the development of the RLPE INSET scheme.

A parallel exercise, which was planned prior to the RLPE INSET scheme and which commenced as outline plans for the latter scheme were being drawn up, is extremely relevant and influential. Early in 1986 the author was formulating proposals for a scheme of in-service education and training at Loughborough to support teachers and to supplement existing training schemes related to the proposed course work requirements of GCSE Mathematics. The author had brought together a small team of colleagues from the Departments of Education and Engineering Mathematics to consider future research and development schemes. This group discussed and agreed proposals, which subsequently attracted UGC (University Grants
Committee) funding through the Post Experience Vocational Education (PEVE) scheme. As a result a group of senior and junior Mathematics teachers from ten local secondary schools and Loughborough Technical College was formed and centred at CAMET. Throughout the academic year 1986/87 members of the group attended a series of meetings in the Department of Engineering Mathematics to compare experiences, exchange ideas and to seek solutions to the problems the members were encountering as they prepared to implement the course work requirements of GCSE Mathematics. A resource bank and library of relevant published materials was established at CAMET, to which the group had access. The author regularly visited the schools and colleges involved to observe and discuss the implementation of the course work. Examples of course work and pupils' work were collected as a result of these visits and these were included in the resource library. The examples were presented, discussed and evaluated at workshop sessions during the year.

It was discovered that local schools had chosen to follow a wide variety of GCSE Mathematics schemes. Although this, together with industrial action and other pressures on teachers, meant that members of the group were not prepared to co-operate in producing resources to the extent which had been envisaged, it provided an opportunity for a valuable comparative exercise. The onus for producing new resources, however, fell on members of CAMET.

An extremely valuable opportunity was provided by this exercise for the author to visit schools and colleges to conduct interviews with teachers and to ascertain their needs as far as GCSE preparation was concerned. In this way the author was able to refine and select the interviewing techniques, which form an important element of the methodology of this research programme. It was this opportunity which persuaded the author to use an informant style of interview and to employ a tape recorder/transcriber. The author was also able to practise and hone his techniques of participant observation during the group meetings. For example, an observation, which is not irrelevant to this research, was that on several occasions two Heads of Mathematics (who had already been to GCSE 'phase' training under the 'cascade' programme [Department of Education and Science and Welsh Office, 1988]) adopted the roles of 'experts'. The author subsequently observed an apparent lowering of confidence levels and a development of
negative attitudes in some junior staff. This observation was supported by subsequent interview data. This has worrying implications for any policy which advocates a sole reliance on school-focused INSET, particularly where staff with limited qualifications and experience are concerned [vide infra 7.5]. Another group of Heads of Mathematics warns against 'college theorists' in an In-Service Handbook, 400+ Questions [Mathematical Association, 1986] and other promoters of school-based INSET refer dismissively to ".....courses for teachers taught 'out there' by 'experts'....." [Everton, 1989]. The author is sympathetic to these latter views but, as a researcher and participant observer, he warns against 'unwary experts' in general.

As a result of the meetings of the group and interviews with teachers it was decided to produce a package of resource material concerned with Practical Work in Mathematics. This would meet a need perceived by almost all the teachers interviewed. Subsequently a first draft of this material was produced, which was evaluated by RLPE INSET teachers at the residential course at Loughborough in September, 1987. This was later evaluated in schools and revised accordingly [vide Appendix 7]. A video presentation, concerned with GCSE course work implementation was also produced by the author and directed by a Head of Mathematics from Rurishire, who had been seconded by the Authority to conduct research under the supervision of the author.

4.3 Action on Teacher Supply

4.31 Responses to the Shortage of Mathematics and Physics Teachers

The RLPE INSET scheme was developed in parallel with a more general set of activities related to teacher supply. This parallel, interacting work commenced in earnest during early Spring 1986 and continued over the next three years. The work is described here, since it was almost certainly an influence on the design and development of the RLPE INSET scheme. In addition, together with those activities described earlier in this chapter [vide supra 4.2], it provides data which has been used in the comparative analysis whereby a 'naturalistic' model of INSET design and development was constructed [vide infra 9.2, 9.5].

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For many decades prior to these activities, concern had been expressed about the shortage of Mathematics and Physics teachers in this country. Numerous reports and surveys had highlighted this problem [Mathematical Association, 1963, Royal Society, 1969, Institute of Mathematics and Its Applications, 1969]. The Engineering Council had been a particularly powerful voice in demanding a national programme to respond to these shortages. The Council recognised that the country faced a long-term problem because the falling numbers of Mathematics and Physics teachers meant that schools were not providing enough qualified youngsters for Engineering courses in Universities and Polytechnics. In May, 1986 The Engineering Council published the document "The Shortage of Mathematics and Physics Teachers". This called for action and funding to increase teacher supply in Mathematics and Physics by, amongst other methods, giving "increased priority for in-service training in mathematics, physics and technology across the curriculum", encouraging "polytechnics and universities to offer a one-year bridging course in mathematics and physics to enable school leavers to prepare themselves for mathematics, physical science and engineering undergraduate courses", offering "intensive courses for updating and conversion to teaching" and encouraging "biology and other suitable graduates at the postgraduate certificate of education (PGCE) stage to reorientate to mathematics and physics" [Engineering Council, 1986]. The author was influenced by the Head of the Department of Engineering Mathematics and Director of CAMET, Professor Avi Bajpai, who was also a member of the Engineering Council, to investigate ways in which the Department and Loughborough University might respond to these issues. Consequently, the author conducted exploratory discussions with the Departments of Physics and Education, at Loughborough University, and with the then Loughborough Technical College, a Further Education College.

These discussions persuaded the author that a design model for curriculum/INSET development must include potential for consultation with a wide variety of parties. They also convinced him that a design model must take account of the assumptions, preferences and prejudices of those parties [vide infra 9.2]. Data gathered from these discussions supports the view that 'naturalistic' curriculum/INSET development does not necessarily follow a prescriptive model and that 'means-ends' models must be treated
with extreme caution [vide infra 9.1]. In the discussions the author had found a mixed response to his speculative proposals. The Department of Engineering Mathematics had been supportive and welcomed new initiatives. The Department of Education staff had been supportive also, although they were pursuing their own priorities. The Technical College had been enthusiastic and had indicated that they wished to be involved in any bridging courses which enhanced access to Higher Education. It must be said that those members of the Department of Physics who had been consulted had been less than enthusiastic. They had considered that it would not be feasible to recruit to a BSc Honours course in Physics and Education. Regulations for such a course existed at Loughborough University but after some discouraging and unsuccessful years, when the course was provided, recruitment to the course had ceased. Physics tutors saw little advantage in re-designing the course. Previous students of the course had not performed well and the Department was concerned about the low entry qualifications which had applied to this course.

As a result of these activities the author was in a position to respond immediately to the Consultative Document "Action on Teacher Supply in Mathematics, Physics and Technology" published by DES in July, 1986 [Department of Education and Science, 1986b] and issued in draft form in late June. A memorandum was prepared and circulated within the Departments of Engineering Mathematics and Education.

Since it was essentially a set of speculative plans, this memorandum represented a phase of the curriculum/INSET design [vide infra 9.2]. Observing the reaction of various parties to this memorandum provided data on 'naturalistic' curriculum/INSET development and this contributed to the formulation of the INSET model which emerged from the overall research data. It must be acknowledged that the memorandum itself was influenced by the Situational design model [vide Appendix 4]. The memorandum analysed the external situation, regarding teacher shortage, prevailing in England and Wales and then the relevant internal situation at Loughborough. Extremely general aims were identified but these were regarded as speculative and very different from the testable aims of 'Objectives' models of curriculum design [Tyler, 1949]. Alternative programmes were outlined to alleviate teacher shortage and to increase the
supply of candidates for undergraduate courses in Engineering, Physics and Mathematics. These programmes included: Pre-BSc bridging/enhancement courses, which would be collaborative ventures between local Further and Higher Education establishments; restructured BSc Honours courses: Postgraduate conversion courses; INSET schemes and updating and taster courses. Implications of implementing these programmes, such as the need to examine access, regulations, counselling, resources, funding and relations/collaboration with outside agencies were outlined. Evaluation and research were highlighted as essential elements.

The memorandum was forwarded for consideration by the University as a whole, through the offices of the Academic Registrar, the Dean of the School of Engineering and the Dean of the School of Education and Humanities. The subsequent replies to the memorandum from the Schools and the University as a whole reflected those of the Physics Department. The University, and in particular the Department of Mathematics were worried about admitting students with below average GCE A level grades. Conversely some senior staff of CAMET, Department of Engineering Mathematics, including the Course Tutor of the BSc Honours Course in Education and Mathematics, took the view that the University should be prepared to lower entry requirements to that course. They also commented that the one-year intensive bridging course based at the Technical College had much potential and merit.

Apart from those received from CAMET, Department of Engineering Mathematics, comments suggested that many members of the University were conservative and resistant to new initiatives to increase teacher supply. The maintenance of GCE A level points score levels was a much quoted concern. It was not clear if this concern was with academic or financial matters. The University was certainly concerned generally with resource implications and was anxious that full funding would be provided for any new developments. Government expressions of concern on teacher supply, the perceived need of the University (and Universities) and the arrangements of funding agencies such as UGC, not to mention the regulations of bodies such as CATE (Council for the Accreditation of Teacher Education) and UCCA (Universities Central Council on Admissions), appeared to be contradictory.
The Vice-Chancellor of Loughborough University wrote the Assistant Secretary of CVCP (Committee of Vice-Chancellors and Principals) on September 1986 commenting on the DES Consultative Document. It appeared that he was not adopting such a conservative approach as many departments might have preferred and that he had accepted certain proposals, which had been included in the author's memorandum, with minor qualifications. These included the proposals on collaboration with the Technical College on bridging courses, retraining people trained in other subjects such as Biology, and the recruitment of mature people into teaching. He also stressed the importance that any programmes should include research and evaluation.

In the light of the replies to the memorandum, and after further consultation within the Department of Engineering Mathematics, the author modified the responses to 'Action on Teacher Supply'. This constituted another phase of the 'naturalistic' curriculum/INSET development in which a spiral approach is evident [vide infra 9.34]. In October, 1986 the modified responses were sent by CAMET/Department of Engineering Mathematics to DES. By that time UGC funding had been obtained for the proposed PEVE INSET scheme and negotiations were well under way with Rurishire LEA concerning INSET provision.

4.32 Higher Education Works for Schools

This research suggests that in naturalistic curriculum/INSET development external agencies and factors have an important and unpredictable influence on design. In September 1986, as part of a collective response from the University, the Department of Engineering Mathematics had submitted the modified set of proposals [vide supra 4.31], together with a brief description of the work of CAMET, to the Universities Information Unit of CVCP. The Information Unit was planning a unique one-day 'event' designed to promote ideas from Higher Education for supporting teachers, training new teachers and encouraging more young people to take up Mathematics, Physics and Technology in the future. The 'event' was to be called 'Higher Education Works for Schools' and would bring together people from all parts of Higher Education to share with each other and with their 'customers' (local authorities, schools, employers and Government)
plans for helping to meet the national crisis of teacher shortage. A 'Hanging Committee', chaired by Professor Alec Ross on behalf of CVCP, CDP (Committee of Directors of Polytechnics) and SCOPAD (Standing Conference of Principals and Directors of Colleges and Institutions of Higher Education) considered the work and proposals of interested groups. Consequently in October Professor Avi Bajpai, Gordon Bell (Administrative Assistant of the Department of Engineering Mathematics) and the author were invited to attend 'Higher Education Works for Schools' at the Royal Institution, on 24 November 1986, to display the work of CAMET and to present their proposals to invited guests.

'Higher Education Works for Schools' proved to be extremely influential in the author's subsequent development of INSET programmes. With invaluable assistance from Gordon Bell, Secretarial Staff of the Department of Engineering Mathematics and the University Audio Visual Services a professional quality presentation was prepared. This showed aspects of the work of CAMET in the initial training of teachers, the in-service education of teachers and the production of resources to support the teaching and learning of Mathematics in schools. The presentation consisted of photographs and charts together with packages of CAMET brochures and hand-outs describing proposals for courses and programmes to tackle teacher shortage in Mathematics. This professional approach was well appreciated by the organisers of 'Higher Education Works for Schools' and by visitors. It resulted in a valuable consultation exercise with many interested parties, who included many eminent figures from academic, political and industrial spheres. The lesson was well learned and subsequently applied to the design and preparation of resources for the RLPE INSET scheme, where again the professional presentation was appreciated and contributed significantly to the success of the programme.

In the light of the responses the author had received to his memorandum, which had been circulated at Loughborough University [vide supra 4.31], it is interesting to note that, in a statement to invited guests to 'Higher Education Works for Schools', Sir Peter Swinnerton-Dyer, Chairman of the UGC included the following:

"Some Universities are considering lowering their admission standards for Mathematics and Physics courses in order to admit more students"
who are considering eventually becoming school-teachers, but are worried that the UGC may hold this lowering of standards against them. I want to make it clear that Universities which act in this way will not be put at any disadvantage by doing so. Indeed the UGC welcomes such a policy, provided always that the students admitted are suited to the course they intend to take. Some Universities may need to consider whether such a policy will involve modification of their existing Mathematics and Physics courses."

4.33 Refined Proposals and Outcomes

In December 1986 the author was a member and rapporteur of a working group which considered the problems of teacher supply [vide Appendix 3]. The Director of CAMEI, Professor Avi Bajpai had invited a number of eminent mathematical educationists to join this working group and this enhanced the extensive consultation process which contributed to subsequent INSET development. The Report of this working group included twelve recommendations, the last two of which are particularly pertinent to this research. These were:

(11) There is an urgent need to mount training programmes which will enhance the performance of existing teachers of mathematics in post, particularly those with limited qualifications and/or experience in the subject. Such a programme should be subsidised to offset the high fees which have to be charged.

(12) The problem of teacher supply in mathematics has been serious for some time but it is now critical. In these circumstances a fresh and energetic look at a wide range of approaches is indicated.

By January 1987 the author, after further consultation with members of the Department of Engineering Mathematics, was in a position to modify and refine the proposals related to teacher shortage further. Four schemes were identified. These were:
1 The provision of
   (i) In-service teacher education and training for teachers of Mathematics with limited qualifications in Mathematics
   (ii) A major programme of resource production related to this in-service scheme

2 Courses for mathematically-orientated graduate employees from industry and commerce who are interested in becoming teachers of Mathematics
   (i) Short taster courses
   (ii) One year full-time course

3 Courses for teachers in schools who have qualifications in subjects other than Mathematics and who, while not teaching Mathematics at present, would be interested in doing so in the future
   (i) Short taster courses
   (ii) One year full-time course

4 Conversion and access schemes before entry to undergraduate courses which are relevant to teaching shortage subjects.

By January, 1986 proposal 1 had been translated into action, since the RLPE INSET scheme had been agreed between the local authority and Loughborough University and planning and preparation were at advanced stages. This INSET scheme was fully funded by the authority. In addition resource production was supplemented by the work of the UGC funded PEVE INSET scheme.

4.4 External Influences and Constraints

A number of activities might be regarded as far influences, which acted on the author and other individuals who developed the RLPE INSET scheme. At the same time as outline plans [vide infra 9.33] were evolving for the RLPE INSET scheme the author was formulating a submission to the Manpower Services Commission (MSC) seeking funding to extend the
scheme (in terms of time and geography). The MSC required bids to be submitted in a form which owed much to the 'Objectives' model of curriculum design and development [Tyler, 1849]. This form included Aims, Objectives, Method and Outcomes. In responding to the MSC request the author was forced to consider and formulate Aims and Objectives of the RLPE INSET scheme more explicitly than he, or the Loughborough team, desired or intended at that stage of development. These were as follows:

**Aims:**

1. To undertake a 'pilot' scheme of in-service education and training for teachers of Mathematics with limited qualifications in that subject. This scheme will be provided for Rurishire Local Education Authority by CAMET.

2. To evaluate the 'pilot' scheme in order to continue sensible provision in this field in subsequent years and to extend this over a wider geographical region.

**Objectives:**

1. To identify a group of teachers who require enhancement of their mathematical experience, education and qualifications.

2. To provide a series of regular half-day sessions at the Mathematics Centre, Midchester, Rurishire over the period January to July 1987.

3. To prepare and promote supportive resources including written material, computer software and audio-visual presentations.

4. To establish and resource a programme of evaluation research.

In another parallel exercise proposals were prepared by the author seeking UGC funding for a number of ventures connected with the shortage of teachers. The UGC submissions were constructed using the following sub-sections, which illustrate the influence of Skilbeck's 'Situational' model of curriculum design [vide Appendix 4]:
Aims and General Objectives in this case were intended to be far closer to Skilbeck's Goals than to the Objectives of Tyler's model. As Skilbeck states "Goals imply and state preferences, values and judgements about the directions in which educational activities might go" [Skilbeck, 1982]. Nevertheless, although this submission was formulated as a description rather than rules of procedure, it forced the author and the Loughborough team to consider the Aims and General Objectives of a wider programme than the RLPE INSET scheme. The exercise therefore influenced and constrained the latter scheme. The Aims and Objectives of the proposed wider programme were:

**Aims:**

1.1 To combat the 'hidden' shortage of teachers by enhancing the provision of in-service education and training of teachers of Mathematics who are inadequately qualified in Mathematics.

1.2 To provide in-service education and training for teachers of Mathematics whose mathematical qualifications were obtained many years ago and who require up-dating courses.

1.3 To support departmental heads and other experienced teachers of Mathematics who will act as mentors for less adequately qualified teachers on a long-term basis.
1.4 To provide teachers of Mathematics with the skills, resources and awareness to present Mathematics as an exciting, relevant and applicable subject, in order to increase the future supply of graduates in Mathematics, Physics and Technology.

General Objectives:

2.1 To improve the match between the skills, strategies and teaching styles of teachers and the learning needs of students.

2.2 To up-date that mathematical content which teachers require to ensure the success of the new mathematical curriculum.

2.3 To establish a Central Mathematics Resource Centre at Loughborough University of Technology to serve the needs of teachers of Mathematics within a 50 mile radius.

2.4 To develop written materials and 'new technology' resources for the training, up-dating and support of teachers of Mathematics.

2.5 To formulate and conduct research programmes, which should not only provide monitoring, feedback, assessment and reconstruction through longitudinal studies but should develop and test new teaching/learning techniques, strategies and theories (using new technology as appropriate).

Since the wider proposals included suggestions that the resources developed for the RLPE INSET scheme would be made available to other education authorities, following evaluation and research, it required the Loughborough team to consider and discuss potential content of that programme.

Following discussions between members of the team the main topics suggested were:
1 Mathematics content related to the new curriculum
   (i) Examination syllabuses
   (ii) Mathematics across the curriculum
   (iii) Applicable Mathematics for relevance

2 Methodology
   (i) Teaching strategies and skills
   (ii) Learning styles and skills
   (iii) Matching techniques
   (iv) Practical and investigational work
   (v) Problem solving, modelling

3 Assessment
   (i) Aims
   (ii) Procedures and techniques
   (iii) Evaluation
   (iv) Attainment levels
   (v) Profiling

4 Use and impact of new Technology
   (i) Computer Enhanced Learning
   (ii) Audio-visual hardware, software and techniques
   (iii) Resource production and evaluation

5 The role of the teacher of Mathematics and the Mathematics Curriculum.

The following important clause was included in the proposals since the author was anxious that these topics should not be regarded as predetermined statutory requirements:

   At all times the programme will be subject to formative evaluation and reconstructed as an on-going process to match the needs of the teachers and authority involved.

The author found the exercises of preparing submissions to UGC and MSC
useful in the task of designing the RLPE INSET scheme. However, although these exercises had involved aspects of the 'Objectives' and 'Situational' models of curriculum design and development the author had treated both as guidelines and not as prescriptions. Hence, the formulated Aims, Objectives and Content served as useful frameworks on which to build, providing reminders of points to be considered and checked. The author and the Loughborough team remained firm in their commitment to develop the RLPE INSET scheme in a flexible manner as situations changed and observational data was gathered.
Chapter 5

THE RURISHIRE/LOUGHBOROUGH 'PILOT' EXPERIMENT: A CASE STUDY

5.1 Introduction

A most important research aspect of this Case Study is an investigation of the manner in which ‘naturalistic’ [Walker, 1971] Curriculum/INSET development takes place. In previous chapters it was argued that a report of a research programme with an interpretive and illuminative perspective must include necessary and sufficient description and data to enable the reader, as well as the researcher, to interpret and judge. Such detail should be provided in the pursuit of reflexivity and indexicality. Consequently data and analysis are presented as a running commentary in this chapter to enable the reader to place findings in context. Further analysis and review, however, will be conducted in subsequent chapters.

The running commentary of this chapter is considered particularly suited to the investigation of evolving models of design and to the study of the process of continuous evaluation. The commentary is related to relevant, parallel and contemporaneous activities in which the author was involved during all stages of the INSET provision. Reference is made to these activities as necessary. It is considered important to do this because of the subjective and qualitative nature of much of the data and the manner in which the data are analysed. Analysis of the data obtained by this research suggests that external influences have a much more significant role in naturalistic Curriculum/INSET design and development than is often supposed. Case Studies which describe limited subject matter in isolation and ignore the wider field are unlikely to provide evidence on which judgement can be made and are thus open to criticism regarding validity and reliability.

5.2 The Local Authority Mathematics Inspector

It is proposed to commence this case study with a description of the origins of the Rurishire/Loughborough 'Pilot' Experiment (RLPE INSET scheme), at
stages before the possibility of such a project was envisaged and when the participants were relatively unknown to each other. The seeds of the project were probably sown some years before but it could be said that the first initiative in establishing the Rurishire/Loughborough 'Pilot' Experiment was taken by the Mathematics Inspector of Rurishire. In February, 1986 a request that the Inspector should be allowed to observe an afternoon session of the part-time M.Sc. Degree course in Mathematical Education was forwarded to the author, through the offices of CAMET, Department of Engineering Mathematics, Loughborough University. The author was tutor of this course and readily agreed to the request. Two students of that course were Rurishire teachers and the author assumed that the Inspector was interested in finding out a little more about the course because of this. It was arranged that the Inspector would attend a Mathematical Education session led by the author and then join one of the mathematics or computing options which followed. It was something of a surprise to the author that the Inspector turned out to be Owen Eastwood a former successful student of the M.Sc. course. At that time the author did not know Owen well but remembered that he had conducted a short course of Mathematical Modelling as part of the course which Owen had attended. This meant that Owen Eastwood was well acquainted with the philosophies, perspectives and methods of the course and familiar with the work of CAMET and the author.

The Inspector made his visit and indicated that he was pleased that the nature of the course and its approach was as he had expected. Subsequently the author invited Owen Eastwood to speak to a combined group of students from the M.Sc. Mathematical Education course and from the recently established sister course, M.Sc. Computer Education, on the subject of the recently published MEP In-Service Pack: Secondary Mathematics With Micros [Waddingham et al., 1985]. The Inspector spoke to the combined group at Loughborough University on 20 March, 1986. Following the meeting, Owen Eastwood and the author discussed aspects of INSET and agreed that there existed need to raise the awareness of teachers to new developments in Mathematical Education and in the Mathematics Curriculum. Practical Mathematics and Investigational Methods were specific items discussed. Owen Eastwood was, in fact, the Rurishire Mathematics Inspector with special responsibility for a team of Educational Support Grant (ESG) advisory teachers. It was suggested that the M.Sc. Mathematical Education students might welcome a future talk by these
advisory teachers. The author phoned the Mathematics Centre at Midchester, Rurishire on 24 April, 1986 and confirmed with Owen Eastwood that four advisory teachers would talk to the M.Sc. course sometime in the next Autumn term. By this time the Inspector and the author had established a friendly working relationship.

In May, 1986 the author became more seriously committed to activities which subsequently were influential in the initial and on-going design of the Rurishire/Loughborough 'Pilot' Experiment/INSET scheme, which forms the central subject matter of this case study. These activities, which ran in parallel with the RLPE/INSET scheme, covered three closely connected areas; (i) Teacher Supply in Mathematics and Physics, (ii) Access to University and (iii) INSET Provision for Mathematics Teachers. They have been described in full in Chapter 4 under 4.8 The Post Experience Vocational Experience: INSET Scheme and 4.9 Teacher Supply in Mathematics and Physics. Work in these areas was well advanced when, on 1 September, 1986, the author telephoned Owen Eastwood at County Hall, Rurishire to confirm arrangements for the visit of the ESG Advisory team to talk to the M.Sc. Mathematical Education course at Loughborough. During the course of the conversation the author explained the proposals he was formulating on teacher supply and INSET provision. Tentative proposals had been outlined in a letter sent to Mathematics Advisers/Inspectors in nine local authorities, including Rurishire, from which M.Sc. Mathematical Education students were normally recruited. The Mathematics Inspector was extremely interested and requested further discussions. It was arranged that the Inspector should visit Loughborough University on 17 September to continue such discussions.

When Owen Eastwood and the author met on 17 September the former explained that for some time he had been considering asking CAMET to undertake INSET provision in Mathematics for Rurishire LEA. Consultations which the Inspector had undertaken with Rurishire Mathematics teachers had revealed that they had not always appreciated agency provided INSET schemes which had been organised in the county. The modus operandi of previous INSET providers had often been described as, in the Inspector's words, "handing out tablets of stone". He was aware that CAMET and the author did not work in that manner.
The Inspector identified, in general terms, two target groups; (i) experienced teachers of mathematics, mainly heads of departments and 'in-charges' and (ii) teachers of mathematics with limited qualifications in the subject. Although not giving full details of the LEA's financial arrangements, he indicated that there existed at least two sources of finance to meet the INSET needs of these groups. The author notes that (i) DES Circulars No.5/85 and No.5/86 refer to the teaching of mathematics in schools as an activity to be supported by educational support grants, (ii) DES Circular No. 1/86 specifically includes the training of both target groups in the areas to which the In-Service Teacher Training Grant Scheme applies and (iii) training in the teaching of mathematics (school teachers) was a National Priority Area described in DES Circular No.6/86: Local Education Authority Training Grants Scheme. The latter circular had been published just prior to the meeting between the Inspector and the author (on 29 August, 1986) following an earlier announcement by the Secretary of State of his decision to proceed with a new scheme to improve the quality of teaching and further the professional development of teachers. This Local Authority Training Grant Scheme not only supported national priorities at a 70% rate it also supported training in response to locally assessed needs at a 50% rate.

Initial proposals were that two separate courses, one for each target group, would be provided by CAMET. These would commence in September, 1987. The venue would be either at Loughborough or at the Mathematics Centre in Rurishire. Various modes of attendance were mooted as were various assessment schemes, certification requirements and organisational arrangements.

Discussions continued over the next three weeks by telephone. The parallel work which the author was pursuing at that time, on teacher supply, influenced his contribution and biased it towards INSET for the second target group. This group widened its scope slightly to include teachers who had mathematical qualifications but little experience of teaching the subject. The change was suggested by the Inspector. He was now concerned that a substantial percentage of mathematics tuition in the authority was provided by non-specialist teachers of the subject and that this tended to be given to less able children. There appeared to have been a lack of suitable in-service provision in the county for the teachers concerned; possibly because they often had significant experience in other aspects of the curriculum. They
included deputy heads and senior staff, who are required to 'fill in' mathematics slots in the timetable, as well as the more 'obvious', but less senior, non-specialists. In addition some of mathematics tuition was given by supply teachers for whom, traditionally, in-service training had been limited. Mature entrants to the teaching profession, although normally possessing some qualification and training in mathematics also required suitable in-service provision [Armstrong et al., 1987].

In an additional, but related development, the PEVE INSET, which was about to start at Loughborough influenced both parties to pursue the possibility of seconding a Rurishire teacher to conduct research, supervised by CAMET, into the introduction of GCSE coursework in Rurishire schools and to assist in the Rurishire Mathematics Centre.

On 7 October, 1986, in a meeting at Loughborough, attended by Owen Eastwood, Professor Bajpai and the author it was agreed to begin plans for an INSET scheme for teachers of mathematics with limited qualifications and/or experience. This would to start in January, 1987. It was hoped to provide a scheme for more experienced teachers of mathematics in Autumn 1987. Under the first scheme a team from Loughborough University would travel to the Mathematics Centre one day per week. Approximately 15 such teachers would attend the centre each week, from 2.00 p.m. until 6.30 p.m., during the Spring and Summer terms of 1987. In a discussion on costing and finance the Inspector made it clear that the local authority would provide supply cover for teachers attending the scheme. Government support was available for this. The feasibility and benefits of a residential summer school, at Loughborough or Midchester, of approximately 3 weeks would be investigated. Certification, based on modules and summer school sessions was also to be considered further. Input to the course would be provided by the Loughborough team together with some from Rurishire Schools and the Mathematics Inspectorate. Professor Bajpai agreed to be director of the INSET scheme and the author would act as academic tutor. Both director and tutor insisted that the scheme should be research based and to that end Professor Bajpai suggested that it should be called the Rurishire/Loughborough 'Pilot' Experiment. Its research findings would provide guidelines for future INSET schemes of a similar nature.
Over the next six weeks the scheme was costed and financial arrangements were clarified. In these discussions the Inspector made it clear that the local authority would provide supply cover for teachers who attended the scheme. Government support was available for this [Department of Education and Science, 1986a]. A block grant would be made by the authority to CAMET for research, development and provision of the scheme subject to final costing.

At Loughborough resource requirements and availability, including staffing, were investigated and plans made accordingly. A small team of Loughborough lecturers was identified. Some secretarial assistance would be provided by the Department of Engineering Mathematics but the bulk of typing would be done by an outside commercial organisation.

On 11 November, 1986 the author visited Rurishire Mathematics Centre, Midchester, to investigate the facilities and resources and to continue planning discussions with the Inspector. The author was introduced to three members of the ESG team, Linda, Emma and Frances who contributed to these discussions in the light of their experience of conducting INSET in Rurishire schools.

The Mathematics Centre had been planned by the Inspector and opened in April, 1986. Teachers were able to use the centre from 9.00 a.m. until 6.00 p.m. every Monday and Thursday. Additional and alternative use could be arranged. The Centre was located on the second floor of an old primary school, in the grounds of the LEA residential college. The lower floor was being converted into a social services day care facility. The Mathematics Centre was still developing but it was already well equipped with books, apparatus and other resources. Walls and corridors were pleasingly decorated with examples of mathematical work done by pupils in Rurishire schools and supplemented by commercially produced charts. The Centre consisted of a meeting room, a workshop, a store room, a small office and toilet facilities. The meeting room contained easy chairs, coffee tables, two BBC microcomputers with disk drives and colour monitors, a large TV/monitor, a flip-chart and a portable overhead projector. Another BBC microcomputer and peripherals, including a printer, were available from the office, as was a VHS video machine. The workshop contained a photocopier and other printing facilities.
The author was very pleased to see these facilities and immediately concluded that the layout was suitable for the pluralistic methods which had been well practised with the AIMEC Project [vide infra, Plan of Mathematics Centre]. The grounds of the residential college would be most suitable for outside practical mathematics activities.

Plan of Mathematics Centre

After the author had toured and investigated the Mathematics Centre discussions turned to INSET plans. Owen Eastwood reported that he had been visiting schools explaining tentative plans to heads and staff and attempting to identify teachers who might be suitable for the INSET scheme. It appeared that he was now looking to a group of 20-24 teachers attending the INSET scheme each week.

The author was a little worried that time was slipping by and thought that participants should soon be identified so that they could be consulted about their perceived needs and views about the form and nature of the INSET provision. Owen Eastwood suggested that he would outline the proposed INSET plans to the forthcoming Rurishire Head of Mathematics Conference in the first week of December. Further discussions were arranged for the second week in December, but the author would continue design and development of the scheme to which both parties had some firm commitment and would do so to include any views elicited from participants of 'Higher
Education Works for Schools' which the author would attend very shortly [vide supra 4.32].

In the second week of December the three ESG teachers, whom the author had met previously at the Mathematics Centre, visited Loughborough University to describe their work on Investigational and Practical Mathematics to teachers on the M.Sc. Mathematical Education course. Owen Eastwood accompanied them and in discussions with the author he described the reactions of Heads of Departments to the proposed INSET initiatives. At the conference in the previous week the heads themselves had expressed concern at the shortage of teachers of mathematics but went further to explain that the full extent of the shortage would never figure in official returns because classes were covered by 'non-experts' in their schools. The small size and rural nature of many schools in Rurishire meant that this aspect of teacher shortage was often concealed. They had in fact identified the 'hidden shortage' but indicated that its true extent was not really known to authorities or Government.

The author reported his observations of the 'Event' at the Royal Institution. He described the concern expressed by Government, and other parties, about teacher shortage and their pledges of support for measures to combat the problem.

Both parties were now convinced that an INSET provision for teachers with limited qualifications and experience should go ahead. It was agreed to postpone commencement of the scheme to the beginning of February, 1987. This would provide a little more time for preparation and for important consultation processes. Owen Eastwood would write to Heads of Schools to ask them to identify teachers who would be suitable for the INSET scheme. An application form would be prepared and sent to these heads, who would be assured that supply cover would be provided where necessary. Suitable teachers would include permanent staff and those currently or recently employed on temporary or part-time contracts.

The Inspector and the author agreed that, given the likely participants, the scheme would need to include some aspects of mathematics content and some treatment of teaching/learning processes but the author insisted that participants must be consulted on this and on other design aspects. Indeed
he suggested that the programme would be subject to on-going modification as formative data was collected. The Inspector was happy to concur with this since it reflected his own views on INSET design and development.

One week later Owen Eastwood and the author were able to continue discussions at Loughborough since the Inspector had been invited, by Professor Bajpai, to join the 'Working Group on the Shortage of Mathematics Teachers' [vide supra 4.33 and Appendix 3]. The author was also a member of that group and was acting as Rapporteur. The Inspector was able to report that applications to attend the INSET scheme were now being received. He described the backgrounds of some of these applicants, all of whom were known to him. Teachers from the LEA Special Education Unit had expressed an interest and the Inspector asked if there were any reasons why they should not take advantage of the scheme and attend the course at Midchester. The author indicated that these teachers would be welcome and would contribute to the scheme. He suggested that an input from participants with a wide variety of backgrounds and experience would be advantageous. One of the general goals of the course would be to increase teacher awareness of current practice. Interchange between participants would be encouraged so that they became aware of each others' experience, work and ideas. Problems which participants faced in their work would provide useful material on which to develop the INSET scheme.

There was a tendency at this stage to refer to the provision as a course, since plans were concentrated on the nineteen sessions, when participants would attend the Mathematics Centre at Midchester. The residential session and the follow up programme were still in mind but not at the forefront of the planning process.

In the second week of January 1987 Owen Eastwood visited Loughborough again as part of the planning process. He was able to report that twenty teachers would be participating in the RLPE INSET scheme. Arrangements were finalised at this meeting for the location and timing of the first stage of the scheme. The teachers would attend the Mathematics Centre from 2.00 p.m. to 6.30 p.m. on nineteen Thursday afternoons; nine sessions in the Spring Term and ten sessions in the Summer Term. The first session would be on 5 February.
5.3 The Loughborough Team

In October 1986, when initial planning of the RLPE INSET scheme commenced it was agreed that Professor Bajpai should direct the scheme and the author would act as academic tutor and designer. Over the next three months other Loughborough Staff joined the planning and tutorial team.

Maureen Green joined the team from 17 November, for the equivalent of two days per week. Maureen had worked closely with the author on the AIMEC Project and the two shared common views on design and development of INSET provision. Consequently, the early planning stages of the RLPE INSET scheme were expedited. The AIMEC Project had drawn to a conclusion in July 1985 and during the 1985/86 academic year Maureen had worked half-time in the Geometrical Modelling Group, which was a research group in the Department of Engineering Mathematics, and half-time as a teacher of mathematics in a local school. She was thus able to bring recent experience to the RLPE INSET scheme, which was invaluable in identifying provisional goals, needs and content of the planned provision. Immediately she joined the team Maureen assisted the author in making provisional plans. Both parties used the opportunity provided by the PEVE INSET scheme to discuss ideas with teachers who attended the meeting and to glean further information about the current situation in schools and the perceived INSET needs of mathematics teachers. Maureen and the author were aware that they would be more heavily involved as designers and providers of the INSET scheme than other members of the team and planned accordingly.

At this stage the author was using a modified form of Skilbeck's [1982] *Situational Model* [vide Appendix 4] as an *Outline Plan* [vide infra 9.33] for designing the INSET scheme. It is important to comment that this model was not used prescriptively. In fact the research data collected by this research suggests that the model could not have been used in that fashion. The author had reviewed and analysed micro-level and macro-level situations but new data was being gathered constantly and situations were in flux. Until the participant teachers were identified it was impossible to collect some extremely important data on perceived needs. Nevertheless, early planning was based on the situational analysis at that time. This involved a significant
degree of 'parallel processing'. Goal formulation, programme building, interpretation, implementation, evaluation and reconstruction were found to be parallel, interacting processes and not sequential, isolated components of design. Each process also interacted with the situational analysis and maintained the state of flux.

The parallel processing required Maureen Green and the author to identify content, plan weekly programmes, prepare materials and to collect resources to supplement those which the author knew were available at the Rurishire Mathematics Centre. It was accepted that much of this work was provisional because of the continuing gathering of data for situational analysis. It was accepted, however, that mathematical content and approaches should reflect the philosophy and work of CAMET. The relevance and applicability of mathematics would be emphasised and the 'model view' would permeate the work. Consequently materials, resources and programmes were selected and prepared to include aspects of practical work and modelling [vide Appendix 5].

One decision which was made at an extremely early stage was that written material would be produced to as near professional standard as possible. The good reception which professional quality material had received at 'Higher Education Works for Schools' [vide supra 4.42] influenced this decision. Consequently it was decided to produce all material using a Macintosh word processor and Laser printer. Since the Department of Engineering Mathematics was unable to provide staff to cover all of this work an outside agency was employed for the bulk of the typing.

The designers made other important decisions at an early stage, which they considered to be justified by past experience and by the analysis of the situation at that time. One such decision was that pluralistic teaching/learning strategies should be employed. This decision was based on experience with other INSET provision, consultations with teachers and the Rurishire advisory team and in the light of the current practices and proposed changes in the school curriculum (for example, GCSE coursework). Since, it was intended that members of the Loughborough team would not to be cast in the roles of 'college experts' [Mathematical Association, 1986] the scheme was planned as a problem solving, rather than a solution based, exercise.
Situational analysis also suggested that the scheme should not include formal assessment. Tentative working goals had been identified to increase awareness, to change attitudes and to bolster confidence of teachers with limited qualifications and experience in mathematics. The author's previous experience convinced him that mature learners should not be placed in threatening situations. This would apply equally well to the teachers who were expected to attend the RLPE INSET scheme. In such a group, which was likely to include teachers with mixed backgrounds, formal assessment could well be threatening and counter productive. The Rurishire Mathematics Inspector and the author had discussed the possibility of requiring the participant teachers to complete set tasks in their schools between meetings. The Loughborough team considered this to be a worthwhile suggestion but planned to incorporate this into the programme gradually and in the light of evidence collected by observing events and participants as the INSET scheme progressed. It was by no means certain that all teachers would be able to accommodate these tasks, if evidence from the PEVE INSET programme was to be believed and generalised. Well qualified and experienced mathematics teachers attending that latter programme appeared to have difficulty in meeting extra demands.

The author considered it highly desirable that members of the Department of Education of Loughborough University should be involved with the RLPE INSET scheme. He had worked closely with one member of that department, George Abbott, for a number of years because of their mutual involvement in the B.Sc. Education and Mathematics and M.Sc. Mathematical Education courses. George Abbott agreed to contribute to the scheme but preferred to postpone this until the summer term because of other commitments. He suggested that Philip Dean, who had just joined the Department of Education of the University after many years experience as Head of Mathematics in a comprehensive school should join the team. Philip had also begun work with the author on the MSc Mathematical Education course and he had attended the meetings of local mathematics teachers organised under the PEVE scheme. Maureen and the author had become acquainted with Philip at these meetings. Philip readily agreed to join the team and it was agreed with the Department of Education that he would visit Midchester on three afternoons during the early part of the Spring term and twice in the
Summer. In January, following a meeting of the team, Philip Dean also began to prepare material. It was agreed that he should plan and prepare three sessions on Investigational Work, although it was still accepted at that stage that plans were provisional. They would not be confirmed until consultations had been held with the participants. Nevertheless, it was confidently expected, following extensive consultation with other teachers, advisers and trainers, that investigational work would be identified as a matter which the participant teachers would want to include in the scheme.

An interesting aspect of the discussions, which the Loughborough team held at this stage of the development, was that Philip Dean argued that the teachers would be far more interested in content than in teaching and learning processes. He based his argument on recent experience of an INSET scheme and on his work as Head of Mathematics in a school. The author was convinced that this would be true but resisted inclining early planning too far in this direction, since he believed interaction during the scheme and an increased awareness in teachers, which this would bring about, would change perceived needs. The author's experience of previous INSET schemes for teachers of mathematics with limited qualifications suggested that to weight the scheme too heavily in favour of content would be detrimental.

It is interesting to note that Philip brought to the planning process his own set of beliefs and assumptions about INSET provision. In certain respects these matched those of the other two designers, who shared very similar beliefs and assumptions, but in a number of matters there was some divergence. Philip appeared uneasy in not having a prescriptive design procedure to follow. His expectations of the participants also differed from those of the other members of the team, both prior to meeting the teachers and afterwards. He held the view that the teachers should be required to complete a substantial amount of work in their own time and would have time to do this. His recent background as Head of Mathematics and his new appointment appeared to be influencing his approach and perspectives, just as the background of the other team members influenced their preferences, values and judgements. It is argued later that situational analysis must be undertaken as a research exercise more inclined towards interpretive/illuminative perspectives than to the positivistic approach. Judgements about situations and analysis are perhaps rather more
subjective than is often acknowledged.

The Loughborough team was completed by David Green, a member of the Department of Engineering Mathematics. David joined the team shortly after the INSET scheme had commenced at Midchester and when consultations with the participants revealed that they were interested in discovering more about probability and statistics. David had conducted research in schools related to the development of probability concepts in children and was ideally suited to provide this input.

5.4 Making Ready

January, 1987 was an extremely busy month for members of the Loughborough INSET team. Maureen, Philip and the author finalised materials and arrangements for the contributions they would make to the opening sessions of the RLPE INSET scheme at Midchester. It has been emphasised in the previous section [vide supra 5.3] that the design model employed as an Outline Plan was not regarded as prescriptive. Nevertheless the MSC and UGC submissions described in Chapter 4 provided useful guidelines, particularly in highlighting topic areas which might be used early in the scheme.

The author also continued the process of long term planning. This involved discussions with other members of the team who would contribute to sessions later in the year. More data was available on the participant teachers and the author was frequently in contact with the Rurishire Mathematics Inspector and his advisory team to collect that information. It was confirmed that 21 teachers would be involved in the RLPE INSET scheme and details of their backgrounds began to emerge. It was suggested that, at that time, the majority of the participant teachers would employ predominantly teacher centred methods in their classrooms. Exposition, demonstration and skill/drill techniques would be more common in their teaching than discussion. Practical work, investigation and problem solving would be used infrequently, if at all. Classrooms would often be formally arranged in rows. The nature of Rurishire schools was a dominant influence in determining classroom practices. It must be stated that later research by the author confirmed that for many of the participant teachers this was a valid description but not for all. Nevertheless, the description echoes the Cockcroft
Report which, in 1982, stated "that there are still many (that is, classrooms) in which the mathematics teaching does not include even a majority of these elements (that is, those listed in Paragraph 243)" [Department of Education and Science, 1982].

Additional data about the probable needs of teachers with limited qualifications and experience was gathered by the author from several sources. As part of the work of the PEVE INSET scheme the author was visiting local schools to observe the progress which was being made in preparing for GCSE coursework and to discuss the contributions which members of that scheme would make to future PEVE meetings. These visits enabled the author to speak to heads of departments and to other staff and to elicit information pertinent to the planning of the RLPE INSET scheme. It became obvious that preparations for the implementation of GCSE, was a major concern in schools. Coursework, assessment and new teaching/learning strategies would almost certainly need to be prominent features of any INSET provision.

Another source of data was the teacher, Gerald Drake, who had been seconded by Rurishire to conduct research under the supervision of the author. Gerald would be seconded part-time from January and full-time for the academic year 1987/88. It was decided that his topic of research would be the Implementation of Mathematics coursework into Rurishire Schools. Gerald was currently Head of Mathematics at Yardley High School, Ruriston, where he had started to introduce coursework into the lower school mathematics curriculum. He was also organising and conducting a number of self-help groups for mathematics teachers around the county. Consequently he was able to provide the author with considerable, useful data about the probable needs of Rurishire schools and of the type of teachers who would attend the RLPE INSET scheme. A member of staff of his own department would be attending the RLPE INSET scheme.

The on-going consultation process and the parallel preparation of submissions to UGC and the MSC which the author was undertaking (the latter with the assistance of the Rurishire Mathematics Inspector) enhanced the analysis of the situation and hence the design and planning of the INSET scheme. By the end of January the team were well prepared to commence the provision.
5.5 The Midchester Programme

This section describes the main phase of the RLPE INSET scheme which took place on 19 Thursday afternoons in the Rurishire Mathematics Centre, Midchester. During that phase there was some commonality in the organisation and procedures which were adopted each week. For instance, essential equipment, such as scissors, protractors, string, glue, rubber bands, compasses and rulers was brought to Midchester each week. The participants were encouraged to build up a similar set of resources in their own schools. Written materials were prepared in Loughborough and brought to Midchester. It had been decided that the participant teachers would be given a significant amount of written material each week, in the form of notes, timetables, resource packs, etc., which they would keep to assist their work in schools and to encourage them to try out ideas between sessions. Many of the resources were intended for distribution in their schools. Copyright was waived to enable this dissemination to occur and papers were designed to facilitate photo-copying. It was hoped that this would widen the scope of the INSET scheme and build a foundation for its future continuation. In practice it appears to have assisted the participants to enhance their roles within mathematics departments and to increase their confidence.

"One advantage of this in-service course is that I am no longer treated as a dog's-body by other members of the Mathematics Department."
Derek Castle.

"I ended a report on the course to my Head, 'Handouts: 3 kg!'
Mark Davis.

At the start of each week the teachers were given a timetable of the planned events of the afternoon. For each event they were also given a cover sheet outlining the Aims and Objectives of the exercise and the manner in which it would be implemented. These aims and objectives were provided as guidelines to enable participants to 'establish their bearings' and orientate themselves for the activities of the afternoon. They were not intended to describe outcomes and certainly not ends to be evaluated. Implementation
details were provided to facilitate organisation (for example, location of
groups, arrangement of circuses) and so that the participants knew roughly
what was expected of them and what learning/teaching strategies were
involved. Participants were made aware from the first week that these cover
sheets were regarded as guidelines and that they would be used flexibly
and modified to match prevailing conditions or identified needs. Example
cover sheets are given in Appendix 6.

5.5 Setting Out: The First Three Weeks

Thursday 5 February 1987: Week 1

On the morning of Thursday, 5 February Maureen Green, Philip Dean and
the author travelled from Loughborough to Midchester; a journey of 75 miles.
It had been decided that the team would travel by hired car and that the
driving would be shared between them. This is not an insignificant factor,
since a great deal of planning, feedback and evaluation took place in the
course of the journeys to and from Midchester. Data collected in this manner
was extremely valuable, as observations were recent and data was freshly
gathered. The author had also requested members of the team to provide
him with written comments on each session they attended.

The Mathematics Inspector had given the author a set of keys for the
Midchester Mathematics Centre and the Loughborough team arrived at the
Centre well before lunch, in sufficient time to arrange the rooms and to
organise resources before participants arrived at 2.00 p.m. This procedure
was followed each week. Lunch was usually taken with the Rurishire
advisory team at a hotel in the town. This provided excellent opportunities to
discuss the work of the RLPE INSET scheme with the Mathematics Inspector
and the ESG teachers. The advisory team were in regular contact with
participant teachers and their schools and therefore feedback and
evaluation were facilitated.

All 21 participant teachers attended the first session. They brought with them
complete application forms, a copy of which was given to the author by the
Mathematics Inspector. These provided further data about the teachers such
as the name of their school, qualifications, ages and ability levels of the
children to whom they taught mathematics and the number of periods of
mathematics they taught in a week. The application forms did not in every
case give comprehensive detail and the author decided that further
information would need to be gathered by other means during the course of the programme. Nevertheless at that time the forms were extremely useful. One teacher, Brenda Burton explained that she could only attend each week from 2.00 p.m. to 4.00 p.m. because of other commitments but she hoped that it would be possible to allow her to continue as a participant. The Inspector and the author agreed that this was acceptable.

During the preliminary introductions the author explained that the programme would be conducted in a problem solving mode as far as possible and that the Loughborough team would not be providing ready made solutions to speculative problems. He also stated that the methods would be pluralistic and would mirror those the team hoped to encourage in school classrooms. The teachers appeared to be extremely pleased that these approaches were to be adopted. From the outset interaction between the participants and the Loughborough team was much in evidence and this was encouraged. First name terms were immediately adopted and an extremely friendly relaxed atmosphere was established. The Mathematics Inspector contributed significantly to this since he was well known to most of the participants and had already established extremely good and friendly relationships with the teachers.

The teachers readily and excitedly involved themselves with the activities of the afternoon. The exercise on quotations about teaching and learning mathematics produced much discussion and not only served its purpose of enabling all those involved to become acquainted but also motivated the teachers. A number commented that they had not thought about mathematics in the terms brought out by the questionnaire and discussions before and were pleased to be given the opportunity to do this. In fact the teachers were so engrossed in discussion that they and the Loughborough team forgot that tea had been arranged in the nearby residential centre at 4.00 p.m. Consequently tea was delayed and apologies had to be offered to the caterers.

From a research viewpoint tea was an ideal opportunity to gather data and to continue participant observation. The team became acquainted with most of the members over tea and good relationships were beginning to be formed. Small details of the members' backgrounds, such as Bob Bell's passion for bell ringing and his engineering background, added to an
important cumulative pattern which enhanced the INSET design. A wealth of relevant data was collected openly by the team during this tea break and in subsequent weeks, which would not have been gathered by written survey techniques or formal interviews.

The discussions which the quotations generated overlapped tea and continued into the next activity, which was the consultation exercise designed to elicit the perceived INSET needs of the teachers and their hopes for the programme. In fact the overlap was beneficial since it prompted a number of ideas on needs. It became even more apparent to the author that identification of needs was an exercise which would have to continue throughout the course and which called for a variety of data gathering methods and interpretive techniques. Nevertheless a great deal of useful data was collected by the exercise which was used to design and modify subsequent sessions.

The teachers had split into three groups to discuss needs. A member of the Loughborough team joined each group. At the end of the afternoon the team met to exchange findings. These were discussed again on the journey home. The next day the author was given a written summary of the teachers' needs which had been identified by each of the team. In fact, the needs which each group had identified were similar. In a note Maureen Green summarised the hopes and expectations of her group which reflected closely the views of the other two groups. The note listed the following:

1. Advance their own mathematical knowledge, particularly of 'modern mathematics' topics.
2. Look for new approaches to 'old' mathematics topics (for example, percentages, ratio). Build up a 'resource bank' of starters, games, motivators. Concentrate on topics which are on the MEG GCSE syllabus.
3. GCSE - What is it all about? Some know little about it, do not teach classes for it at present, but would like to be able to do so if required.
4. Use of computers in mathematics. Software: What is available? Micros seem to be under-used at present. How do they organise whole class so as to use 1 or 2 micros?
5. Teaching through problem solving.

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Mathematics across the curriculum / applicable mathematics.

How to use apparatus.

Text books and resource materials. Opportunities to see these and browse.

Assessment.

Perhaps, they could sometimes be split into groups according to the types of classes they teach (for example, (i) lowest ability group, (ii) supply teachers, (iii) GCSE classes and (iv) those who teach for qualifications other than GCSE.

This finding may be interpreted as a result of the list provided by the cover sheet on the consultation exercise but that list was purposefully comprehensive and it is likely that it acted as a memory aid rather than a prompt. Members appeared to have their own priorities. The advent of GCSE appears to have been an important influence in determining perceived needs. Members were also conscious of their mathematical weaknesses and were anxious to remedy these. One might have expected many of these needs to have been satisfied by school-based INSET but this appeared not to have been the case for these 'hidden' teachers who are often not regarded as bona fide members of a mathematics department. Such teachers appear to be hidden in a different sense from that used by DES. In other words they are not only hidden from statistical returns but also from colleagues. A number of needs are also hidden from colleagues by teachers who through lack of qualifications and/or experience feel insecure and are anxious not to reveal self-perceived weaknesses. This supports an argument for the provision of some 'out of school' INSET in neutral locations; an argument which was often made for Teachers' Centres, which now appear to be nearing extinction.

The needs identified by the consultation at Midchester closely matched those which the team had listed prior to the first session. It was not altogether surprising therefore that the penultimate activity of the first session turned out to be very appropriate. Maureen Green introduced a video presentation of several lessons showing different styles of teaching/learning. This involved the members in discussing classroom practice and in analysing Paragraph 243 of the Cockcroft Report. It produced an interesting and lively discussion and prepared the ground for future sessions.
These discussions continued into the plenary session and furnished extremely useful data. A number of members expressed their anxiety that in their schools the *status quo* would discourage the use of teaching methods which were apparently new and revolutionary. At least one teacher reported that the norm in his school was for children to sit in isolated desks arranged in rows and that he foresaw difficulties in attempting to change this situation. The group as a whole appeared to accept that he would experience such difficulty and did not seem surprised by his dilemma. This may be interpreted as traditional teacher resistance to innovation but the social norms of schools cannot be discounted as a barrier to change. Later visits by the author to members' schools provided evidence that social influences were at play in resisting change.

As they left the Mathematics Centre at the end of the first session a number of teachers approached the team to express their thanks and to say how much they had enjoyed the session. This was much to the surprise of some of these teachers. They appeared to have expected something different.

Each teacher had been given a package containing extracts from reports concerned with the question "Why Teach Mathematics?". A cover sheet requested them to read the papers in the package and to research other publications in order to prepare themselves to join in discussions on that question in two weeks time.

At the conclusion of the afternoon the Loughborough team were extremely pleased with the events of that day. Everyone expressed pleasant surprise at how quickly the afternoon (four and a half hours) had seemed to pass. Philip Dean later wrote:

"The tutors were agreed that this introductory session exceeded their expectations and were very pleased by the positive response from the course members."

Maureen Green commented in her diary;

"Participants appear very keen, and there are no bad signs yet!"

On their return to Loughborough the team held further discussions and
exchanged information and ideas. It was decided that it would be possible to plan the next two weeks in some detail in the light of the consultation undertaken at Midchester and elsewhere. GCSE Mathematics and Investigational Work were topics which had been identified as needs and the next two sessions were designed around these. The team agreed that the pluralistic methods had been well received and decided to continue this approach to enable the teachers to experience those learning styles which GCSE Mathematics would demand in their own classrooms.

The team also agreed that the process of gathering data about perceived needs should be a continuous exercise with course design being subject to constant modification. Provisional plans were drawn up for the whole of the first term but final detailed weekly timetables would need to be prepared each week following feedback from previous sessions. The team considered that much of the preparation they had already undertaken had produced resource material which matched needs and that they had sufficient information to prepare and produce more. Consequently responsibilities for preparing selected elements of the INSET scheme were delegated. Materials would be forwarded to the author for final editing and he would be responsible for their final preparation through external agencies where necessary. Maureen assumed an arduous responsibility for preparing photocopies and collating weekly resource packages with the assistance of the author and office staff when available.

**Thursday 12 February 1987: Week 2**

Maureen Green, Philip Dean and the author formed the team for the second session. They were pleased to note that all 21 participant teachers attended the session. Roy Brent was a little late, setting a pattern which he would maintain throughout the course. It was noticed that the teachers had formed relationships the previous week and tended to sit in the same groups as in the first session; even though the opening activity was to be a talk by the author on GCSE Mathematics and the easy chairs had been arranged in a 'circle' with the overhead projector as a 'focus'. However, there was a great deal of interaction. Information and ideas were exchanged freely across the group. It appeared that cliques were not forming. One or two members were possibly keeping themselves to themselves at the start of this session but this did not persist once discussion groups were formed. Derek Castle, for
example, tended to isolate himself at times. He would sit near the door when the strategy was exposition by a member of the Loughborough team but readily joined in group activities. Roy Brent was unable to confine himself to one particular group for long and frequently changed groups or engaged a free member of the team in conversations about his problems of teaching mathematics to low ability children. This was also a pattern he maintained throughout the programme.

The afternoon programme began with a short description by the author of what the team had planned for future sessions as a result of the previous week's consultation exercise. The teachers appeared to be quite happy with the proposals, which the author explained were subject to modification. The author then presented an introduction to GCSE Mathematics, encouraging questions and discussion from the outset. The Loughborough team were surprised at the lack of knowledge on GCSE in the group of teachers. In fact the teachers freely admitted they knew little about the new examination. It became necessary to discuss GCSE criteria, Examining Groups, assessment patterns, proposed mathematics syllabuses and nature of coursework. There were many questions which the author and the team answered. The group were keenly interested in GCSE, although many of them thought they would not be required to teach to that examination. The author made the point that children would need to be introduced to the styles of teaching, learning and assessment promoted by GCSE in lower school years. GCSE training schemes appeared to have failed to reach the majority of the group at that stage.

Wendy Wood
"I think I understand what GCSE is all about now. It is much clearer. Why didn't someone tell us all this before?"

The next activity was introduced briefly by Maureen Green. The teachers were given 2 introductory mathematical investigations. Maureen explained that the investigations were meant to promote an awareness of the value of mathematical investigations and to increase understanding of the attitudes and feelings of students when doing their first investigation. To this end the teachers were asked to try the investigations individually or in pairs for
approximately 40 minutes. The teachers spread into the three available rooms of the Mathematics Centre to do this. It was evident that the distribution was influenced by relationships which were forming between members. After the allotted time two larger groups were formed (in two separate rooms) to discuss the attitudes and feelings which had been experienced and to compare the different investigational approaches which had been adopted. The teachers were obviously unfamiliar with investigational work but attempted them with interest. Much lively discussion continued throughout the exercise. An example lesson of an investigation had been shown as a video the previous week and it was pleasing to hear from many participants that they had tried this in their own classrooms. Many had acquired the necessary apparatus (that is, hoops) from the Physical Education department of the school. In fact some of those who had tried the investigation were Physical Education teachers. The team took the opportunity to encourage this interchange between departments. This encouragement became a feature often repeated during the programme. Members who complained that they lacked equipment would be told by others to "raid" this or that department.

The tea break once again proved to be a valuable data gathering exercise. It was becoming evident to the Loughborough team that the group was even more mixed than had been thought. It included supply teachers, deputy heads, special needs teachers and a variety of subject specialists other than mathematics. Grammar, comprehensive and secondary modern schools were all represented. Current mathematical teaching covered all ability levels in the 11-16 age range.

After tea Philip Dean developed the earlier work on investigations to look at Extended Pieces of Work which were being used by fourth year students in the school which he had recently left. This prompted the group to ask a number of questions about the organisation and conduct of the work. For the rest of the session the group spent time in a role playing activity, acting as fourth year students attempting the same pieces of work and experiencing some of the emotions and frustrations involved. The teachers readily and enthusiastically involved themselves in this role playing exercise although they had obvious difficulty in adapting to the roles. Nevertheless, after some initial embarrassment and good natured hilarity, the role playing exercise continued quite successfully.
The afternoon appeared to be well received with the members enjoying the activities. Members were very willing to take part in all the activities and demonstrated a keen interest. The team observed that the teachers were beginning to feel increasingly at ease with each other and with the team. A great deal of good humoured banter was evident, encouraged by the role playing exercise. Maureen and the author were well used to team teaching together as a result of their work with the AIMEC Project. They often raised discussion points not only with participants but with each other. The members seemed to enjoy mathematical arguments, which the two pursued openly. This had the desired effects of emphasising that there often existed several approaches to mathematical and learning problems and encouraging interaction between the team and members of the group. Philip soon began to contribute to these exchanges. Some contributions from the teachers suggested that many had thought that there was always a "right way" to do mathematics or to teach it.

Maureen Green

"They tended to think SUMS were what mattered and that 'practice' was the only way of 'making perfect'. One (Lawrence Terry) was always ready with a 'rule of thumb' trick which worked."

Once again the team took the advantage of the car journey home to exchange views on the proceedings of the day and to plan ahead. They agreed that the day had been successful and pleasing. Philip and Maureen had prepared several activities connected with GCSE syllabuses, assessment and coursework and it was decided to capitalise on the obvious interest the teachers had in that area by continuing related work the following week. The team were becoming impressed by the enthusiasm of the participant teachers and by their willingness to consider new ideas. It was realised that there was still some resistance to these ideas but the fact that some teachers had tried out investigations in their own classrooms was encouraging.

Thursday 19 February 1987: Week 3

It had been decided that the author would not accompany Maureen and Philip to Midchester that day. There were a number of reasons for this. The
team were anxious that they should not dominate proceedings and it was felt that a trio may have been too large. Philip would not be joining the team again until week 14 and he was keen to try out some of his ideas on assessment of extended pieces of work with the group alone. He still appeared a little resistant to team teaching.

Since the author did not observe proceedings that day the following has been compiled from diaries and accounts supplied to the author by Maureen Green and Philip Dean. Although they do not constitute primary data collected by the author as a participant observer, as accounts, they do provide extremely useful information to enhance interpretation and illumination.

An extract from Maureen Green's diary;

"In groups we looked at various GCSE Syllabuses and sample Examination Papers. They worked well at these, and there was considerable interest in and discussion of the exam questions at the three levels compared with the present G.C.E./C.S.E. papers.

After the tea break, Philip Dean...... talked about his recent experience in setting and Assessing Coursework. The members then worked in pairs to assess some of his pupils' work, using the assessment schemes supplied by him, discussing the usefulness and applicability of these schemes.

Members are continuing to gel into a happy working group."

Maureen Green.

Philip Dean reported that when the four groups which had studied the GCSE syllabuses came together in a plenary session there was "lively discussion with considerable disparity of views". His own contribution on extended pieces of GCSE coursework had required the members to split into three groups to consider examples of coursework for the foundation, intermediate and higher levels.
"It was intended to be a fairly subjective exercise and not to be taken too seriously, as there are obvious problems in assessing 'cold', but was felt to be a worthwhile exercise since examples of coursework are not usually available."

Philip Dean.

In the whole group discussion which followed "more questions had arisen than answers" but Philip considered that "a less confused picture had emerged". He reported that:

"As in previous weeks the sessions had been lively and stimulating (to the tutors at least) throughout. It was again pleasing to hear that many earlier ideas had been tried out in members' schools."

Maureen added that, "in the plenary session some members expressed feelings of frustration and eventual boredom when doing the extended investigation in the previous week. Others said they had not been able to leave it alone long after the workshop had finished." Maureen had spoken to quite a number of teachers who had tried out some of the investigations with one or more of their classes, with varying degrees of success.

"As with the previous two sessions we as tutors, were greatly impressed by the openness of all the discussions, the willingness to share even 'bad' experiences and the general positive attitudes of course members."

Maureen Green.

It appeared the methods, styles and approaches which the Loughborough team had chosen to adopt were appropriate to match the situation as it had been currently analysed. Additionally, the RLPE INSET scheme was evidently having some effect on classroom practice by introducing new teaching and learning styles and methods.

At the end of the afternoon Maureen gave each member a package of 17 investigations and suggested that members might like to try out some of the ideas it contained in their own schools. Later visits to members' schools by the author, suggested that many of these ideas had been used in schools and that other staff had taken advantage of them.
5.52 Reflection and Continuation: The Next Six Weeks

The Rurishire schools mid-term break was an ideal opportunity for the Loughborough team to reflect on the implementation of the INSET provision after the completion of three sessions. Those sessions had been successful in establishing a good working rapport with the participant teachers. The team now thought that the participants would be receptive to new approaches to teaching mathematics and in particular new ways of looking at topics, which although familiar, apparently caused them some concern. The teachers referred to these as 'old' topics: percentages, ratio etc. The team were also anxious not to separate these topics from those which the teachers called 'modern mathematics'. The latter term seemed still to denote a remote, mysterious subject to these teachers, despite the wealth of R, D and D (Research, Development and Dissemination) projects of the 1960's and 1970's. This research suggests that INSET provision in mathematics has failed many non-specialist teachers of mathematics over the last twenty five years and is a matter which must be addressed in respect to the 'hidden' shortage. It appeared that the teachers had little overall perspective of mathematics.

Consequently it was decided to adopt the 'model view' of mathematics for the next part of the programme and to combine this with a practical approach. The author suspected that the teachers would be unfamiliar with the concept of the mathematical model and the skills of modelling. Experience with well qualified and experienced mathematics teachers on the M.Sc. Mathematical Education course provided ample evidence to support this suspicion. There was some discussion by the team concerning the suitability of the 'model view' of mathematics for teachers who were not mathematics specialist, but the advantages of the approach were judged to make an experiment worthwhile. Since the programme was subject to constant review this was considered to be an appropriate strategy.


The author's suspicion that the participants would know little about mathematical modelling was confirmed in a discussion at the commencement of the afternoon. A majority of the teachers had heard the
term mathematical model but that was the limit of their knowledge of the idea. There was a keenly expressed desire to find out more about it. The author introduced the members to the concept of the model and related that concept and the techniques of mathematical modelling to the aims and objectives of GCSE Mathematics as given in the National Criteria and in a number of syllabuses from various Examining Boards. In a following exercise the members, in small groups, attempted to construct their own mathematical models from a list of suggested situations given to them by the author. They were given a flow chart of a possible modelling algorithm to assist them. Examples of models constructed by teachers on the M.Sc. Mathematical Education course were also available for inspection.

"This was new ground to nearly all of them and they obviously enjoyed the learning experience and began to appreciate the power of the new idea"

Maureen Green.

The modelling theme was continued in the second half of the afternoon when Maureen introduced work on graphs. This was a set of practical exercises which required members to collect data from real situations and experiments. Various types of graphs were used as models to represent these situations and to draw conclusions and make predictions. There was some extremely enthusiastic participation in the experiments and graphing of data. The team record that there was much laughter and excitement. Austin Matthews, who was a Physical Education specialist, took a leading part in organising many of the experiments. It appeared his skills of organising teams were extremely appropriate to these exercises. Science specialists such as Jack Connelly also played important roles in helping others to record and analyse data. It was evident that a number of teachers were not used to employing apparatus in mathematics classrooms. The Loughborough team had brought with them a significant amount of apparatus and had borrowed some from the Mathematics Centre. It was hoped that this would encourage members to seek out apparatus in their own schools and to introduce it regularly into their mathematics classrooms. There was a great deal of useful interaction and input by members in these exercises and they developed into valuable self-help activities.
Thursday 12 March 1987: Week 5

A valuable and pleasing element of feedback was received over lunch. Before the afternoon session the Mathematics Inspector commented:

"You are receiving a very good press around the county."

It appeared that in visiting schools he was receiving extremely encouraging comments about the RLPE INSET programme from members and from other staff. He was also pleased, and slightly surprised, none of the teachers had dropped out of the programme. He indicated that in a number of INSET courses, with which he was familiar, a fairly high drop-out rate was the expected and observed pattern. In addition his advisory team had been impressed with some of the techniques and methods used by the Loughborough team, particularly during the practical exercises. They asked if there would be any objection to them coming into future sessions to observe strategies and techniques. The two members of the Loughborough team were delighted to agree.

This afternoon session itself built on the modelling and graphical work of the previous week. It commenced with an introductory talk on functions and graphs, developed from sets and relations. In addition to attempting to unify a number of topics the author discussed different approaches that the teachers might take towards teaching functions and graphs. Although the group demonstrated interest in this topic it was noticeable that pertinent questions were asked by those members with better qualifications in mathematics or more experience in teaching the subject (Barbara, Glynis, Joan, Wendy, Ursula, Jack, Bill). Others indicated that the topic was strange to them and that they were usually only required to teach basic arithmetic, a little elementary geometry and very little algebra. They tended to regard mathematics in a compartmentalised manner. As Maureen had observed 'sums' were what mattered to them.

The rest of the afternoon was organised as a circus in which four small groups looked at commercially produced material on graphs and functions. When circus strategies were employed the team arranged the three rooms beforehand into workstations. Each workstation was labelled with an easily seen sign (usually a lettered card) and necessary resources were placed at
each station. Circulation was clearly indicated on the cover sheet, which was issued to the participants before the circus commenced [vide Appendix 6].

By organising circuses in this manner, which was based on experience with the AIMEC Project and INSET workshops conducted by the author in India, it was found that groups formed and worked efficiently with the minimum of confusion. Minor organisational problems were quickly sorted by the team who were always at hand and often joined small groups to offer advice and assistance. The team considered it extremely important to organise a circus well in advance and to use a cover sheet. The author was pleased to note, in later visits to schools, that the circus strategy had been adopted by some members. Rita Rigg, in particular, had used it extremely successfully and to the approval of her Head of Department [vide supra 6.71].

The activities of the circus in question included computer software. The team were surprised to find how few of the group had used a microcomputer before. A great deal of excitement and interest was generated by the microcomputer activities. The activities in which the members examined commercially produced written materials did not generate the critical discussion which was desired by the team. They concluded that a great deal more time and individual examination was required for such exercises to be worthwhile. Nevertheless, many of the teachers borrowed copies of the materials from the team and from the Mathematics Centre to study in their own time and to try out at school. This had the desirable effects of increasing the awareness of teachers and of encouraging an increased use of the facilities of the Centre by members and, in certain cases, by their colleagues from schools.

The team were by this time on extremely friendly terms with all members of the group and the group itself were becoming closely knit.

In casual conversation Rita Rigg revealed that her haste to depart at the end of the afternoons was to attend an evening class some miles away. The team had known this, from incidental conversations, for some weeks but had assumed that Rita was teaching the class. In fact she was attending the class to study for her GCE O level Mathematics. She said the RLPE INSET course was assisting her greatly in this.
Roy was still drifting from group to group and seemed to have great difficulty in concentrating on matters in hand or in co-operating with others. He was, however, a very keen contributor to discussions and often declared how valuable he was finding the programme. His focus of concern at that time was Records of Achievement and Profiling and he was extremely anxious to discuss the work he was doing on RSA Mathematics with the team and with others. The author encouraged Roy Brent to give a talk to the rest of the group on this matter and to lead a discussion. Roy had some initial doubt about his ability to do this but eventually agreed to make a contribution. The author was pleased that members were beginning to gain sufficient confidence to contribute more to the course. It was arranged that Roy would make his contribution in week 7. He was anxious to discuss his plans with the author beforehand and this was arranged for Week 6.

Thursday 19 March 1987: Week 6

After reviewing the activities of the previous week the team decided that the presentation and discussion of functions and graphs should continue. The two team members were aware that some of the teachers were experiencing difficulty in coping with the mathematical concepts involved but that most were keen to find out more. It was becoming obvious that as far as mathematical background and ability was concerned the teachers formed a 'mixed ability group'. To cater for this and to continue the process of increasing confidence it was decided to follow functions and graphs by starting to look at ways of teaching and learning basic numeracy. Percentages had been identified as a cause of concern by many of the teachers and this seemed to be a good topic with which to commence.

The short presentation on functions and graphs produced much pertinent discussion. The teachers appeared to have given quite some thought to the subject over the intervening week. This discussion continued after the teachers had been shown a video presentation *Teaching Functions and Graphs*, produced by JMB/Shell Centre [1985].

Over tea Barbara Charlton and Glynis Dobbs told the author that they had found the session extremely useful. They had both taught functions and graphs, in what they called the 'modern mathematics' fashion, for many years but, until that afternoon, they had not really understood what it was
about or why it was approached in that manner. They were now much happier about teaching these topics. Some of the less well qualified teachers also indicated that the treatment of content had helped them.

Jennifer Hall

'I found it (the INSET programme) very helpful because...........I mean........ my maths in my O level isn't particularly high.....and........I did find there are a lot of things on the syllabus now that I never actually covered when I was at school...........So it was a great help to hear some of these words and find out what they meant.'

In the second half of the afternoon Maureen introduced some ideas for teaching percentages, concentrating on motivating students by teaching from real life situations. Extracts relating to percentages from an Open University video recording *Working Mathematically with Low Attainers* was shown and discussed in the light of the members' own experience. All of the teachers had experience of teaching low attainers and two had considerable experience with special needs. The teachers were each given a package containing example lessons on percentages, and sample worksheets and questions. These were discussed and criticised in small group activities. This produced a considerable and useful interchange of ideas which the team found to be an important advantage of this type of INSET provision and which they encouraged. One other important advantage of this type of activity was found to be that teachers discovered that they were not alone in having particular teaching problems. To discuss difficulties and identify solutions, in a neutral location, with peers who were not school colleagues was crucial for increasing confidence [vide infra 7.6].

Thursday 26 March 1987: Week 7

Maureen Green took responsibility for planning and running the major part of the afternoon session, which was a continuation of the basic numeracy work commenced the previous week. In an introductory discussion Maureen considered approaches to teaching fractions. A circus of small group activities followed. The teachers were delighted to become aware of research work [Hart, 1981,1984] which they found relevant to their own
classroom practice and to discover a new and potentially useful piece of computer software (a spreadsheet).

The author's main activity of the afternoon was discussing with Roy the contribution the latter would make to the afternoon's programme. They had discussed this at some length the previous week but Roy still appeared extremely anxious about addressing his peers. He had collected a wealth of material to show the group and the main task of the early afternoon was to select and reduce this to reasonable proportions. In the event Roy gave a very useful and interesting talk on RSA Mathematics. He shared some of his experience of conducting that scheme with low ability, poorly motivated fifth formers. His talk was well received by the group and many, obviously in empathy with him, continued to question him after the session.

The team were well pleased with this participant input and suggested to the group that others should consider making future contributions, which would be encouraged and welcomed. As a result Barbara Charlton agreed to talk to the group about her experiences of using the Integrated Mathematics Scheme (IMS [Kaner, 1985]) in her school. She had mentioned this earlier in the discussion on fractions and others had shown an interest in discovering more about the scheme. Barbara was anxious to have some time to prepare this talk and for the team to advise her on the suitability of her plans. It was agreed that she would contribute early in the summer term.

**Thursday 2 April 1987: Week 8**

At this time the preparation and production of resources was well advanced and the team were able to review the programme in the knowledge that modifications to it could be accomplished expediently and easily. In many ways this was fortuitous since, on the previous Thursday the recommendations of the Working Group on the Shortage of Mathematics Teachers had been released to the press [vide Appendix 3]. During the following days Professor Bajpai and the author were busy responding to questions from the media and giving interviews to both press and radio. In fact this was beneficial to planning since it was instrumental in crystallising the author's ideas on teacher shortage and in prompting further critical evaluation of the RLPE INSET provision. Consequently the design and planning of Week 8 was conducted in a stimulating atmosphere; the work
seemingly more relevant and essential than ever.

Since the work on functions, graphs and fractions had revealed a possible inadequacy in the group's knowledge of the structure of numbers it was considered appropriate to commence Week 8 with a review of the Real Numbers. This began by considering some of the previous work and looked at integers, fractions and decimal fractions as members of the set of Real Numbers. This gave rise to a very fruitful discussion since some of the teachers had not used the terms Natural, Rational, Irrational and Real Numbers before and did not understand the relationship between them. The connection with functions and continuity was also discussed with some advantage. The small group activities which followed produced keen interest and were discussed very carefully. It was pleasing to observe some members, encouraged by Roy, turning to the microcomputer to investigate rational numbers as terminating or periodic/recurring decimal fractions. Practical exercises to investigate pi using cans, string and rulers also generated a great deal of discussion and interest. The programme began to run late but the team decided that it was worthwhile pursuing some of the activities for some time after tea.

The afternoon was completed by an exposition and whole group discussion on vectors, which had been identified by many of the members as a topic they would like to be included in the course. A number of them had taught some aspects of vectors but were not confident that they understood the basic concepts. The author intended that the session would be an introductory excursion into vectors, to be followed in later weeks by practical work. It seemed to provide an opportunity to tie up some loose ends from earlier work and to unify some ideas from number, algebra and geometry. He outlined the following aims and objectives as scene setters.

**Aims**

(i) To increase awareness of the role, development and use of Vectors in the teaching and learning of mathematics.

(ii) To consider the confusion which language, terminology and usage causes in the teaching and learning of Vectors.

(iii) To reduce confusion.
Objectives

(i) To introduce Vectors as a Mathematical Model.

(ii) To distinguish Vectors and Vector Quantities.

The main vehicle of the exposition and discussion was the following diagram, which was given as part of a package to each member and illustrated as an overhead projector transparency.

**VECTORS AS MATHEMATICAL MODELS**

![Diagram of vectors as mathematical models]

The exposition involved example of vector spaces with elements such as magic squares, matrices, sequences, arithmetic progressions and polynomials. This led to a discussion of the Euclidean plane, points, lines, line segments and directed line segments and thus to geometrical vectors.

Maureen Green writes in her diary:

"PKA gave an introduction to Geometrical Vectors in the setting of Vector Spaces using several other examples of these to illustrate the main properties. Many members found this rather difficult, but nevertheless appreciated this extension of their own knowledge."


In fact, a number of members referred to this session on vectors when the author interviewed them in their schools.
"I tell you what I found really helpful .... Vectors..... because I never really ...... was very good... understand......... understood it correctly...... That was great... it was a great help."

Ursula Tripp (Interview: 3 March 1988).

The questions and discussion which were generated by both of the topics treated in the afternoon caused the planned programme to over-run. The team decided to allow this under the circumstances as they judged this to be worthwhile. This supports the notion that planning, action and evaluation were regarded as parallel processes (or that the period of a possible cycle through plans, action and reflection was extremely short and that many such cycles were completed in the course of one afternoon). In the prevailing situation to have adhered rigidly to preconceived, prescriptive plans would have been restrictive, if not destructive. The analysis of the afternoon's activities indicated that there was a need to look further at vectors and to re-examine basic concepts with the members. It was decided that this should be delayed for some time so that the teachers were not overloaded with information on one area in a short space of time. As the programme proceeded goals were constantly being reformulated but it was found that certain general aims were emerging from the analysis of observed data. To increase awareness and confidence were becoming more important goals than a goal that teachers learn mathematical content. The disparity of mathematical knowledge, backgrounds and abilities precluded the latter and suggested that a variety of different INSET provisions would be needed to achieve that particular goal. Using the former goals as navigational guides it seemed appropriate that the next session should be somewhat different in content and approach. In this instance long term and short term planning and design conveniently matched and produced little organisational difficulty and re-organisation.

Thursday 9 April 1987: Week 9

This was to be the last session of the Spring term and it had been planned for some time to complete the term with something rather different from the preceding weeks. David Green had assumed major responsibility for planning the content of this session, which was to revolve around Statistics, but would stress process more than content. The approach was to be practical, using a number of resources including computer software.
After an introduction by David Green entitled 'What is Statistics?' the teachers were formed into small groups, which circulated around pre-prepared workstations in the Mathematics Centre to undertake practical exercises on visual discrimination. These activities required the teachers to collect, collate and analyse data.

The second half of the afternoon involved the teachers in experimental work. One experiment made considerable use of the microcomputer facilities. Members studied various distributions by physically tossing coins and then compared these with a computer simulation purporting to be 'fair' coin tossing. Important concepts of randomness, fairness, bias, run length etc. were introduced in a practical manner. The software was selected from a package (MICROCOSM Project) produce by CAMET. A copy of this package was given to each participant for use in their own schools. It was observed that members were becoming increasingly confident in using microcomputers. This appeared to be a significant effect of the INSET scheme.

A second experiment tested various hypotheses about the contents of tubes of 'Smarties'. This activity was extremely successful and produced a great deal of useful discussion about statistics. In subsequent weeks many members reported that they had tried this experiment successfully in their own classrooms. It appeared to have had the desired effect of introducing more practical work into classrooms. One member reported some resistance. This time from a parent, who had enquired suspiciously why sweets were replacing mathematics in the classroom.

The three members of the team observed much keen participation, debate and enjoyment by the teachers during the afternoon's activities. The group of teachers welcomed a fresh face to the team and responded well. The team had been required to provide considerable guidance and advice to members once data had been collected and questions in the plenary session were mainly focused on treatment of data. This plenary session produced very useful discussion. Analysis of data was a weak point with almost all the teachers.

David thought that much insight was generated in the teachers as a result of
the activities of the afternoon and wrote:

"My overall impression was of a highly successful day, but at a fairly superficial level. Further time might have been usefully spent going over the statistical content of the day's activities to bring out more essential features".

The two members of the team who were more familiar with the group were not as surprised by this as David, since they were aware of the mathematical background of the teachers.

5.53 Mid-Course Correction

The three week Easter break was opportune since it allowed the team to reflect on the programme and to modify plans accordingly. It was becoming clear from the analysis of the data collected by participant observation that this group of teachers, most of whom would fit neatly into the category described by DES as the 'hidden' shortage, was far from homogeneous. This diverse nature of the 'hidden' shortage is more significant than, perhaps, DES and other authorities might anticipate. It cannot be described simply in terms of qualifications, in the fashion of paragraph 625 of the Cockcroft Report [Department of Education and Science, 1982]. Qualifications (mathematical and other), experience, position, schools, colleagues, aspirations, attitudes, confidence, awareness etc. are all attributes which describe categories of hidden shortage.

Once again the press was influential in prompting such analysis and review, since towards the end of April the author was preparing an interview with The Times on the ways Loughborough University was tackling the problems of teacher shortage in mathematics. The interview was reported in a special report on 18 May, 1987. It is important to highlight this aspect to provide the reflexivity and indexicality which it has been suggested are essential in a research report of this nature. It certainly encouraged the process of continuous evaluation and influenced design and development of the INSET scheme. As previously suggested in the introduction to this chapter, external influences of this kind are not always recognised, or afforded sufficient significance, in the analysis of 'naturalistic' curriculum development [vide infra 9.2].
The team considered the observations of the recent contributor, David Green, at some length. He had suggested that the session he had designed might have been modified to allow more time for 'going over' content. All members of the team had observed that the teachers had weaknesses as far as mathematical content was concerned. The programme had not been directed to improving the mathematical knowledge of the participants in depth and it had not concentrated on mathematical content. After much deliberation it was decided that the course should not be reoriented in that direction. The group was far too mixed in many of the senses outlined in the paragraph above for such a change of direction to be feasible. There was an identified need to improve individual mathematical knowledge and skills but a different type of provision would be needed. Enhanced awareness and raised affective levels were judged to be more important for this provision. Indeed the data which was being collected reinforced the author's view that pre-determined aims and 'means-ends' approaches were entirely unsuitable and unworkable for this type of INSET provision. Goals were emerging but these, like the theories advocated by Glaser and Strauss, were grounded in data. In fact, goals might well be regarded as grounded theory. Data also suggested that the team were designing and developing the programme in a non-linear fashion. The observed design and development process could be modelled either, by interlocking and interacting cycles of varying periodicity, or by parallel processing. This is developed as theory later.

Data also suggests that situations change frequently, quickly and unpredictably and that, if design is based on situational analysis, prescription and prediction will be ephemeral, if not ethereal. Changing situations often demand that plans are formulated for expediency or convenience. Naturalistic INSET (curriculum) development is not as neat as many models would suggest. Situational analysis, perceived needs, expediency and convenience certainly played their parts in the design of the next phase of the RLPE INSET scheme. In fact staff availability turned out to be extremely convenient for designing the next phase and matched need closely.

The author was anxious to increase the size of the team and to distribute their individual input to maintain the variety which he judged would raise the
affective levels of the participant teachers. These levels were already high if attendance patterns were a valid indicator. For instance the attendance on the last afternoon of the Spring term, halfway through the main course, was 20 members out of a possible 21. The previous two afternoons had seen attendances of 19 and 20 respectively. The absentees were different in each week. Group and individual attendance figures were high throughout the Spring term. Nevertheless, the contribution David Green had made to the last session seemed to suggest that the members welcomed a new face and approach from time to time. Fortunately all members of the Loughborough team were able to contribute to the Summer term and this facilitated planning.

Data collected by informal conversation with members, often over tea, had indicated that some of the teachers wished to consider the mathematical needs of low attainers and learning difficulties more closely. As a result it was decided to include these areas in the summer term but, because of the structure of the group, to widen the theme to include other individual learning characteristics such as gender and language. This would interlace the work which had already been started and which would continue. George and Philip had some experience and expertise in these ‘theme’ areas and they planned appropriate activities. The author had also consulted the Mathematics Inspector about a possible visit by the teachers to a school in Rurishire, where he knew a teacher had conducted interesting work related to mathematics for low attainers. Part of that work had been the construction of a ‘Mathematics Garden’-by students of the school. A visit to the school would provide a unique opportunity to show the teachers new approaches to teaching mathematics. The Inspector thought that such a visit would be an excellent idea and agreed to contact the teacher concerned and her school and to make the necessary arrangements.

5.54 Onward: The Next Four Weeks

Thursday 30 April 1987: Week 10

It had been decided that, in the opening session of the summer term at Midchester, George Abbott would discuss the issues of gender in mathematics teaching and learning. This would enable a new member of the Loughborough team to be introduced to the programme and would begin
the theme related to individual learning needs.

Observing the afternoon's events proved to be academically and socially interesting and stresses the dangers of placing contributors to INSET programmes in the role of 'college expert'. With hindsight gender differences may have been an unfortunate subject for George to tackle with them on first contact. It appeared to be regarded by many of the members as; either a theoretical issue which was irrelevant to their classrooms, or a matter with which they were very familiar and not enhanced by statistical data or research evidence.

It may also have been preferable for George to make his initial contribution in the second half of the afternoon. The author had observed that when the teachers arrived at Midchester on that afternoon they had greeted each other, Maureen and himself excitedly. They were obviously pleased to be back at the Centre. There was some concern that Rita Rigg was not present and as many knew of her teaching situation they were concerned that she might not be able to continue to attend. The members appeared to be forming an even more closely knit family group than previous observation had suggested. The author concludes that George was introduced into this situation as an outsider. This together with the topic of his contribution, which was somewhat more theoretically based than many previous inputs to the course, prompted the teachers to cast him in the role of 'educationalist' or 'college expert'. It must be emphasised that this role casting appeared to have little to do with George himself since, in the next two sessions in which he was involved, he was unreservedly accepted as a member of the 'family' and the teachers found his work extremely relevant and valuable.

It is also interesting to note that in the questionnaire survey no teacher commented on the session on gender and in the interviews only one teacher mentioned it. The particular interview referred to does provide some important data and illustrates a degree of teacher resistance, not to say chauvinism, associated with the topic.

PKA

And did our course meet your needs at all?
Laurence
Oh yes..... very much so..... I did.......emmm... in some cases... I mean it is easy to say about the good things which were very good and very adequate but there were one or two topics which I found were..... if anything.. irrelevant..... em..... I think I've already mentioned...... I thought the em.......distinction of gender was ...emmm..... unnecessary ... if I.... I em...you know riled a little bit as our friend was talking er... I didn't feel it necessary... I felt I wanted to get on with numbers and maths... and shapes and patterns and not the possibility that women weren't taking up maths err..... perhaps they are not..... perhaps they ought to do too but I didn't want to talk about it then but...... maybe I'm wrong emm..........

PKA
Was that something to do with you being a careers teacher anyway?

Laurence
I don't think so... no I don't think so... no ... I do em... we do try to kill this prejudice or indoctrination or conditioning .. is that the phrase about women in careers but em...... err...... it is being done ... I don't think it's necessary any more than there ... in fact I think it's adequately covered now .... em... I think we're giving ... You know, women aren't taking their place in society generally are they ... are they?... Perhaps they are because they are mothers but in....... you take the number of women MP's... the number of women in the judiciary ... the number of women in many many fields except teaching and there is not enough of them but er... we must encourage them but I did think that that particular aspect of it was encouraging... perhaps it was necessary to tell some teachers this to encourage them to encourage women to take part but to me it wasn't necessary....no.

The second half of the afternoon was directed by Maureen who briefly introduced some of her ideas on teaching Ratio and Proportion. The teachers then separated into small groups, each of which tried three activities related to ratio and proportion. The first was a modelling exercise, the second a practical activity involving gears (Meccano, LEGO and Technical LEGO) and the third a look at a package of cross-curricula mathematics exercises. The groups worked well at these activities and made particularly significant progress with the gears. Many teachers later reported using this practical work in their classrooms, borrowing equipment from their school CDT departments. This seems to have encouraged some degree of
cross curricula activity in schools. It was pleasing to observe that many of the teachers took a practical approach to the modelling exercise by employing the sets of 'multicubes' which were available in the storeroom of the Centre. Earlier the Mathematics Inspector had given each member a set of these 'multicubes' to take back to their schools.

A number of parallel and connected events influenced planning and evaluation at this stage. On 30 April, 1987 the Secretary of State for Education and Science wrote Professor Bajpai in response to the recommendations of the Working Group [vide Appendix 3]. The Minister of State, DES and the Parliamentary Under-Secretary of State for Higher Education also responded soon afterwards. The Secretary of State referred to the series of DES sponsored regional conferences on the problems of teacher shortage which would take place in the near future. On the same day, because of the work the author and his colleagues had done to meet the problems of teacher shortage, the author was invited to attend the DES sponsored conference to be held on 4 June at Manchester Polytechnic and to submit a paper [Goodwin et al., 1987].

The invitation was seen as an ideal opportunity not only to describe the work to a wide audience but also to review and evaluate the programme so far. It was decided that Professor Bajpai, Owen Eastwood and the author would prepare a joint paper, based on discussions between themselves and other members of the Loughborough and Rurishire teams. The paper was accepted by organisers of the conference and circulated by them later in May. Unfortunately the conference had, by that time, been postponed until September because of the recently announced General Election. The paper is a most useful indicator of the evaluation which took place at that time since it includes contributions from the Loughborough team and the Rurishire Inspectorate. The following extract is particularly interesting in this respect;

"It was apparent that existing INSET schemes were not catering for the teachers involved and that a specially designed programme was required for a group who soon proved to be highly motivated, receptive and adaptable. An encouraging indication of these qualities in the participants (and, perhaps, the effectiveness of the design model chosen) is that the 'drop-out' rate more than halfway through the
programme is zero and promises to remain near or at that level. Reactions from schools, ascertained by the Mathematics Inspectorate, have been very favourable. The teachers have now become almost obsessive resource borrowers from the Mathematics Centre and more than one HOD has been pressurised to purchase new material and learning aids. Participants report back regularly that they have used the strategies and resources to which they have been introduced in the course and provide useful criticism of these.

Thursday 7 May 1987: Week 11

Further data on which evaluation might be based was obtained when the Loughborough team visited Midchester on 7 May. Over lunch Owen Eastwood, the Mathematics Inspector reported that the programme continued to be well received in schools. His visits to schools had identified a need to provide INSET for (i) mathematics teachers who had not had the benefit of such provision for many years and (ii) for deputy heads and senior staff who tended to teach mathematics because slots remained in the school timetables after all other staff had been allocated teaching duties. He asked the author to consider designing and providing a suitable INSET programme from September, 1987.

Barbara Charlton commenced the afternoon by giving a very clear account of the Integrated Mathematics Scheme (IMS). She gave the members an opportunity to look at the relevant texts and answered questions on her own experience of using IMS and other mathematics schemes. The teachers responded positively to one of their number leading an activity and a lively discussion ensued. Other teachers described schemes with which they were familiar such as SMP 11 to 16 [1985]. A number of the teachers borrowed copies of the texts from the Centre and were given addresses from where further information on IMS and other schemes could be obtained.

Derek was extremely interested and continued to ask questions of Barbara and the team for the rest of the afternoon. He was always seeking ways of assisting him to cope with his low attaining teachers and at times appeared almost desperate and extremely isolated. This is illustrated by an extract from the interview the author conducted with Derek Castle in March 1988.
PKA

So it's ideas you want?

Derek

It is......definitely.......and money...(laughs)..but................No, I must admit that .....the mathematics department...here......Mr Johnson in particular .....very ,very helpful, so is Don..........They'll go out of their way to help you........er ........The difficulty I find is....if I see something...."Oh, I wouldn't mind having a go at that "......"There's no money for it!"( almost sighing as he said this).I can't, I can't do that,so.... I've got to use what facilities we've got...which are fairly good......er....but I need help, now, with knowing what equipment, or books, or whatever....I could ....go armed with......to the Headmaster, if necessary,and say, "Look, I think if I had these, or this, then we could do something with these children" (sigh).............................

And to round up......I think that (slowly .as if weighing his words carefully) this level of child is being..........ignored.

There's not many people want to know about them...they're forgetting them...even from the Secretary.....of State for Education, himself.....It's all the way down...........................................

Mention it...."No, we need money for the top levels...They've got to get through their examinations. They've got to do GCSE. We need textbooks for them"......and this level of child is not cater...not being catered for adequately. ......No, I think that's pretty general, but....er.......That's the impression I get here... Not just in Mathematics. In all subjects.....They're pushed to the bottom and they are.........not foisted onto...but they are certainly given teachers....who are not experienced with those children.....

And this is the position, I feel, that I am in. I've been given these children...not that I object to that....at all........but I am not really qualified ....to teach these children.........and that's why I say that the.....It's foisted onto....to any teacher, who's just there at the time......rather than a constructive...er..... syllabus or methods have been worked out for them......Just playing at it...........Well, I don't know how.....what percentage does it amount to?... About six or seven percent of...er... population, isn't it?....Must be an awful lot of children.......They're just being put to one side, and not helped......................

The following activity extended the previous work on vectors and relied heavily on the notion of the mathematical model and modelling. It was designed to relate geometric vectors and algebraic vectors. To do this small discussion groups studied GCSE syllabuses and various extracts from publications on the teaching and learning of vectors and matrices. In a plenary session the author suggested that in teaching these topics it would be advantageous to take a unifying approach so that geometric and algebraic vectors were treated as mutual models which could be used to model physical and non-physical phenomena. Some members immediately appreciated the value of this approach and joined in the discussion enthusiastically. Others were obviously not familiar with the topics and had never taught them. This had been anticipated and after tea, in a discussion/exposition, entitled 'Geometric to Algebraic Vectors', the author spent some time dealing with the topics and with points of difficulty which members' questions indicated.

A practical modelling exercise on vectors followed in which the teachers were required to use geometric vectors to model forces. This was received extremely well and appeared to clarify further a number of points already discussed. From observation of this exercise and from comments made by the members it seemed that the teachers saw that the model concept was valuable in a learning situation. The exercise was in fact the familiar 'triangle of forces' in reverse. At a recent conference the author was dismayed to hear an invited speaker on practical mathematics declare that he thought that exercises of this kind should not be used "because they give the wrong answers". He appeared not to regard practical work in any modelling sense and seemed to think that vectors and physical phenomena, such as forces, were the same things. The exercise observed at Midchester illustrated that it was the very fact that "triangle of forces gives the 'wrong' answer" which makes it valuable. The teachers came to realise the difference between models and the real world, to question assumptions and to identify the limitations of mathematical models. The enthusiastic discussions demonstrated that the teachers were developing modelling skills. There was much debate about what variables were important and how the model might be improved. The exercise was far from the traditional 'cook book' version of 'triangle of forces'.

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Thursday 14 May 1987: Week 12

The whole of this afternoon was devoted to the learning and teaching of Geometry. The activities were designed by George Abbott, after discussions with the author, who encouraged him to take a varied and practical approach. The session was led by George with Maureen and the author assisting in discussion groups and workshops. The teachers were asked to carry out a variety simple practical geometrical tasks. One of these tasks introduced the teachers to LOGO [Hoyles et al., 1987], which was a new discovery for almost all of them.

The great variety of activities and geometrical tasks were greeted with enthusiasm by the members who participated to the full. The enthusiasm which George demonstrated, and the relationships he established with the teachers, contributed significantly to the success of the afternoon. The teachers were much happier with work which they could relate to classroom practice than with the theoretical issues George had discussed in an earlier afternoon session.

Derek reported the difficulties he was experiencing in schools in persuading senior staff to purchase texts he had encountered during the INSET course. Financial restraint appeared to be the major obstacle although he indicated that his position as a teacher of the less able also meant that some of his recommendations were not treated as seriously as he would have liked. He had ordered quite a number of texts to use in his classrooms himself and was prepared to pay for these from his own pocket.

The author observed that members, including Derek, were making increasing use of the borrowing facilities of the Mathematics Centre, especially of items highlighted as part of the course. The Shell Centre package 'Functions and Graphs' [Joint Matriculation Board et al., 1985] was very popular. Brenda Burton had asked the author if he could recommend books on the history of mathematics and he was pleased to lend her copies from the CAMET library. Mark Davis raised the possibility of undertaking an inventory of mathematical resources in Rurishire schools. In subsequent talks with the Mathematics Inspector it was agreed that Mark would be seconded from his school, on a part-time basis, to do this work. These developments were pleasing outcomes of the RLPE INSET scheme.
Thursday 21 May 1987: Week 13

It had been planned to commence the afternoon with a talk by a representative from Royal Society of Arts Examination Board. This had been suggested by Roy Brent who had agreed to arrange the visit. In the event Roy was late and the programme was rearranged. Instead the first activities of the afternoon involved the members investigating, discussing and criticising resource material related to mathematics for low attainers. This material included commercially produced packages and journals (for example, Struggle). The work of ILEA and material from SMILE and the West Sussex Institute of Higher Education were prominent features.

Although this activity was closely related to needs, which had been stressed by many members, the enthusiasm and interest were not as high as in previous weeks. The author observed that the teachers had difficulty in criticising the material and concluded that they did not have sufficient time to acquaint themselves with it. Later comments indicated that the teachers did not like this type of exercise. Perhaps, because of this some members drifted to tea rather more quickly than usual. This was encouraged because three teachers had to leave early because of commitments at their schools. This was coincidental but it had the effect of disrupting groups and extinguishing discussion. It was unfortunate, therefore that Roy Brent and John Purchase from RSA arrived just before tea. Arrangements appeared not to have gone to plan at Roy's school, which John had visited. Additionally John had another urgent engagement and was only able to speak briefly to a few members who were 'captured' before going to tea. This was all most unfortunate but beyond the control of the Loughborough team by that stage. This could have been a most useful session. In the event all was not lost because John was able to leave sufficient literature for each member to become acquainted with the work RSA was undertaking in respect of TVEI and 'Assessment Across the Curriculum'. This included profiling and integrated awards.

After tea a smaller group than usual looked at Matrices and Transformations. The author and the teachers discussed how items in GCSE syllabuses; such as functions, vectors, matrices, simultaneous equations and transformations could be integrated to effect a unified approach in teaching and learning. Following this the teachers worked at activities including CAL software,
produced commercially and at CAMET [Green, 1986], which was related to transformations and matrices. Each participant was given a package describing applications of matrices in various fields. There was a positive response to this material and it was observed that much of the content was new and exciting to the teachers. Their comments indicated that those who had taught matrices before had tended to take a rather 'dry', algorithmic approach based on rules of manipulation. Matrices were usually treated in isolation from other mathematical topics and were identified more with arithmetic than algebra, geometry and applications.

The author had observed that when the teachers were becoming a little restless in looking at resource material in the first part of the afternoon Mark had taken the opportunity to demonstrate some magical tricks which he used with his own pupils. The next day he wrote the author:

"Presented as magical tricks, mathematics can be subtly introduced into lessons in a form that attracts the interest of even the least able and least willing!

Several course members have already made contributions from the front. If you feel that there is still time available within this course - assuming you feel there is merit in my argument - I would be willing to lead a 45 minute session. This would have the aim of helping my colleagues discover the fun and value of using 'magical maths' themselves."

Mark Davis (22 May, 1987).

This offer was, of course, welcomed and accepted by the author. It provides evidence that the programme was becoming interactive and that members had the confidence to exchange mathematical and teaching ideas with each other and the Loughborough team. It also has implications for design and planning. From a potentially weak session an opportunity had presented itself for changing the programme in a very worthwhile manner. It again demonstrates that rigid pre-determined aims and objectives are often restrictive. The rapidly cycling design model continued to evolve [vide infra 9.34] and appear more useful than classical prescriptive models [vide Appendix 4].
5.55 Review

The Rurishire mid-term Summer break provided a convenient opportunity for the team to reflect on the work at Midchester and to finalise plans for the next 6 sessions. Contributions by Philip Dean, George Abbott and David Green were already planned as was the visit to the 'Mathematics Garden'. Discussions with participants had revealed a need to look at the use and role of calculators in mathematics classrooms and Maureen and the author agreed to develop work for this. Participants were also anxious to continue work on practical mathematics and Maureen agreed to look at this area. The contribution from Mark Davis was also included in the plans which emerged.

On Wednesday 3 June, 1987 Owen Eastwood and a new member of his advisory team, Marianne, visited Loughborough to discuss arrangements for the RLPE INSET residential week-end with the author and Professor Bajpai. It was agreed to hold the residential week-end at Loughborough University in September, 1987. Possible certification for teachers who had taken part in the scheme was an item on the agenda. The opportunity was taken to discuss future INSET schemes which the Inspector proposed CAMET might provide for Rurishire.

The author also discussed how the Rurishire Inspectorate might assist the evaluation of the RLPE INSET scheme. The Inspector promised to arrange for his colleagues to be involved in this evaluation exercise. He confirmed that he had, in fact, been evaluating the programme as it proceeded, in the same manner as the author. He was well pleased with its progress. He was still delighted that all the teachers were attending on a regular basis.

5.56 The Coda: The Last Six Weeks

Thursday 4 June, 1987: Week 14

Philip had indicated that he would prefer to work alone that afternoon. The author agreed to this but travelled to Midchester in case he was needed in an emergency. This enabled the author to continue discussion concerning the residential week-end and future INSET activities with the Inspector.
The author did not observe the activities of the afternoon but he had discussed the work, which Philip intended to do, prior to the session. He had asked Philip to provide a report of the afternoon's activities. Philip had planned to look at learning difficulties in mathematics. To do this he decided to divide the afternoon into two sessions. He had chosen to use the following aims and objectives.

**Session 1**

**Aims**

To achieve a deeper understanding of why difficulties occur.

**Objectives**

(i) To explore the feelings of pupils who are failing in mathematics.

(ii) To consider how negative feelings might be changed to positive ones.

**Session 2**

**Aims**

To examine the learning process in mathematics for the less able.

**Objectives**

(i) To explore issues of concept development.

(ii) To consider the issue of learning difficulty in relation to problem solving.

Philip gave a general introductory talk on learning difficulties and then the teachers held a number of small group discussions based on questionnaires they were asked to complete. Short video extracts were used to illustrate certain discussion points. A plenary session completed the sessions.

Commenting on the afternoon Philip Dean writes;
"Although there were no particular difficulties I felt that this session was the least satisfactory of those I have been involved in. This was partly due to the nature of the material and partly changes within the group since my earlier involvement (sessions 1, 2 and 3). The most pleasing part was the final 30 minutes when group members spoke freely about their feelings on the course so far."

Thursday 11 June 1987: Week 15

Only Philip Dean and George Abbott attended this week and once again the author was unable to observe. Philip had discussed his observations of the last week with the author and the original plans he had made for the third part of his work on Learning Difficulties were radically altered. It was agreed that the previous work had not used the experience of the teachers sufficiently and thus had not appeared as relevant to their teaching as it might have. Philip's programme, which would occupy the first half of the afternoon, became:

Session 3 (Modified Version)

Aim

To exchange ideas and to explore attitudes related to Learning Difficulties in Mathematics.

Objectives

(i) To prepare, as part of a role playing exercise/workshop, outline schemes of work, assessment programmes and teaching/learning approaches for students who have learning difficulties in mathematics.

(ii) To consider areas of interest concerning Learning Difficulties in Mathematics which are of particular interest to you and other members.
Implementation

Part 1: Large Group Discussion (15 min)

Part 2: Small Group Activity (75 min)

Part 3: Plenary Session (30 min)

Philip Dean comments;
"As a result of the previous week's discussions I changed the format and made the workshop tasks more routine and realistic, this seemed to work. These were preceded by a 50 minute discussion on learning difficulties between group members, this was excellent. I felt much more satisfied about this week's work."

This review and change of plans is a good illustration of the design procedures which the team adopted. Situations, goals, content and methods were constantly monitored and modified.

After tea George reviewed the work he had done with the group on Gender and Geometry. He completed the afternoon with a session on 'Language in Mathematics Teaching and Learning'.

Reflecting on the work both members of the team were extremely satisfied and pleased with the outcomes. They judged the afternoon to have been very successful and comments from members appear to confirm this.

Thursday 18 June 1987: Week 16

David Green took responsibility for planning and leading this session. Maureen Green and the author attended in support. The theme of the day was Probability. The afternoon commenced with a short introductory talk by David, on chance and probability concepts in school children aged 11 to 16. This lead into a 'Computer Prediction Game' in which the whole group attempted to predict which of two symbols (" or \(\checkmark\)) would be displayed on a large computer monitor. The symbols were generated randomly according to a fixed proportion. David was not altogether happy with this introduction, which he thought took too long to complete and he suggested afterwards
that a shortened simpler version should be designed. He wrote;

'The psychological nature of the activity precluded explanations being given before completion of the experiment......Although some useful analysis of the results was achieved there was inadequate time to do this fully.'

The main part of the afternoon involved 7 small group activities which were organised as a circus. These activities included computer simulations, practical work and three person games. David was happier with these activities, which he thought were quite successful. In the following plenary session the members indicated that they had enjoyed the afternoon's work and had found it interesting and valuable.

David judged the afternoon to have been a useful practical activity but rather lacking in terms of analysis. Maureen and the author, after speaking to many members and observing the activities, both concluded that the day had been extremely successful and, given the mathematical backgrounds of many of the teachers, they were not surprised that the activities had resulted in limited analytical work.

**Thursday 25 June 1987: Week 17**

The venue was temporarily changed for this afternoon. The teachers joined Maureen Green and the author at Benton School and Community College, Ruriston. Joan Warwick was a teacher at the school and she had made excellent arrangements to accommodate the visitors. The afternoon provided a unique opportunity to meet an inspired and inspiring teacher, who was Head of Social Studies at Benton School [Barthorpe, 1986]. The Social Studies Department had 'harnessed' itself with the Mathematics Department to cater for the needs of children who were unlikely to attain more than Grade 3 in CSE Mathematics and CSE Community Services. Over ten years she had developed a number of practical projects which combined Mathematics with Community Service. These included decorating the local village hall, building adventure playgrounds, clearing graveyards and painting murals in bus-stops. The most recent project involved the construction of a 'Mathematics Garden' at a nearby mental hospital. The teachers travelled to see this garden during the afternoon, where they took
the opportunity to discuss with the teacher the mathematics which she thought the children had used and learned.

After visiting the hospital the Head of Social Studies described a current project involving Mathematics in Traffic Education (MITE). The teachers were impressed and enthused by the project approach and asked many pertinent and probing questions. The members of the Loughborough team were pleased that the visit had reinforced some of the work they had previously undertaken to promote practical work in mathematics. The element of field study involved in the 'Mathematics Garden' was welcomed. This reflected some of the suggestions which had already been made to the participant teachers by the Loughborough team. A surveying exercise planned for the final session at Midchester would continue this theme of field study.

The author had arranged with Mark Davis that the latter should conclude the afternoon by presenting a paper, entitled 'Mathemagic' and by demonstrating some of his 'magic' tricks. His contribution was well received and, in the following discussions, the members concluded that this approach and the tricks involved would be useful with low attainers in mathematics and other special needs children. The Loughborough team thought that this might not work for all teachers. Mark succeeded because of his personality and enthusiasm. The weakness was that Mark was unable to follow up many of his tricks with a mathematical explanation. The author offered to supply some of these in written form the following week and did so. This provided an opportunity for the author to demonstrate the usefulness of sets, matrices and transformations and to demonstrate how these tricks might be used as the basis of investigational work. These were welcomed by the group and by Mark.

Thursday 2 July 1987: Week 18

A number of incidental comments by members during the course of the INSET programme led the author and the Loughborough team to believe that many of the teachers were concerned about the role and use of calculators in the mathematics classroom. There was a degree of resistance, from a number of members, to the use of calculators in mathematics classrooms and most of the group had not considered the role of calculators to any extent. The team had been discussing amongst themselves a
possible session on calculators for some time. Maureen had designed a programme and prepared resource packages related to this. She was a little concerned that it might be a little late to introduce calculator work but after some discussion the team agreed it was necessary to devote a whole afternoon to this aspect.

The author began the afternoon by giving the teachers written explanations (in mathematical terms) of some of the 'Mathemagic' tricks which Mark had demonstrated the previous week. There was a very brief discussion on these but the author suggested that individuals who were interested might care to raise points and questions with him during the course of the afternoon. He also had brought along information on Mathematics Attainment Tests and their availability, which he gave to the teachers. There had been expressions of interest in these as a result of previous activities. During the course of the afternoon the author was able to discuss the 'Mathemagic' papers and Attainment Tests with interested members of the group.

Maureen then distributed copies of the 'Calculator Packages' she had prepared and gave a short introduction to the work of the afternoon; 'Calculators in the Mathematics Classroom'. Following this the teachers divided into four groups to carry out role playing exercises. These were designed to increase the awareness of teachers to the attitudes they were likely to encounter from colleagues when the issue of calculators in the mathematics classroom was discussed. In addition it was hoped that the members would question their own attitudes, and perhaps change those which tended to be negative.

The points raised in the role playing exercises were listed by each group for later discussion in a plenary session. The groups were asked also to discuss the differences, if any, which calculators had made to their own classrooms and to summarise these differences for the plenary session.

The role playing exercises were difficult for some members, although others quickly adapted to the roles they were asked to play. Maureen writes in her diary:

"The participants were rather more inhibited than I had expected in the role-playing exercise, but most of their fears, and prejudices, concerning
the use of calculators did surface in the subsequent discussions.*

The plenary session was lively and it appeared that members were questioning and modifying their own attitudes and beliefs, which many had not realised they held.

The teachers again divided into small groups and for 45 minutes they used a worksheet called 'Getting to know your Calculator'. Each group was given a variety of calculators and some members had brought along their own, following a plea by Maureen the week before. There was a great deal of discussion and the two members of the team were fully occupied explaining technical points and joining in the lively debates. This exercise proved to be far more valuable and necessary than the team had anticipated. It revealed that several teachers could not use even a simple calculator, with basic keys, with any confidence. Most members had not previously realised that there are major differences between calculators and their modes of operation.

Over tea the team discussed the programme and decided to change the order because of what they had observed during the afternoon. It was decided to view a video immediately after tea. This showed calculators being used in mathematics classrooms. In the discussion which followed members expressed doubts about the value of calculators in the teaching of the algebra with which they were familiar. It emerged that most members had only been aware of traditional algorithmic methods for solving equations and sets of equations. The notions that some equations could not be solved analytically, and that equations could be solved numerically, were new and strange to them.

The teachers were extremely interested in the Loughborough packages and in the other publications on calculators which the team showed them. It was clear that most of the teachers had been unaware of such material but that they intended to make use of it in the immediate future. The teachers explored and investigated the material for rather longer than the team had envisaged but it was considered well worthwhile that extra time should be devoted to this activity.
The groups eventually reformed to look at some other ideas contained in the Loughborough packages. These were mainly related to arithmetic, algebra and investigational work. Very fruitful discussions ensued, which were continued after the official session had finished. A number of members were quite late leaving that evening. The team were surprised to observe how necessary the afternoon's work had been but gratified with the response from the teachers, which suggested that some changes in classroom practice might be implemented almost immediately.

Thursday 9 July, 1987: Week 19

The regular lunchtime meeting between the Loughborough Team and the Mathematics Advisory Team had proved to be an important aspect of the design, planning and evaluation processes of the RLPE INSET scheme. For some time the Mathematics Inspector and the author had been forming plans for the residential session, the on-going programme and a continuing evaluation process. The first part of the final afternoon at Midchester was arranged as a direct result of these regular meetings. The Inspector thought it would be an excellent idea to include a reception on the last afternoon. He had been reinforced in this view by independent approaches to him by members of the group, who wished to express their thanks and appreciation for the INSET opportunity. The Loughborough team, quite coincidently and independently, had suggested that they would like to provide a reception to express their gratitude to the teacher participants and the Rurishire Advisory Team for their support and enthusiasm over the last two terms. Since there was much mutual agreement it was decided to organise a reception before the main INSET activities of the final afternoon commenced.

The reception was extremely successful and welcomed by all. A presentation was made to the Loughborough team (that is, Maureen Green and the author) by Barbara Charlton, on behalf of the participants. She expressed the thanks of the participants for what she described as a most useful and successful INSET provision and she hoped that this would continue for the current members and that it would be extended to other teachers in the county. Other participants spoke to support these views. The Inspector spoke of his satisfaction with the INSET scheme and he also hoped the provision would continue. The author took the opportunity to thank the members and the local authority for their valuable support and
contribution to the success of the course.

From the author's point of view the reception was extremely useful in providing more valuable data by which evaluation and analysis could be enhanced. Importantly it served another purpose in raising the affective levels of the teacher in respect of the residential part of the programme and the on-going provision. The teachers had become an extremely closely knit group in which members supported each other. The speakers indicated that they wished to maintain and protect this aspect of the provision.

The main activity of the afternoon reflected the Practical Work in Mathematics which had been emphasised throughout the programme. The activity consisted of a set of 'surveying' exercises which incorporated practical work and problem solving. These had evolved from work which had been conducted for many years with the AIMEC Project, both in the UK and in India, in which the modelling philosophy was emphasised rather than a more traditional techniques and skills approach. Maureen had used many of the exercises with children in schools and was able to offer valuable design advice in the preparation of a package of twelve exercises which was given to the participants. This included an appendix describing resources for surveying in schools and explaining how simple apparatus could be constructed. Discussions revealed that only one of the participants of the RLPE INSET scheme had done any surveying exercises in schools before, although many were aware of surveying equipment which was stored, unused, in their own schools.

Everyone joined in this practical field work with enthusiasm and, although problem solving and modelling were emphasised, observation suggested that the teachers' understanding of techniques such as the 'offset method' and 'triangulation' and their skills in using the simple surveying apparatus provided increased significantly as they carried out the exercises. As Maureen Green writes;

"...............which is what I have always found with a class."

The teachers were quite ingenious in their problem solving and many developed multiple approaches which pleased the Loughborough team. The teachers illustrated that they did not regard the exercises simply in terms
of skills and techniques. The exercises were conducted in the grounds of the residential college and the obvious enjoyment and enthusiasm of the teachers aroused much curiosity from other mature students attending college courses. Many of those mature students were extremely interested in the activities and some remarked that they wished they were involved in the INSET programme. This may have been prompted by the fine sunny weather which fortunately prevailed.

The Loughborough team concluded that the afternoon, and indeed the whole first phase of the RLPE INSET scheme, had been extremely successful.

"We were quite overwhelmed by their (the teachers) individual expressions of thanks as they departed, and everyone seems to be greatly looking forward to the Residential Weekend"

Maureen Green.

Although the evaluation and research perspective tends to shy from quantitative data it is interesting to conclude this section by noting that the attendance in the second half of the programme had continued to be impressively high. The sequence of attendance figures in the Summer term was 19, 21, 19, 21, 19, 21, 18, 19, 18.

5.6 The Residential Element

The design of the residential element of the RLPE INSET scheme was influenced by a number of important factors; some anticipated and others, unfortunately and sadly, unforeseen. The Loughborough team were saddened to hear of the tragic death of one of its members, Philip Dean. His contribution to the success of the scheme had been much valued and he would be sorely missed. George, a close departmental colleague of Philip, was deeply affected. In fact, for other reasons, George had indicated that he would be unable to attend the residential week-end.

On a happier note Ray Ware, a mathematics teacher at a local comprehensive school and a former Ph.D. student of Professor Bajpai, agreed to contribute to the weekend. In addition the team were able to rely heavily on the services of Gordon Bell, the Administrative Assistant of the
Department of Engineering Mathematics, who ably looked after organisational details. Maureen Green, David Green and the author made up the rest of the team, with Professor Bajpai continuing as Director.

The author was able to consult the Rurishire Mathematics Inspector and his colleagues extensively during the summer, prior to the residential week-end. This consultation included discussion of financial and organisational arrangements, since the teachers were to be released from their schools on Friday, 25 September to travel to Loughborough. The Inspector assumed responsibility for contacting schools, arranging supply cover and agreeing financial requirements with County Hall. In addition the meetings contributed significantly to the review and evaluation processes and, consequently, were extremely important in the design and planning of the residential element of the INSET scheme. An important meeting was held at Midchester, on 11 September, between the Mathematics Inspector, the Language Inspector (who was assisting with the programme evaluation), the Head of the Rurishire Professional Development Unit and the author. In addition to discussing the completed programme and the forthcoming residential week-end the possibility of CAMET providing further INSET for the county was mooted. It was proposed that other, better qualified, mathematics teachers would be given opportunities to attend such INSET provision.

The Mathematics Inspector and the author also discussed the contribution they would make to the forthcoming conference at Manchester Polytechnic. They were able to add to the evaluation and analysis contained in the paper they had written with Professor Bajpai in May for the postponed conference. Both agreed that the INSET programme had been successful and that its research findings would be valuable for other authorities and providing agencies. Unfortunately the Inspector was unable to attend the Manchester Conference on 24 September but the author was able to communicate their shared views to the conference.

In another significant activity the author had interviewed local mathematics teachers who had been participants in the PEVE INSET scheme [vide supra 4.2]. As a result of these interviews the author had identified a need to provide resource material on Practical Work for teachers preparing for
GCSE Mathematics. It was decided, therefore, to make Practical Work, from a modelling perspective, a central theme of the residential element. Although many of the teachers would not be involved directly with GCSE it was considered important that they were aware of its consequences for their own teaching and for their students. The primary intention was to continue to motivate the members to introduce practical mathematics into their classrooms. A secondary aim was to ask them to assist in the evaluation of a resource pack 'Practical Work in Mathematics' [CAMET, 1987] which Maureen and the author were preparing. It was hoped this evaluation would commence during the residential week-end, continue when the teachers returned to their schools and, thus, encourage the on-going INSET programme. The package was sent to all members of the course in early September so that they would have sufficient time to acquaint themselves with its contents. A covering letter requested the teachers to try out at least one item with their own classes before the residential week-end. Some teachers reported that they were able to try items with classes but the pressures of a new school term precluded others doing this. The package included an introduction, which described the modelling approach to Practical Work in Mathematics, and notes giving suggestions for its use in schools. Teachers' Notes and 34 Student Worksheets were included [vide Appendix 7: Worksheet 35 added after residential weekend].

One other important aim of the residential weekend was to evaluate further the RLPE INSET scheme itself. Part of this evaluation would be conducted using the questionnaire given in Appendix 1. However, since the nature of the research suggested that data should be gathered in a more non-positivistic manner, it was decided that the personal contact and participant observation, which the residential element would facilitate, should be used to supplement the questionnaire. Consequently the questionnaire was not designed as a 'remote' data gathering device but one which could be used in parallel with informal interviews and conversations. It included open ended items.

An important design aspect, which was anticipated and achieved, was that the excellent residential and catering facilities at Loughborough, together with the pleasant surroundings and friendly campus atmosphere would enhance the evaluation process. In fact, a great deal of valuable data was collected during meal-times and in informal gatherings in common rooms.
and University bars.

The residential week-end commenced at 2.00 p.m on 25 September. Sheila Sharma had phoned the author to apologise for not attending. She had a previous Open University commitment. Lawrence Terry also phoned to say he had family commitments which would prevent him coming to Loughborough. Wendy Wood brought apologies from Steve Bow who was busy with activities at his school. Nothing was heard from Bob Bell, who had recently finished his temporary teaching and had not obtained another post at that time. Pleasingly the remaining 17 members arrived during the afternoon and were registered in the same postgraduate hall of residence.

A suite of rooms in the Department of Engineering Mathematics had been converted into work-stations and seminar rooms. Easy chairs, coffee tables, resources (including flowers) mirrored the relaxed working conditions, which the teachers and the Loughborough team had enjoyed and appreciated at Midchester Mathematics Centre. This proved to be an important design aspect, which the research findings highlight as an important guideline for INSET provision. A well designed working environment must be a significant design feature of INSET. Almost all members indicated that they welcomed and appreciated the efforts made to provide a relaxed and comfortable atmosphere in workshops, residence, and on the campus as a whole.

The overall academic work of the week-end is indicated by the following timetable.

Friday 25 September
2.00 pm Registration
3.00 pm Welcome and Introduction to the Course
3.20 pm Background and Aims of the Package Practical Work In Mathematics
3.40 pm Whole Group: Initial Reactions to Practical Work In Mathematics
4.00 pm Tea
4.15 pm Small Groups: Evaluation and Development Suggestions for Practical Work In Mathematics
5.00 pm Close
6.00 pm Dinner

Saturday 26 September
8.00 am Breakfast
9.30 am Apprentice Mathematics Ray Ware
### Schedule

<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
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<tbody>
<tr>
<td>10:45 am</td>
<td>Coffee</td>
</tr>
<tr>
<td>11:00 am</td>
<td>Workshop: <em>Practical Work in Mathematics</em></td>
</tr>
<tr>
<td>12:00 noon</td>
<td>Close</td>
</tr>
<tr>
<td>12:30 pm</td>
<td>Lunch</td>
</tr>
<tr>
<td>2:15 pm</td>
<td>Workshop: <em>Practical Work in Mathematics</em></td>
</tr>
<tr>
<td>3:45 pm</td>
<td>Tea</td>
</tr>
<tr>
<td>4:00 pm</td>
<td>Further Statistics</td>
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<tr>
<td>5:30 pm</td>
<td>Close</td>
</tr>
<tr>
<td>7:30 pm</td>
<td>Lunch</td>
</tr>
<tr>
<td>8:00 pm</td>
<td>Course Dinner</td>
</tr>
</tbody>
</table>

**Sunday 27 September**

<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
</tr>
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<tbody>
<tr>
<td>8:00 am</td>
<td>Breakfast</td>
</tr>
<tr>
<td>9:30 am</td>
<td>Workshop: <em>Practical Work in Mathematics</em></td>
</tr>
<tr>
<td>10:15 am</td>
<td>Plenary Session</td>
</tr>
<tr>
<td>10:30 am</td>
<td>Coffee</td>
</tr>
<tr>
<td>10:45 am</td>
<td>Close</td>
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It can be seen that the main academic activities of the weekend involved workshops using the resource package on Practical Mathematics. This was valuable since it allowed the members to make significant and considerable contributions to the residential element and, thus encouraged the interaction and exchange of ideas which had been found so important in raising affective levels in the sessions at Midchester. The teachers involved themselves enthusiastically in these activities and made full use of the apparatus provided. They also provided extremely useful comment and criticism of the resource package. For example, some groups reported difficulties with the worksheet which dealt with the turning circle of a car. They also identified certain errors which the Loughborough team had missed. Jack and Derek, who had previous engineering experience, and Austin were extremely enthusiastic and supplied valuable support to other members. The author redrafted this worksheet, and supplemented the package, in the light of this useful evaluation.

The contributions by Ray Ware and David Green were also extremely valuable in providing variety and useful INSET activity. The talk by Ray was based on the book 'Apprentice Mathematics' which he and Professor Bajpai had written together. He also described the work he had been pursuing in attempting to relate school mathematics to industry. This prompted interested discussion as the teachers indicated that they wished to learn more of the way in which he used local industry in his mathematics teaching.
and how they might do the same. David had devised a set of workshops to follow up his earlier contributions on Probability and Statistics. He intended that the teachers would analyse results rather more than they had when he had seen them last at Midchester. In fact that previous experience at Midchester proved to be valuable to David and to the teachers so that the exercises were conducted extremely satisfactorily.

Jack Connelly supplies supporting evidence for the conclusions of the paragraph above in the interview the author conducted with him in March 1988.

PKA
Yes... What about the residential weekend?

Jack
Yes... I thought that was valuable as well... say... part of that I have used ....... the statistics part .. used it simply I had not ......er........ analysing it as we did there ......ermm......... and also some of the ideas ......ermm......... I think it was a maths teacher from another school on about making a container to measure out a certain number of tablets.

PKA

Jack

...things like that. I thought there were some good ideas there which I've got noted down and possibly will use sometime.

At the end of the week-end all the teachers expressed their thanks to the Loughborough team for what the visitors from Rurishire considered to be an enjoyable and valuable experience. These expressions of gratitude and appreciation were also expounded at the course dinner by participants and by Owen Eastwood. The only negative aspect of the residential element was the dismay and sadness with which the members learned of the death of Philip Dean.

Maureen Green and the author who were, perhaps, personally closer to the members than other members of the team received a number of letters during the following weeks from members who had attended the residential week-end. Extracts are included here because they provide evidence that the INSET scheme was having some effect on the teaching practice of at
least some members and possibly their colleagues. They also illustrate the relationships which were being established amongst members themselves and the supportive nature of these relationships. Later interview data also illustrates this and supports such analysis.

"Many thanks for a really stimulating week-end at Loughborough. I can't tell you how much I enjoyed it and what a difference that sort of week-end makes to the next week's teaching. Jennifer has just been on the phone to me this evening asking my opinion on some school matter, and we have only ever met at the course!"

Rita Rigg (3 October 1987).

"It was a most happy re-union for everyone and certainly did much for our figures - both the mathematical and bodily sort!!"

Barbara Charlton (3 October 1987).

"At last a few lines to thank you both for an enjoyable and very valuable week-end in Loughborough. I have shown the 'package' to my head of department and colleagues. As yet we have not really been able to discuss it as a group. (We have not had a departmental meeting recently and as this counts as directed time I feel awkward about raising it in a more informal context). However several colleagues have expressed interest."

Joan Warwick (8 November 1987).

A selection of comments, which were made by members during the interviews which the author conducted in the first half of 1988 are also interesting. These throw further light on the residential element.

(i)
Austin Matthews

..................on the week-end at Loughborough.....I think we spent most of our lunch hour doing our project because we were.............fully enjoying it..........

(ii)
PKA

What about the residential course?
Jean
Oh, that was excellent

(iii)

Jennifer Hall
To start with and I think on the whole we got what we wanted. A bit more practical work, but then I'm practically minded I'm afraid, I'm not very good at theory but when it comes down to actually doing it with my hands, I'm a lot better... I can get further that way. It was fine. I enjoyed the weekend...ahah.

PKA
Was that a benefit, the weekend?

Jennifer
Yes it was, yes, particularly I think, Sunday morning we all actually sat down and we had really got into it...ermm.... It was Saturday afternoon I think... and Sunday morning we really began to get going...ermm.... Sunday morning when we were finishing off... you know... it reached a lot. I certainly enjoyed it anyway.

PKA
I thought you achieved quite a lot?

Jennifer
Yes.....I think having actually had the couple of days together helped........Saying that........the evenings were long enough sessions........ the days might have been too long........I think, occasionally, you need that bit longer.......otherwise we seem to be breaking off just as we were getting there and we could have done with another half an hour....ermm........yes, I think it was a great weekend.

(iv)

Glynis Dobbs
Yes, particularly the weekend away at Loughborough because there we could just sit down and get on and do some maths for yourself which you could never do when you're working... I mean if you are in school there's always something else to do, if you're at home there is always something else. To actually be away and have nothing else to do is......err......goodness gracious...... what would you like to do?
Chapter 6

THE CONTINUING INSET PROGRAMME: A CASE STUDY

6.1 Self Motivation and Development: A Catalyst

On 24 September, the day before the residential element of the RLPE INSET scheme [vide supra 5.7], the author attended the rearranged DES Sponsored Conference 'Action on Teacher Supply' at Manchester Polytechnic. The paper, which Professor Bajpai, Owen Eastwood and the author had written on the RLPE INSET scheme [Goodwin et al., 1987], had been circulated to delegates and the author was able to discuss this, and other relevant matters, with representatives from DES, Industry, TASC (Teaching As A Career) and Education. It was clear from these discussions that very little was being done nationally, at that time, to address the problems of the 'hidden' shortage of mathematics teachers. The RLPE INSET scheme was exceptional in seeking solutions to those particular problems. However, the author was pleased to hear Michael Richardson, Head of Teacher Supply and Training Division, DES, declare in the Opening Address to Conference;

"For the future, we think that the problems we described as the 'hidden shortage' in the consultative document last year, that is to say the shortage subjects being taught by people inadequately qualified to teach them, is now possibly more important than the overt-shortage i.e. actual vacancies in schools. Hopefully improved opportunities for INSET, for supply cover while under-qualified teachers undertake INSET to have their skills strengthened must form the main plank of the next phase of our strategy for relieving shortages."


The author discussed the possibilities of taking advantage of the opportunities described by Michael Richardson, with Owen Eastwood when the latter visited Loughborough on the second evening of the residential week-end. Both parties were anxious that the RLPE INSET scheme should continue as an on-going venture and that opportunities should be extended to other teachers.
The author had hoped and planned that, following the first phase at Midchester and the residential element at Loughborough, the participants of the RLPE INSET scheme and the Rurishire Advisory Team would assume greater responsibility for continuing and developing the programme to meet their own needs. He had indicated that he would be pleased to act in an advisory role but his main concern was to research the continuing development over, at least, the next year. In fact, soon after the residential week-end, evidence emerged that the Practical Mathematics Package would act as a catalyst in the continuation of the scheme. Before and during the week-end, the Loughborough team had asked the members to forward criticisms of the package when they had had chance to try out the exercises with their classes. At the end of September the author wrote the teachers to remind them that criticism of the package would be welcome. A small group of teachers, Barbara Charlton, Rita Rigg, Joan Warwick and Ursula Tripp, were apparently more enthusiastic than others and replied during the first half of the Autumn term. It was this group who took leading roles in using the Practical Mathematics package as a vehicle to promote the on-going INSET provision. Barbara wrote the author in October;

"I am sure that it would be most valuable if someone was given the time to look at all the practical projects and ideas which we have been given, and for each one work out:-

(a) what basic skills are needed to tackle the task
(b) what skills are learnt from doing the task,
(c) what areas of the syllabus are covered by the task.

This kind of information alongside each task would be a helpful asset to teachers in planning their work and making it more applicable to a syllabus, so that practical mathematics would become the everyday norm and not the 'treat it often tends to be at present."

Barbara Charlton (3 October, 1987).

The Rurishire Mathematics Inspectorate and the Advisory Team were approached independently by members of the RLPE INSET scheme, who asked that the scheme should continue so that they could build on the work already done. The ESG Advisory teachers had seen some of the group
using the Practical Mathematics package in their schools and supported the idea that continuing INSET might explore this further [vide infra 6.5]. The author was interested to observe these developments since they provided evidence that the programme was beginning to move in the direction he had hoped.

6.2 Perturbations

Subsequent events produced a degree of instability. They are described in this case study since they illuminate important characteristics of 'naturalistic' curriculum development and lend further support to the conclusion that prescriptive models of design and development must be used with caution.

Perhaps, the most significant event was the resignation of Owen Eastwood as Mathematics Inspector in Rurishire. Owen had been appointed as a Senior General Adviser to another authority and would take up that appointment in December 1987. This was to have a dramatic effect on the on-going INSET programme and, more importantly on Mathematics INSET in Rurishire as a whole. The author spoke to many Rurishire teachers and to advisory staff, who were unanimous in regretting Owen's departure and dismayed at the future prospects. Owen made every effort to ensure the continuation of the INSET programme and introduced the author to many colleagues at County Hall who promised to assist the on-going provision and the evaluation process. This support evaporated, however, following Owen Eastwood's departure. The other Inspector of Mathematics, Clive Peat, worked closely with the author following Owen Eastwood's departure but he retired shortly afterwards (in September, 1988) and the Mathematics Inspectorate was depleted for some time. A new appointment was not made until April, 1989.

The Mathematics Advisory Team also suffered since Linda moved to another county at the end of the Autumn term 1987. Emma had returned to classroom teaching earlier in that year. This left Frances Watts, an ESG Teacher, to carry the main burden as far as the Secondary School Mathematics Advisory Service was concerned. Marianne also took a share of the work but her main activities were in primary schools.

Frances, in fact, was extremely able, and worked closely with the author and
the participant teachers as the programme continued, but she possibly lacked the necessary status and responsibility in the authority to determine events as she would have liked. As well as the departure of Owen Eastwood and the imminent retirement of Clive Peat, other staff changes in the authority exacerbated the situation and made decision making difficult. Frances never appeared to have been informed, by the authority, who was in charge of the Mathematics Centre at Midchester following Owen Eastwood's departure. She used this Centre as a base for her work, with the assistance of Marianne and a secretary, Clare. As well as her ESG commitments in schools Frances took a great deal of responsibility for a number of other ventures. She worked with 'key' people from the RLPE INSET scheme to organise 'follow-up' sessions and with Clive Peat to plan and arrange the Rurishire Head of Mathematics Conference [vide 6.7].

In March 1988 the Director of Education suddenly and unexpectedly resigned and in May the Primary Mathematics Inspector, who by then had assumed some responsibility for the Mathematics Centre, also resigned to move to another authority. On 18 May, 1988 Frances spoke on the phone to the author. She reported that the authority had asked them not to commit funding to new or current projects, Frances complained that "no-one seems to be at the helm" in the authority. Her own position and future as an ESG advisory teacher were far from clear. The situation in which Frances found herself was most unfortunate for her and for the continuing INSET provision. This situation was not to improve a great deal over the next year [vide infra 6.8]. Some temporary support was provided by the county, who seconded two Heads of Mathematics Departments full-time for one year, commencing September 1988, to assist schools to prepare for the National Curriculum. One of these was Keith Clamp from Southgate School, where a member of the RLPE INSET scheme, Rita Rigg, worked until July 1988 [vide infra 6.71]. In fact, Rita joined an area-based INSET, which Keith organised in 1989 in the locality of her new school.

The perturbations described above were certainly detrimental to the continuing INSET provision but they are extremely interesting and valuable data for a research study of naturalistic curriculum/INSET development. Once again they indicate that design and implementation must take account of constantly changing situations and that, in the prevailing circumstances, the flexible model of design used for the RLPE INSET scheme was more
suitable than a rigid prescriptive model.

6.3 The Autumn Meeting

Since the Rurishire Advisory Team and the author had received the requests from members of the group, which had been prompted by the Practical Mathematics package [vide supra 6.1], it was proposed to organise an initial 'follow-up' session of the RLPE INSET scheme at the Mathematics Centre, Midchester on 26 November, 1987. The original plan was to organise some workshop activities, based on the experiences of members who had used the Practical Mathematics package with their classes and to present certificates to participants on behalf of Rurishire LEA and CAMET. Professor Bajpai and Owen Eastwood had discussed this certification and its format for some time and the Professor, as Director of CAMET and of the RLPE INSET scheme agreed to give a talk to the members and to present the certificates, which he signed together with the Director of Education, Rurishire. In the event Professor Bajpai addressed all the participants (the teachers, the Rurishire Advisory Team and CAMET members) and, in reviewing the work of the RLPE INSET scheme, he indicated that he thought it had been a successful venture and urged the participant teachers to contribute to a continuing provision as developers as well as recipients [vide infra 9.43]. The presentation of certificates by Professor Bajpai was followed immediately by a reception for the Mathematics Inspector and the member of his advisory team, who were both taking up new appointments in the near future. The reception was attended by staff throughout the authority and members of the Loughborough team. This provided a unique opportunity for the Loughborough team to collect more data from Heads of Schools, Heads of Departments, teachers and officers. Professor Bajpai, Maureen Green and the author met later to collate and triangulate this important data. There was much appreciation and approval of the RLPE INSET scheme and of its effects in schools. Many comments called for a continuing provision. The author was also able to make personal contacts which subsequently assisted this research/evaluation and the on-going provision.

The meeting and reception also enabled the author to collect further data by means of the second questionnaire [vide Appendix 2]. This had been designed to supplement the data of the first questionnaire and its format was
influenced by analysis of that previous survey. The author had discussed the second questionnaire with serving teachers who were attending MSc Courses in Mathematical Education and Computer Education at Loughborough. They suggested minor modifications to the wording of certain items. More fixed response items were included in the second questionnaire than in the first, because the team expected it to be completed by members in their own time and at a distance. In fact the members who attended the meeting found time to complete their questionnaires and to hand them to the team before they departed. This allowed some element of consultation to be introduced into the second survey as well as the first. This fitted well with the overall research pattern.

Of the RLPE INSET members Lawrence, Andrew, Brenda, Steve and Bob did not attend the initial 'follow-up' meeting at Midchester. The author wrote these members, sending a copy of the questionnaire with an explanatory letter. A reply and completed questionnaires were received from Andrew shortly afterwards.

Lawrence had phoned the author the day before the meeting to say he would be unable to attend. He promised to return the first questionnaire, which he had not yet forwarded, and to complete the second. He was extremely anxious to point out that he was not altogether convinced that a questionnaire survey would reflect his opinions and hoped that his responses would not be taken out of context. He stressed that his written comments were not meant to be disapproving of the course, which he thought had been extremely valuable to him. The author assured him that any report would reflect the telephone conversation. Lawrence's distrust and suspicion of questionnaires may explain why he never sent the author the first questionnaire. He gave the author the completed second questionnaire when he was interviewed in March, 1988.

It appears that even with a captive, friendly, committed target group the response to survey techniques is not always total. Nineteen members eventually returned the second questionnaire. Brenda and Bob did not reply. The first questionnaire used at the residential week-end also did not elicit a total response. Copies and explanatory letters were sent to absentees in that instance also but only 17 completed questionnaires were collected eventually. Roy who was at the residential week-end never returned his

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questionnaire, Brenda who also attended posted a completed questionnaire one week later. Sheila, Bob and Lawrence, who did not come to Loughborough, did not forward the first questionnaire. Steve, who had not attended the residential week-end, gave the author completed copies of both questionnaires when interviewed in March 1988.

At the 'follow-up' session on 26 November, 1987 Rita and Joan both asked Maureen Green to provide them with another copy of the Practical Mathematics package. Rita's original copy "had been dismembered" and passed around colleagues in her department, who all seemed keen to try out various parts of it. In addition, Joan came with a note from her Head of Department;

"Joan,

Can you get me a copy of the whole booklet from Loughborough. It's excellent (90%) of it.
P.S. If not can I borrow it to get the office staff to photocopy it next week?"

Head of Mathematics, Benton School (November 1987).

In conversations during the reception the Loughborough team reported that there was wide agreement between members and the Rurishire Advisory Team that the INSET programme should continue in the form of full working day sessions held at least once per term. Although the plans had been changed because of perturbation it was still evident that members were keen to organise another meeting based on the Practical Mathematics package.

6.4 The Emergence of 'Key' Persons

With the Rurishire Mathematics Inspectorate and Advisory Service now depleted Frances Watts, the secondary phase ESG teacher, worked closely with Barbara and Rita to organise the next 'follow-up' session of the RLPE INSET scheme. The author maintained regular contact to collect data on the progress of the continuing INSET development. Extracts from the author's research diary illustrate this.

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3 November, 1987
Frances Watts phoned. She had visited Southgate School, where she had seen Rita Rigg using Practical Mathematics with pupils. Rita had reported how the pupils enjoyed using the worksheets. Frances asked to be sent a copy of the package. She also wanted a list of names of other 'Pilot' teachers so she could visit them to see how they used the package. I agreed to send this material to Frances. I pointed out it was in draft form at the moment and that it was under evaluation. Frances indicated that she might help us in this evaluation. Letter received from Ursula Tripp. She has tried out a number of the Practical Mathematics exercises with her classes and has discussed the package with her Head of Department and other colleagues. "They all agreed that it is a most useful package and that it would not be too time consuming to adapt it for the needs of the individual pupil, if necessary".

5 November, 1987
Visited the Mathematics Centre, Midchester. Discussed my research plans with Owen Eastwood. He suggested that I visit as many 'Pilot' schools as possible to interview participants. Owen Eastwood asked that I let him see my research plans so he could be able to advise and clear them with schools. We agreed to shelve suggestions for an INSET venture in Thorpe for the time being.

Mark Davis was visiting the Mathematics Centre as part of his work on his 'Mathematics Inventory'. He has a one day per week secondment this year. This is one positive result of the 'Pilot' experiment. He is realising that it is a formidable task. Incidentally he is collecting data on the mood and problems of teachers.
Gave Frances a copy of Practical Mathematics. She agreed to feed back comments for evaluation purposes.

11 November, 1987
Spoke to Frances Watts at Maths Centre, by phone. She had visited Barbara Charlton to see children (lower school) using the practical exercise on 'Linkages'. This had worked well and she and the children had enjoyed it and learned a great deal from it. The "boys" were looking forward to trying Gears. Frances and I raised the question of "girls" in relation to the package. Must consider this more. Teachers had told
her that we should link the package to syllabuses to convince teachers to use the package. The usual 'time available' arguments had cropped up. **Must include a section on this.** Frances wanted the package tested in fourth and fifth years and promised to look for a sympathetic Head of Department to do this.

Letter on Practical Mathematics received from Joan Warwick. She and a colleague have done quite a bit of work on the package with some success.

17 November, 1987

Telephone: Spoke to Owen about possibility of three-way 'follow-up' to RLPE INSET scheme (i.e. Heads of Departments/Advisory Teachers/Loughborough Team).

The following extract from a note by Frances also illustrates the progress and direction of the continuing INSET programme.

"**During October 1987 members of the 'group' asked if it was proposed to continue the initiative so that they could build on the year's work.**

**Having worked alongside two teachers from the 'group', who were then using ideas from the Practical Mathematics Package, I was pleased that they agreed to act as co-ordinators for the original 'group' and to plan a day's course. This was to give the 'pilot' scheme teachers the opportunity to:**

a) Meet again.

b) Share ideas and explore the use of the material for the practical package.

c) Discuss future meetings to be held regularly, when the group as a whole would work on the production of a classroom/syllabus related package which has application to teaching every age and ability group."

Frances Watts (May 1988).
On 18 January Frances invited Barbara Charlton, Rita Rigg and Mark Davis to the Mathematics Centre, Midchester to talk about the continuing INSET arrangements. By that time Paul was busy touring schools in the County pursuing his work of preparing an inventory of mathematics textbooks and declined to become heavily committed to the work. Consequently Barbara and Rita accepted a major share of the responsibility of contacting other members of the group to invite them to a meeting and workshop in the Spring term.

An extract from the author's research diary describes pertinent events which took place at that time;

26 January, 1988
Phoned Frances Watts at Midchester. She told me that Barbara and Rita had visited her and that they were excited about the Practical Mathematics package and its implementation. They thought it should be modified and extended for secondary modern school children. They and Frances had agreed to arrange a meeting of the original group on Friday 25 March. Rita and Barbara were taking responsibility to contact the others and to ask them to bring their own ideas for new exercises to be written into the package. Descriptions of what members had done, tried and experienced would also be encouraged at the meeting. I agreed to attend and provide an input.

Frances had suggested to Rita and Barbara that they visit schools and demonstrate some team teaching of practical work. I said this was a good idea.

I described my ideas for local 'cluster' groups using our people as KEY persons. She thought that this was exciting and she would support the idea. We would discuss this with the people in March.

Frances phoned back to ask me to agree to be Course Tutor for a Certificate of Professional Studies Course at Thorpe starting next term. This would be for Primary and Secondary teachers.

[Note: On 25 February, 1988 the author discussed the possibility of a course at Thorpe with Frances and two Heads of Mathematics]
Departments. For some time previously these Heads had been organising local self-help groups for teachers in schools in and around Thorpe. They were now requesting an outside 'agency' input to this INSET activity together with adequate funding. They were well aware of the RLPE INSET scheme and were asking for a parallel INSET provision for better qualified mathematics teachers. The author studied plans which Frances and the two Heads had formulated and gave advice, which appeared to be welcomed by the others. He explained some of his ideas for 'cluster groups' which would combine 'area-based' and 'agency-based' INSET modes. The proposed Thorpe scheme appeared to present a suitable opportunity to try out these ideas. Nevertheless, the author formed the impression that funding would not be available. This impression appears to have been correct. One of the two Heads again approached the author for assistance at a Head of Mathematics Conference in June, 1988 but he appeared, by then, to have given up hope of any suitable INSET provision in the county for his teachers.

The ideas on local cluster groups and 'key' persons referred to in the diary were contained in a discussion paper which the author had prepared and which he forwarded to Frances. The research which had been conducted on the INSET programme at that stage suggested that any one specific mode of INSET would not cater for the needs of mathematics teachers in the 'hidden' shortage. The author suggested that although 'agency-based' INSET might initiate programmes it should be phased out as schemes developed in favour of a mixture of 'area-based' and 'school-based' INSET. It was suggested that the original RLPE INSET scheme should be developed by:

(i) Setting up school-based INSET groups at those schools in which committed members of the original experiment worked. Organisation of these groups would be by a partnership of a trained 'key' teacher, Head of Department and Rurishire Mathematics Advisory Team. Advice and support would be provided by Loughborough University as required.

(ii) Establishing area-based INSET, in the form of 'self-help' groups, with trained 'key' teachers from the original RLPE INSET scheme acting as 'animators', assisted by Rurishire Mathematics Advisory Team. The 'key' teachers would meet at regular intervals (say once every school term) with the Loughborough team to review and update their work and to exchange
ideas and experiences.

In fact, 'key' teachers were beginning to emerge and Barbara and Rita were primary candidates. These two teachers invited the author and Frances Watts to meet with them, on 11 February 1989, at the Mathematics Centre Midchester to discuss their plans. The author accepted this invitation because it enabled him to act as a participant observer and it fitted nicely with his research schedule. In fact he visited two schools in Midchester on that day to conduct interviews with Barbara Charlton and Glynis.

The meeting was a very useful exercise from planning and research points of view. It was evident that Barbara and Rita were doing a great deal of work in their classrooms and schools to promote practical mathematics. The RLPE INSET scheme had had a positive effect in their schools to change practice and attitudes. Barbara was, of course, a long-standing senior member of staff (Deputy Head) in her school. Rita on the other hand had only obtained a temporary post in her school for the Autumn term of 1987. On 3 January she wrote Maureen Green and the author as follows;

"Many thanks for sending me another copy of the notes. Several people at Southgate have had a delve into the investigations in the pack and it has been well used. My Head of Department has used things that are more suitable for older or brighter children and has found them pretty useful.

Now for the really good news. I am not leaving Southgate at Christmas after all, but I am staying until August, so I am hoping that you will still feel able to come over if you have time, and hopefully help me as well as seeing children in action with your work pack."

Rita Rigg (January 1988).

This extract illustrates a significant development for a mathematics teacher who had passed her GCE O level Mathematics in the same Summer term that she was attending the RLPE INSET programme. This is discussed further later [6.71].

In early March Barbara and Rita circulated an invitation to all members of the
original RLPE INSET scheme which contained the following:

"We are now contacting all members of the group to confirm the workshop day of 25th March (start 9.30 am, finish 3.30 pm) and ask that in preparation for that day you bring any work, worksheets, videos etc that you have used, either from the Loughborough package or your own personal work on one of the following topics - Circles, Nets and Solids, Curves.

The success of the workshop day will be governed by everyone having something to contribute, and the result should be everyone having a classroom/syllabus related package to take away which has applications to teaching every age and ability group. Also if the day is successful it is hoped to provide others to fit the needs of the group from discussion on the 25th March."

The author had visited and interviewed all members of the RLPE INSET scheme prior to the 'workshop day' which Barbara, Rita and Frances were organising. This gave him the opportunity to remind members of that 'follow-up' exercise. It also enabled him to see the members in their schools, to see some of their work and to talk to their colleagues. Fortunately Bob had obtained a temporary teaching post at St Benedict's School, Ruriston so the author was able to re-establish contact with him. Sheila who taught at St Benedict's had located Bob and persuaded him to apply for the post. Mark was interviewed at his home (he had kindly invited the author to dinner) since he was still travelling around the county researching his 'Mathematics Inventory'.

From school visits and from the responses to his call for critical comment the author concluded that the Practical Mathematics package was having a positive effect on many, but not all, members and their classroom practice. An enthusiastic core of members were more influenced by the package than others but no entirely negative opinions or evaluations were received. In letters and interviews some members thought the package was too biased toward Engineering and suggested that the package might be improved by examples from other fields. Frances' evaluation in schools also raised the question of gender [vide supra Diary Extract, 11 November]. Rita also refers to this aspect in a letter;
"I also discarded mentally, for the time being, those that seemed to be in a strongly male preserve, the engineering type of things (and rugby tries)"

Rita Rigg.

It is interesting that Maureen had selected and written the exercise on rugby tries and most of the Engineering applications. Nevertheless, Brenda reflected Rita’s comments in an interview with the author:

PKA
Well yes we are producing material.....er.....mmm............ Ttalking of material, we prepared the Practical Mathematics.
Brenda
Yes.
PKA
Do you use any of that?
Brenda
Yes I did... I used......certainly used the one on the cones and I liked..... do you remember at the end of the course we were working on that.. those........
PKA
The turning circle of a car?
Brenda
Yes.
PKA
I've rewritten that completely.
Brenda
I did quite a bit of that.
PKA
I'll send you a copy.
Brenda
.........just because it was interesting to me and......er......mmm.............. and the children were interested ... we got quite a lot out of that ....
PKA
Oh, good.
Brenda

I think generally the book... I have to say it was too Engineering based I think.... probably.

On 16 February Owen Eastwood visited Loughborough to collect copies of the Practical Mathematics package from the author. He had asked permission to use these in an INSET activity he was organising in his new appointment. The author was pleased to provide these since it would extend the evaluation process.

6.5 The Spring Meeting

The author arrived at the Mathematics Centre, Midchester at 9.00 a.m. on Friday, 25 March, 1988 to meet Barbara and Rita, who were organising work rooms and resources for the second RLPE INSET scheme 'follow-up' session. This enabled the two members to describe their final plans with the author. The two teachers, with the assistance of Frances Watts, the ESG teacher, had prepared the following written timetable, to be given to other members as they arrived.

Aim: to examine the topics

Nets and Solids
Curves
Circles

and to develop ways of teaching them which cover the needs of the syllabus at all levels of ability in as interesting and original way as possible

9.30 a.m. Introduction and Plans for the Day Rita Rigg

Barbara Charlton

9.45 a.m.-12.00 noon
(coffee break 10.45-11.00 a.m.)

Workshop: 1) In groups pool together all the ideas which have been brought along and cross reference them with the syllabus (note any gaps)
2) Construct a package (worksheets, computer prog. book ref. etc) which could be used by a school as a teaching guide/aid/activity (also indicating the parts of the syllabus covered)

3) Try to develop some worksheets/activities for parts of the syllabus not already covered.

1.30 p.m.

1) Evaluate the morning and share ideas
   Peter Armstrong, Frances Watts, Mr Peat

2) Where do we go from here? Plans for work to be undertaken before next meeting.

The author noted that the first phases of the RLPE INSET scheme had employed written timetables in a similar way and with a similar format. Although the author suggested to the two teachers that he would have preferred rather different wording and content, he was pleased to observe that the original scheme was having an incidental, but welcome, effect on the organisational aspects of the 'follow-up' programme. The plans for the afternoon session indicate that the teachers were still seeking support from the Rurishire Mathematics Inspectorate and Advisory Service and from Loughborough University.

9 members of the original 21 teachers attended this session. These were Barbara, Rita, Brian, Joan, Lawrence, Steve, Sheila, Jennifer and Roy. It is pleasing to note the continued interest of Lawrence and Steve who had missed the last two gatherings of the group. A number of non-attenders had sent apologies. Many of these teachers had difficulty in finding time to leave their school work for that day.

In addition to the teachers and the author, Frances Watts and Mr Peat (Rurishire Mathematics Inspector) attended the session. It was pleasing to see the interest being taken by Mr Peat now that Owen Eastwood had departed.

Barbara, Rita, Brian and Joan had brought along some extremely useful examples of the work they and their pupils had been doing in connection with Practical Mathematics and they were able to lead two separate groups. The day did not altogether follow the plans drawn up but it was extremely
useful, since many imaginative ideas were exchanged and members benefitted from learning of the experiences of their colleagues. The author discussed the day with Mr Peat at the end of the afternoon and was pleased to hear that the Inspector had thought the day worthwhile and that he was impressed with the work the participants had been doing in their classrooms. The Inspector intended to visit the teachers involved at their schools to see more of this work. Frances Watts wrote in a report of the day:

"The meeting of all members of the group arranged at the Maths Centre was a great success. The teachers discussed and shared their classroom experiences, tried out ideas and materials developed on the year's course. These are excellent ideas and examples of children's work which triggered further ideas and suggestions.

It was then decided that the teachers would each work on a presentation of an assignment to pupils, to be sent to me at the Mathematics Centre by the end of May. These assignments will be put together as a package of materials to be sent to all Rurishire Secondary Schools. The effective use of this package by teachers in most schools which have been involved in this pilot experiment requires that members of the group can be called upon to assist in the schools.

Members of one group now have the experience which will enable them to act themselves as co-ordinators of local groups to increase awareness of alternative approaches in their teaching. To sustain this widespread development the sub-group co-ordinators will need to meet from time to time. They will also need to discuss their progress with people 'more experienced' in mathematics education.

The 'pilot' scheme gave a few teachers with little experience of mathematics, confidence and ideas that they were willing to try out. While these people are now able to help other colleagues in their own schools there are many other teachers in the county who would benefit from a similar Rurishire/Loughborough model and who would in turn influence more teachers through local groups."

Frances Watts (May 1988).
As well as confirming that the 'follow-up' session had been successful the report extract above provides evidence that Frances had accepted some of the suggestions made by the author [vide supra 6.3] for a continuing INSET provision and was advocating these. The words which are underlined by Frances may be interpreted in two ways. Either Frances refers to the 'key' persons who were beginning to emerge or to the group of 21 teachers who were able to attend the RLPE INSET scheme. In either case she appears to be recommending that other teachers would benefit from INSET based on the RLPE INSET model and emphasises this by underlining the word 'other' and writing it in bold type.

6.6 The Summer Meeting

In the plenary session of the second 'follow-up' session, on 25 March, the teachers who attended suggested that another session should be held in the Summer term. They asked that this third 'follow-up' meeting should concentrate on the use of microcomputers in the mathematics classroom. In particular they requested that work on LOGO and DART should be included. It was agreed that Frances would ask certain members of the group to arrange this session for the first week in July. The author spoke to Frances immediately after the second 'follow-up' meeting and suggested that she should attempt to involve other members as 'key' persons. Barbara and Rita had, in fact, told the author in conversation that they were a little concerned that other members might feel resentful if the two of them took more responsibility for the continuing programme. The author suggested that would be an unlikely reaction from the group but that he thought it would be advantageous for others to share the work and responsibility. Frances Watts agreed to ask Joan Warwick and Brian Bird to assist her to organise and plan the next meeting.

On 6 May Frances Watts phoned the author to report that the Summer meeting had been planned for Friday 6 July, 1988. A demonstration of DART would be arranged at King's School, Ruriston. Frances also requested the author to contribute to the Rurishire Heads of Mathematics Conference in July by giving a talk and workshop on Practical Mathematics. Over the next week Frances and the author discussed this contribution and the author suggested that she might like to ask Barbara, Rita, Joan and Brian to assist
in the workshop and to bring along examples of the work their pupils were doing to show the Heads of Departments. She thought this was an excellent idea and promised to contact the teachers and their schools to arrange this.

It appears that Barbara and Rita were still involved as the most prominent 'key' persons in the on-going INSET programme. On 16 May Rita wrote the author to confirm the arrangements for the meeting at King's School on 6 July and to inform him that, in addition to the DART demonstration, a visit had also been arranged to the Microelectronic Education Development Unit (a special Rurishire LEA sponsored venture) at Ruriston College on that day. On 6 June Barbara told the author that she and Rita had written the other members to inform them of the meeting at King's School. Joan was assisting by that time but Barbara and Rita were still the main 'key' persons.

The meeting on 6 July was a very useful activity, although only 7 members (Jack, Derek, Steve, Roy, Joan, Rita and Jennifer), Frances and the author attended. Barbara was unable to attend because of commitmenst at school although she had been involved in the organisational work. John Mudd, a teacher at the school demonstrated the work he had been doing with DART at King's School. He provided ample opportunity for members to try out software and equipment for themselves. There was keen interest and much activity and interaction during this morning session. John kindly gave the teachers copies of many programs, worksheets and documentation, he had written to take back to their own schools.

John had been working as a part-time member of the Microelectronic Education Development Unit at Ruriston College and in the afternoon he led a visit to the centre. Once again the teachers were extremely enthusiastic to find out more about the work of the unit. Staff of the unit were very busy answering many queries and in providing information about the availability of resources. Many of the teachers purchased software and resource packages from the unit for use in their own classrooms and schools.

A valuable opportunity arose during the day for the author to gather more data concerning the relationships between teachers, with limited qualifications and experience in mathematics, and their respective Heads of Mathematics Departments. The information collected by an informal conversation, during the course of a lunchtime car journey, prompts
questions about the roles and positions of such teachers in relation to Mathematics Departments [vide infra 7.46], and about the design of school-based INSET [vide infra 8.33]. This evidence suggests that, in some instances at least, consultation and communication in schools might be improved and the departmental structure might be reviewed with advantage to members of the 'hidden' shortage of mathematics teachers.

6.7 A Study of the 'Key' Persons

During the continuing INSET provision Barbara Charlton and Rita Rigg emerged as 'key' persons. The author had hoped that other teachers would also assume 'key' roles in organising and prompting continuing INSET activity, but this was not observed to any extent. This section is a study of these two teachers in greater depth than the studies of other members of the group [vide supra 5.5, 5.6 and infra 7]. The studies are based on data gathered by a number of techniques and under a number of different situations. Much data was collected by participant observation during all the phases of the RLPE INSET scheme. Data was furnished by two questionnaires, telephone conversations and letters. Extremely valuable data was gathered by interviews conducted in the teachers' schools. The author observed each teacher in their respective schools over a whole working day.

The two teachers' participation in the planning and implementation of a workshop on Practical Mathematics for the Rurishire Head of Mathematics Conference was another source of important data. The author had originally suggested, to Frances Watts, that Joan Warwick and Brian Bird should also be invited to attend the conference and assist with the workshop; because of the Practical Mathematics they were known to be doing with their classes. Unfortunately Joan and Brian could not find time from their school commitments to attend but sent Frances some examples of their work for use at the conference. Learning of this, Barbara again took the initiative and contacted the school where Wendy worked to ask if she could attend and help with the conference workshop. Barbara had been communicating with Wendy and knew that she had done some good work on Practical Mathematics with her pupils. She was aware, however, that Wendy had been taken ill in March and had spent some time in hospital. Therefore she was not surprised to find Wendy was still recovering and had not returned to
school.

On Thursday 23 June, 1988 Barbara, Rita and the author attended the Rurishire Heads of Mathematics Conference at Midchester Residential College. Approximately 60 Heads of Mathematics attended. The conference was to take place on Thursday and Friday but it had been planned that two Practical Mathematics workshops would take place on the first day. Nevertheless, the author was pleased to learn that the RLPE INSET group would be represented the next day, since Mark Davis was to give a talk on his Mathematics Resource Directory, which was now complete and to be published in the near future by Rurishire LEA. The Loughborough influence was also evident in the contribution which another Rurishire Head of Department was making to the conference. Sean Kelly had recently been awarded an MSc degree after successfully completing the Mathematical Education Course at Loughborough. He conducted a workshop on Games and Puzzles on the Friday morning of the Conference.

The author was impressed by the confident and competent manners of Barbara and Rita in dealing with questions from Heads of Mathematics Departments during both workshops and by the examples of the work they had brought along. Barbara was, of course, a Deputy Head and consequently was used to dealing with Heads of Departments but Rita, with a limited mathematical background and more junior position, was equally assured. Both Clive Peat (Mathematics Inspector) and Frances Watts told the author how pleased they were with the contributions from the two teachers and their demonstration of, what he termed, "good practice". The author was also able to talk with the two Heads of Departments from the schools where Barbara and Rita taught. These Heads were pleased that their staff had been invited and were impressed by their work and contributions to the conference.

Perhaps, the fact that three teachers who, less than a year previously, had been identified by a Mathematics Inspector as belonging to a group of mathematics teachers with limited qualifications and experience in the subject were invited to contribute to a Head of Mathematics Conference is evaluation data which supports a conclusion that the RLPE INSET had a beneficial effect in Rurishire.
6.71 Rita's Story

This section is a study of the events which (i) led to Rita Rigg becoming a teacher of mathematics and (ii) occurred as she began to emerge as a 'key' person in the continuing RLPE INSET programme. It is also a demonstration of how useful informal interview is as a research technique, since much of the information and data was provided by Rita in an interview which contained few prompts or interventions by the author (in other words, the 'interviewer'). To illustrate the advantages of the informal interview and the manner in which it was conducted extracts taken from the transcript of the interview are presented. In fact, to a large extent, Rita tells her own story.

Rita Rigg entered teaching in 1961. She has a Certificate of Education obtained after two years training, during which her main subject was Theology, with subsidiary History and some Physical Education.

Rita

.............. basically in my first school I did all the RE .....er..... for four years and that more or less took all of my timetable and the snatching of history and the odd PE lesson and that sort of thing and then I left to start having our family and I was off entirely for about 10 years and .....er..... I then returned slowly to teaching doing sort of part time and supply in the mornings when the youngest child was at playgroup, and that sort of thing .....er..... then gradually working up that I was almost full time again I had spent about 5 years in this process...................I came into remedial when I came back in because I felt .....er..... that I certainly didn't want to do RE again having lost my faith in the middle .. laughter.. and .....ermm..... really I felt that it might be rather difficult to get back into any other subject. I mean when you have been out of teaching for 10 years you can't just write and say I am interested in teaching history but I haven't done a thing since I qualified or I happen to like English and .....er..... I think I'll try my hand at that.

Rita taught part-time for five years in a local school, where she was mainly teaching Mathematics and English at remedial level. She then left teaching again to have her fourth child. After three years she tried to return.
Rita

.............the situation had changed in Rurishire in that they no longer employed part time teachers ....ermm..... unless they could really help it and .....er..... I found it more difficult to come back in on the part time basis then and was really obliged to take supply teaching rather than being able to get say a part time remedial job again.

Rita soon found that her supply teaching meant that she was required for quite long periods.

Rita

............. and so it got to the stage of people saying to me, "Well do you think you could commit yourself for a whole term to cover for Mrs. So and So, who is off for maternity leave .....ermm..... or Mr. so and so who has had a nervous breakdown?"........... This features very frequently in that, the nervous breakdown syndrome. So, I sort of evolved this thing whereby I was covering .....ermm..... science very frequently for a term at a time. All sorts of things I've done 2 terms of physics and a term of Rural Studies and..........er.......... a couple of terms of biology.

Science teaching prompted Rita to seek further training.

Rita

So......ermm..... it really got to the situation where I was doing science with oddments of maths as well .....ermm..... and I tried very hard to get myself on to some training course for science you know to be a science teacher but .....ermm..... when I applied within the county the science adviser said to me .. well in my experience.. anyone who wants to change their subject area is a failure in their first subject area ......which of course was absolutely not true because a lot of women are in my situation of returning to work and .....er..... their initial subject area being now completely overloaded. I mean who wants an RE teacher now in any case they are ten a penny really.

In 1985 Rita had attempted to find a suitable Science Course but colleges
and Universities to which she applied required GCE A Level Sciences, which she did not possess.

Rita was then asked to take a temporary post teaching Mathematics, for a year, covering for a teacher who was on sick leave. In fact that teacher resigned at the end of the year and Rita applied for the permanent position.

Rita

I applied for the job but it was given to Mr. Armitage, who again you know, because he is from your University, he being the new bright young thing and me saying at my interview I had had a very happy year and the Headmaster saying yes, and I had done a good job and the children were sitting down and enjoying themselves and he was well content with the way things were going but I did need training and me saying I'd like to do your maths job but I also need training. You know day release would do me very nicely. So they decided to appoint the man who was already trained.......ermm.... so .....er..... he said, "I'm sorry I can't offer you any more maths work."

Although no mathematics teaching was available Rita stayed at the school for another two terms to teach French. Strangely this resulted in Rita attended the RLPE INSET at Midchester, which was her first INSET opportunity since entering teaching.

Rita

..............but my kind Headmaster said, "Well you did me an enormous favour last year and you are doing me an enormous favour now.......... because I know you don't speak a word of French....... and there is this Maths course coming up at Loughborough, it starts next week I'll try and get you on it.".............. and that's how I came to the Loughborough pilot scheme at Midchester

In the Summer term of 1987, during the first phase of RLPE INSET scheme, Rita completed her two terms of French and obtained a post in H.M. Prisons, teaching Mathematics to adult prisoners. At the same time she successfully passed GCE O Level Mathematics.

In September 1987, just before she attended the RLPE INSET residential
week-end, a vacancy occurred at Southgate School, where a mathematics teacher was taking a one term maternity leave. Rita applied and was interviewed. The fact that she was interviewed surprised Rita, because this was a rare event in her teaching career.

Rita

......... and so again I applied and this time had an interview and he said, "Well, yes we will give you a try." .......... and......ermm...... as that maternity leave finished..........which from my point of view seemed to have gone very well .....er..... the Headmaster said, "Well this man in the next room wishes to retire and you are obviously happy here .....ermm..... why don't we try and work it so that he goes and you stay,while we advertise for a proper teacher."

Southgate School is a mixed, 11-18, comprehensive, County School (owned and provided by the County Council) with a roll of approximately 1042, a 'planned admission limit' (PAL) at 11+ of 210 and at 16+ of 50. It is situated in the extreme south of the county in a rural area. Rita stayed at Southgate for a whole year and was apparently valued by the Headteacher and by the Head of the Mathematics Department, both of whom confirmed this in interviews with the author. Towards the end of the Spring term the post Rita was filling as a temporary teacher was advertised as a permanent position.

Rita

.........when the job is advertised in a fortnight or so .....ermm..... I have expressed an interest in it and the Head of Department has .....er...... said that yes he .....ermm..... would also be pleased if I applied for the post. We'll see how it goes from there. But .....ermm..... I feel myself that if there are lots of people apply with qualifications again they are going to beat me to it though .....ermm..... I feel......well I suppose I feel quite confident.......the Head of Department here has been happy with me........ I mean he knows there is an area of mathematical training still very necessary for me .....ermm..... and .....er..... you know we will have to bear that in mind really that if other applicants come and they look good I don't stand a chance.
Rita was still in a difficult position as a teacher of mathematics with limited qualifications, despite the high regard which senior staff had for her work. The author was able to observe this work on two occasions. Before interviewing Rita, at Southgate on 24 March, 1988, the author observed Rita teaching a mixed ability second year class in the room she referred to as her room. It was arranged informally so that small groups of children could work together at practical, problem solving and investigational work and so that a 'circus' lesson could be easily accommodated. The walls and ceiling were decorated with examples of the children's mathematical work. A BBC microcomputer, monitor and disc drive was situated in one corner.

Rita was using material from the Loughborough Practical Mathematics package. The class was divided into 7 groups and Rita had organised a 'circus' using 7 exercises from the package. One of the exercises involved the microcomputer. A support teacher was assisting with remedial children. It was pleasing to observe how well Rita employed the Loughborough material and the methods she had experienced on the RLPE INSET course. She admitted that the RLPE INSET had changed her teaching style.

Rita
I expected..... and wanted....... to sit down and be talked at.......... I wanted to sit down like I did at my O level class and be told what to do .....ermm..... I felt this is how I learnt best........... and it took me until between the Easter and the Whitsun to realise that the way that you were teaching me in terms of..... well....... "Get up and do it, get up and experiment"........ was actually good for me........because that's the way things are done now........ in fact, that's the way things are done now in my maths classroom..........ermm..... "Get up and experiment" .....ermm..... but I had to learn that rather than be told it

PKA
Did that experience change you?

Rita
Yes, yes immensely

PKA
So you are teaching that way now because of that?

Rita
Yes, yes, immensely .....ermm..... I find .....er..... my whole discipline has changed I am very much more relaxed with the children now
even though I really have 2 rather naughty lots of 4th years .....ermm..... here which are always very tiresome..........................

Later in the interview when describing an unexpected success with a difficult group Rita expanded this theme.

Rita

......... it has been better than I anticipated and that's because I came on the course and it made me rethink......... I didn't rethink it..........er..... it evolved within me.....One day it came over me like a cloud........"Oh my God, I'm being taught in the way that modern teachers are supposed to teach and so this is how it feels to be a pupil."

Rita's relaxed manner and her willingness to experiment with new methods was evident in the lesson observed by the author. The 'circus' was a great success and ran very smoothly. The children were very active and enthusiastic. A great deal of discussion took place between the two teachers and the pupils and between the pupils themselves. The author was soon participating as a third teacher.

The interview extracts presented above are taken from the transcript of an audio tape. However, in an unrecorded conversation Rita told the author, who had commented on the wealth of children's work decorating the class, that others had commended her on this decoration. After she had been at the school for half a term the Head of Mathematics had told other members of the department that they should follow Rita's lead and brighten up their classrooms. This has not been received too well by a couple of colleagues who were mathematics graduates. Later a member of HMI had reported that he thought classrooms in the mathematics department left something to be desired, with the exception of Rita's room. This also produced some antagonism. Rita had received a number of complaints from other members of staff because her pupils often blocked the sink in the mathematics preparation room with paper and glue when cleaning up after lessons.

In May the author received a letter from Rita to say that she had been unsuccessful in her application for the mathematics post at Southgate
School. The appointment had been given to a newly qualified mathematics graduate. Rita was disappointed and the Headteacher was a little embarrassed. He had asked Rita to tell the author that the only reason Rita had not been appointed was her lack of suitable qualifications. He had indicated that he would like to discuss the circumstances with the author because of Rita's involvement with the RLPE INSET scheme.

Subsequently the author arranged to visit Southgate on 9 June to observe Rita's work over a whole school day. The Head was pleased to agree to this since it would enable him to speak with the author informally. The Head of Department, Keith Clamp, also welcomed the visit. Keith confirmed, in a telephone conversation with the author, that Rita was an excellent mixed ability teacher and he was pleased that she had been invited to help at the Head of Mathematics Conference which he was helping Frances Watts to organise. Frances Watts also confirmed that Rita was doing excellent work in classrooms when the author spoke to her by telephone.

Before that visit both the Head and the author had been making attempts to find suitable re-training opportunities for Rita. The Head had spoken to County Hall about possible funding. The author had contacted another University which was developing a Diploma Course in Mathematics and Mathematical Education for teachers of mathematics with limited qualifications. He persuaded Rita to apply for that course which she did. Consequently Rita attended an interview and was accepted. Rita continued her attempts to obtain financial assistance to re-train. She thought that only limited funding would be available and that this would result in some hardship and inconvenience for herself and her family. After family discussions she decided to join the course but, unfortunately, her attempts to obtain financial support founder at County Hall and she abandoned the idea of re-training.

Clive Peat, Rurishire Mathematics Inspector suggested that Rita's training on the RLPE INSET Scheme was adequate. He had seen her work and considered it to be an example of "good practice". He promised to support Rita if she applied for mathematics posts in the county.

Rita was considering two positions at the time. One was near Southgate but in the next county. The second was in Rurishire. Rita was not convinced that
the second post would be suitable for her, although she preferred to stay in Rurishire to continue the RLPE INSET work and to keep in contact with the other members of the group. The Rurishire school had the reputation of using very 'traditional' didactic teaching methods. Rita was becoming very despondent as the following extract from a letter she wrote the author on 1 June 1988 indicates:

"It looks as though I shall be jobless in September."

The author revisited Southgate School on 9 June, 1989 and observed Rita's work over an entire school day. Briefly Rita's timetable (entirely mathematics lessons) for that day was as follows:

<table>
<thead>
<tr>
<th>Time</th>
<th>Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.30 a.m.</td>
<td>3rd year group</td>
</tr>
<tr>
<td>10.40 a.m.</td>
<td>4th year group (set 7 of 9)</td>
</tr>
<tr>
<td>11.35 a.m.</td>
<td>3rd year group (set 5 of 7)</td>
</tr>
<tr>
<td>1.50 p.m.</td>
<td>1st year group (mixed ability-SMP 11-16)</td>
</tr>
<tr>
<td>2.45 p.m.</td>
<td>4th year group (set 3 of 9)</td>
</tr>
</tbody>
</table>

The observation during the day confirmed the impressions that the author had formed on his previous visit to Southgate. Rita was willing to try a variety of methods in her teaching. The author observed exposition, demonstration, discussion, practice, problem solving, investigations and practical work in Rita's lessons. Teacher produced worksheets, SMP booklets, GAIM materials and Loughborough Practical Mathematics exercises were all used during the course of the day [SMP 11-16, 1985, GAIM, 1988, CAMET, 1987]. In group work Rita moved frequently from group to group enthusing the children to work at exercises. Occasionally she would address the whole class on points and questions which had arisen in particular groups. The children were constantly encouraged to write up results and often Rita stopped to remind them how they should do this. She cajoled slow groups to work harder, using her good sense of humour and wit effectively, so that the 'circus' activities etc. worked smoothly. The microcomputer was in constant use throughout the day. Rita used it for demonstration (electronic blackboard style with SMILE software: Angle 360, Reflect), children performed investigations (Snooker, Frogs) on the microcomputer during lessons and at breaks a steady stream of children arrived (encouraged by Rita) to use the machine and software for a variety of purposes (for example, simple
There was an emphasis on practical work and the use of apparatus (scissors, card, glue, sellotape, rulers, protractors, calculators, multicubes, MIRA's, geo-strips, counters, dice, tiles). These were all observed in use during the day but, through informal interviews with pupils during the course of lessons, the author found that this was not always the case. Children expressed a variety of opinions and described different experiences.

During the second period with the 4th year the author talked to a boy who had completed his practical exercise before the other children.

PKA
You've finished have you?
Boy A
Yes.
PKA
That was quick........Do you like this type of work?
Boy A
Yes
PKA
What do you like about it?
Boy A
Because I can get on and do it without listening to her.........Mrs Rigg.
PKA
Do you often do this type of Maths?
Boy A
Now and then.
PKA
But not always?
Boy A
No, she talks to us....I don't like that......I'd rather do this.
PKA
Do you always work like this......with card and stuff?
Boy A
No, sometimes we use books.
PKA
Do you like that?
Boy A
Yes, if I can get on on my own.

PKA
Do you use books more or do you do this sort of practical work more?
Boy A
We use both.

In period 3 the author talked to two third year girls as they cut out geometrical shapes from card.

PKA
Do you often work like this......cutting out with scissors?
Girls
Yes.
PKA
Often?
Girl A
We sometimes work from the board. (Points to blackboard)
PKA
About how much do you work at this type of Maths.....about half and half?......How much on the board and how much at practical?
Girl B
Yes.....about half and half we do this.
(The author realised he had probably led the girls to reply in this way)
PKA
What do you like best?
Girl A
On the board.
PKA
Why on the board?
Girl A
Because we can do it quicker.

In the same 3rd year group the author questioned another boy who was trying to fit pieces of card representing a broken plate together to form a whole circular plate.
PKA
   May I ask you a question?
Boy B
   Yes.
PKA
   Do you do this often?
Boy B
   Yes.......What Maths?
PKA
   Well...this cutting out....I know you do Maths often.
Laughter
Boy B
   Yes....you mean practical?
PKA
   Yes...Do you do practical work often?
Boy B
   Yes, its good fun.
PKA
   Do you learn much doing it?
Boy B
   Yes, a lot.

In the afternoon the author spoke to two fourth year girls about the work experience they were about to do as sale assistants at a Littlewoods store. In the course of the conversation he asked if they did practical mathematics work often.

Girl C
   Well, we have been doing revision for exams...... but....yes, we do this pretty often. (They were then designing a kitchen using GAIM materials)
PKA
   Do you enjoy it?
Girl C
   Yes...Well, it is all right.......Yes, it is OK I suppose.............You get a lot of glue on your hands!
During the day the author asked permission, of Rita and the children, to take photographs of the activities and the classroom. They were very pleased to agree. Rita had explained to the children, at the beginning of each lesson, who the author was and why he was interested in their work. As photographs were being taken she often had to explain once more. For example;

Boy D  
What's he taking pictures for?  
Rita  
He's from Loughborough University. He's doing research. He's my teacher.  
Boy E  
What's he researching?  
Rita  
Well, people who teach teachers like me to teach Maths don't often get into see a school, do they?  
Smiles at author.  
Boy E  
Oh...yes........appears satisfied with the explanation.

The author subsequently sent all the photographs to Rita, who used them at a Parents' Evening. The parents were delighted to see the photographs and they helped to make the evening a success. The author was aware, from conversations he had witnessed between Rita and her Head of Mathematics during his day visit, that Rita was not only a 'key' person for the continuing RLPE INSET programme, she was also a leading figure in arranging and designing school events such as the Parents' Evening.

The following sample of photographs illustrates some of the events and situations that the author observed in Rita's 'room' at Southgate school [vide infra Photograph 1 and Photograph 2]. The class shown is involved in exercises taken from the Practical Mathematics package produced by CAMET and from GAIM material. The room is arranged so that the pupils can work in groups and so that discussion can take place easily between themselves and the teacher. Resources are much in evidence (and in use) and the work of children is displayed prominently (a feature on which HMI commented approvingly [vide supra this section]).

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At lunchtime on 9 June the author spoke to the Headteacher of Southgate
School. The Head had made a special point of joining Rita and the author for lunch in the school refectory. He asked if he and the author might have a brief talk in his office after lunch. In his office the Head explained that, although he agreed with the Head of the Mathematics Department that Rita was an excellent teacher for the type of groups for which she was currently timetabled, he and the Governors of the school had felt obliged to appoint a mathematics graduate to the post in question. He and the Governors thought highly of Rita. The RLPE INSET scheme, in his and the Head of Mathematics opinions, had been extremely beneficial in forming Rita's style and methods of work. Although she had only been at the school a short time, Rita had changed the mathematics department and she had 'shown them how to do things'.

As the author was leaving the Head's office to return to Rita's classroom he found Keith Clamp the Head of Mathematics waiting in the foyer to speak to him. He re-iterated all that the Headteacher had said. Keith had hoped that Rita would have stayed in his department because she was a good example to the rest of his staff. He was pleased to see the ideas from the RLPE INSET scheme being put into practice by Rita. Keith was not hopeful that many other schools in Rurishire would adopt such methods. In his opinion many Rurishire schools were "rather backwards". He predicted that some of the Heads of Mathematics would make the excuse that they could not use these new ideas in the lower school years because departments lacked mathematics specialists.

On 15 July 1988 Rita was interviewed for a permanent mathematics post at a secondary modern school for girls in Rurishire. She was appointed and assured by the Headteacher that she would be expected to continue the style of practical work she had been following at Southgate School.

"A private word from the Head: "I've appointed you to do what I hear you are good at." So scissors and glue are in order."

Rita Rigg (16 July, 1988).

In November 1988 Frances Watts reported to the author that Rita was not happy at her new school. This was apparently true at the time, as Rita confirmed when the author spoke with her on 11 July, 1989. In that
conversation Rita revealed that she had found the school extremely 'traditional' in terms of staff attitudes and methods. The staff were extremely resistant to change and reluctant to discuss new ideas. When Rita had attempted to discuss her teaching commitment at the start of the school year the Head of Mathematics had simply given her an SMP student's text, lettered books, and suggested Rita worked through it with her class. Rita states that she was told by the Head of Department, "When you have completed that I shall give you the next in the series." During the Autumn term Rita had considered resigning but had decided to continue working in her own fashion. She had prepared her own learning materials for classes, using a photocopier in the school, which she claims is used infrequently by colleagues. She had continued to use practical mathematics and computer software. By the end of the school year she was working closely with a colleague who had recently begun to teach more computer studies and information technology than mathematics. They planned to team teach and to use the 'circus' strategies which Rita had developed following the RLPE INSET scheme. Rita was using microcomputers in both Mathematics and French lessons. She had joined a group in the county who were developing teaching strategies using desk-top publishing. Other colleagues were beginning to take interest in her practical mathematics lessons. At least two colleagues in the Mathematics Department had asked if they might borrow Rita's 'Glue'. By her own account Rita had established herself in the Mathematics Department, and in the school and was effecting some change in attitude and methods amongst other staff. She had also attended an SMP Accreditation Course where she had been pleased to meet Derek Castle. That two members of the RLPE INSET scheme attended this course in 1989 is pleasing and constitutes some degree of INSET continuation. Rita also had some contact with Jennifer Hall who she had met at another teachers' INSET activity unconnected with mathematics. The Rurishire Mathematics Newsletter had not been circulated in Rita's school so she had not seen the open letter from Barbara Charlton [vide infra 6.72].

6.72 Barbara’s Story

Barbara's background as a teacher contrasts sharply with that of Rita. Appendix 1, paragraph A12 of Mathematics Counts describes four arbitrary categories of qualifications of mathematics teachers. Rita would have ben
placed in the 'nil' category since she was a qualified teacher without any recorded mathematics. However, as Barbara held a Certificate of Education, having followed a secondary course in which mathematics was the main subject she would have been classified as an 'acceptable' mathematics teacher. In many ways, Barbara was not typical of the teacher who attended the RLPE INSET scheme and would not have been placed by DES in their 'hidden' shortage. Nevertheless she had found the scheme appropriate. She had done very little INSET before and had welcomed the opportunity to learn more about things such as vectors, matrices, transformations and functions: many of which she had taught herself when faced with teaching SMP. In an interview in March 1988 the author asked Barbara about her Certificate in Education with her main subject mathematics which she was awarded in 1963.

PKA
Did you find that particular qualification was adequate for the work you had to do here?
Barbara
Not the original one because Maths has changed so much...
PKA
So what have you done about it, because you haven't been on any in-service courses?
Barbara
Yeah.....er...taught myself(laughs).
PKA
Why did you opt to come on our course?
Barbara
Because I thought that I need.....and it was such a long time since I trained....Everything I've done since is what I've thought up for myself..and I just wanted some ideas really...in fact I needed to.....because it's just........My whole career, to be honest.......I've just gone along doing what I think is......should be done......er...and nobody's ever said it shouldn't (laughs and shrugs as if resigned to this state of affairs).

Barbara was an experienced teacher, who had taught mathematics in a number of schools and counties over a continuous period from 1963 to the present time. Currently she is Deputy Head of Midchester County Secondary
School: a mixed, secondary modern with a roll of 473 and a planned admission limit of 101. She was appointed as Senior Mistress in 1980 and when the Deputy Head left she was invited by the governors, without interview, to fill the vacant position. Her position in the school meant that she often felt obliged to fill in gaps in the timetable. During the interview it emerged that it was the first year Barbara had taught only mathematics in the school (25 periods out of 40). She welcomed this, as she regarded herself as a mathematics specialist and liked to teach the subject. This pleased the Headteacher who encouraged her to teach more mathematics. In previous years she had taught "every subject under the sun". This included a great deal of science, but since a full-time science specialist had been appointed she had been "relieved of that, and our part time staff now do a lot of the oddments, so I don't have to fill the timetable up". Barbara's position, as Deputy Head of School, does affect her teaching. This raises questions about which teachers, qualified or not, should be included in the hidden shortage.

Barbara

But it is difficult.... being deputy as well......because....like......the other week, when the Head was off for a week...I had to do his work and my teaching....couldn't have anybody in......I mean....I had to literally leave...the classes with work and trust to luck....

Nevertheless, Barbara's position and the fact that the mathematics department of the school was small and not self-contained had given her a great deal of freedom to use her own ideas and those from the RLPE INSET scheme in her teaching.

PKA

And what did you get out of our course? Did that meet your needs?

Barbara

It set me thinking on a lot of things...mm....but...yes, lots of ideas of practical things...but it led me on to......to my ideas...

PKA

So did these ideas of yours come from our course or were you thinking of them before?

Barbara

No I think they came...I think they came from the course because the
course gave me some time to actually sit and think about it .......and that made me think.......Well, if I hadn't gone on the course I suppose I wouldn't have concentrated on it so much...because I would have just gone on ...doing what I thought I could....and, then, I tried to make a lot of the maths practical.....and lots of...little group work and things......er....because I've always done that....but I think that made me really think I ought to do a lot more and there's a lot more that ought to be done.

The other staff who taught most of the mathematics in the school were the Head and Assistant Head of the Mathematics Department and the other Deputy Head of School. In addition the Physical Education Teacher and a probationer CDT (Craft, Design and Technology) teacher taught a little mathematics (2 hours each per week). Barbara had encouraged the CDT teacher to use practical work in his mathematics teaching and the Head of Mathematics Department was building up a significant resource of practical equipment, including surveying equipment. It is likely that Barbara had more influence on this than she cares to admit.

Ray Oldham the Head of Mathematics at Midchester School was, according to Barbara, a very enthusiastic Head. She had discussed with him the practical work she was doing and he had observed a little of her teaching in this area. Apart from her own Head of Department, she has a low opinion of Heads of Mathematics in the county. (This was apparently reinforced later when she assisted the researcher in a workshop at the County Heads of Mathematics Conference). Although this is only opinion it is interesting that a senior member of a school expresses it. Much of Barbara's thinking as a 'key' person of the continuing INSET programme appeared to be connected with a need to convince other Rurishire teachers, and particularly Heads of Mathematics Departments, that the ideas and methods emanating from the course should be accepted. She apparently had little faith in those teacher's ability to consider changing the old order and traditional approaches. Barbara hoped to overcome teacher resistance to development by relating INSET 'follow-up' to syllabus demands.

Barbara
Because I found..... talking to some other people in the group (the members of the 'Pilot Experiment')...... that they go back....and their
Heads of Departments don't really want to know......you know they're probably unintelligible......we're lucky because ..Ray Oldham will...if he wants to know about it and everything......he is introducing a lot........but I think, generally, in Rurishire people have taught in their schools for donkeys' years......I mean we've got people here who have been at school...twenty five to thirty years....and they don't want to change...they just want to keep going on, as they've been doing...and I think the hardest thing is that, probably, these people are going back..their Heads of Departments are probably teachers who have been teaching...twenty to twenty five years... and they don't want to change.

Barbara thought there was a need for agencies and advisers to be involved in any continuing INSET provision, in order to introduce new ideas, to maintain momentum and to take some responsibility for organising programmes. Although she had been organising the next 'follow-up' session she could foresee difficulties in maintaining contact with other members, because teachers changed appointments and moved away. Advisers should assume some responsibility for this. With assistance and encouragement she thought most members would be keen to work in an on-going INSET programme. Nevertheless there were difficulties. Commenting on her communication with members when organising the 'follow-up' session she remarked;

**Barbara**

Most people....on the whole, I felt, were really very enthusiastic........being frank....I mean......I think some...perhaps...were a bit reluctant ...but on the whole most people wanted to... and..er...those that wanted to, I think, would perhaps make an effort to keep it.......more of them..if they felt it was still wanted or that it was........still alive........If they could................but it really is a lot of it is.....comes back to the Heads of Departments......I know it does.....can they justify ..a whole week to train...do one point...because it is....it is pressures of the exam.... ...and there's so much to get through.....I find this.

**Barbara**

That's where, the Heads of Departments....and the established maths
staff....really, they want a course...on all this work..because they're the ones who are there on the ground all the time....

PKA
And all what work?

Barbara
Oh, with practical work that we want to do.....

PKA
So you think there ought to be an extension of in-service work....

Barbara (interrupting)
I think that if you could convert the Heads of Departments...then...that would be very helpful to people who want to try and do some of it...they're the hardest.......... 

The author had observed some of the work Barbara did at Midchester County Secondary School when he visited in March to conduct the interview from which many of the above extracts are taken. He was also aware of the practical work Barbara was doing with her mathematics classes. However, he requested that he be allowed to observe Barbara's work for a complete school day and a visit was arranged for 8 June 1988.

The author arrived at the school at 8.20 a.m. to find Barbara already at work dealing with the administrative details of the day; such as finding three scribes for three children with broken wrists taking GCSE that day. She remarked that she felt as if she had been at school all night because she had attended a Parents' Association meeting until 9.40 p.m. the previous evening. By coincidence she opened her mail to find a copy of a letter from the Rurishire Mathematics Inspector, Clive Peat, requesting her Head to release her to attend the Head of Mathematics Conference, when she would talk to Heads of Departments about "good practice" in mathematics teaching.

The entire morning was devoted, non-stop, to her duties as Deputy Head. Everyday administrative tasks were completed with impressive efficiency, as were random crises. Throughout a hectic and demanding morning Barbara retained a calm composure and tempered encounters with staff, pupils, parents, the "eye lady" and police with charm and good humour. Apart from GCSE problems, two girls had played truant and other children reported that
they were making for a nearby seaside resort, hence the need to deal with parents and the police. Barbara's office also doubled as a medical centre/dispensary and an "eye test" room. The author found the morning quite exhausting and was pleased to accompany Barbara and the Head of Mathematics to lunch in a quiet restaurant outside the town.

Returning to the school the author accompanied Barbara to the classroom which she referred to as her room. Like Rita's 'room' [vide 6.41] the room was decorated with examples of work done by children, most of it practical mathematics. There were also adapted materials from the RLPE INSET scheme on the walls. The tables were arranged so that up to 7 groups of 4 children could work at investigations and practical activities. In fact in the earlier interview the author had learnt that for most of the year Barbara shared the room with other teachers who arranged desks in rows and columns. The desks were traditional (rather old fashioned, with ink well holes) and were not ideal for group work.

At 1.07 p.m. the school bell sounded and 17 fourth year students (set 3 of 4) arrived. Barbara introduced the author and then issued different folders to different groups. The folders contained material from the Spode Group Decision Maths Pack. Barbara reminded the children that calculators, rulers, paper, multi-cubes and centi-cubes were available on the window-sills of the room. She also encouraged them to discuss strategies and solutions in their groups. The children were soon working efficiently although there was little discussion for some time. After about 30 minutes Barbara began to join groups and to initiate pupil-teacher discussions.

At 1.50 p.m. the school bell sounded again. This was to be a double period and the bell seemed to provide a 'natural break' because immediately Barbara gained the attention of the whole class and a discussion started about the merits of strategies and solutions which the different groups had developed. Some groups had only used 'trial and error' strategies and Barbara encouraged them to look for more structured techniques.

The groups continued to work separately. Barbara explained to the author;

"I find the hardest part of this type of work is to keep out. I can get bored. It's not so bad with IMS where I have to teach them but with this I let
them get on."

However, Barbara soon found it necessary to join a weaker group of children and to encourage them to use apparatus, such as multi-cubes, and to adopt an empirical approach. At 2.15 p.m. Barbara discussed the work of the lesson with the whole group. When she had done this she asked the children to return apparatus to store. As they were doing this the bell sounded again and they quickly completed the task and left the room.

At 2.28 p.m a third year class (set 3 of 4) arrived. For some reason Barbara and another teacher had divided this class into two groups; one containing all boys and the other all girls. This particular group consisted of 9 girls. The author questioned Barbara later about this division and was told that because the group was going to do field work in the school grounds it had been decided that splitting the class was a good idea.

The first 15 minutes of the lesson were spent giving out folders and apparatus, reviewing surveying work the girls had done two weeks before and discussing the tasks they were to attempt that afternoon. Three separate groups of three girls each were formed.

At 2.43 p.m. the girls left the classroom and went out to the school grounds. It was raining slightly so Barbara suggested they kept off the grass. Some groups ignored this in their enthusiasm. Before long the groups were scattered about the school ground and were all working keenly and efficiently at an exercise which involved an off-set survey. Some groups were surveying a long length of rubber tubing which they had arranged in shapes of their choice on concrete paths The less wary were surveying flower beds and ignoring the damp conditions. The Head happened to be crossing the car park where some of the girls were working and remarked with good humour to the author that the RLPE INSET course had a "lot to answer for."

By 3.19 p.m. all the girls had returned to the classroom where they worked busily with the measurements they had taken outside to produce scale drawings. Barbara was touring groups, discussing units, scales and drawing techniques.
The photographs above illustrate some of the work observed during that afternoon in the classroom and in the school grounds. Photograph 3 shows the efforts Barbara had made to rid her room of rows and columns, despite the rather 'old fashioned' desks with which the classroom was furnished. The girls worked well in groups, although the facilities were far from ideal. Photograph 4 shows a group from Barbara's class conducting an exercise taken from the set of surveying exercises prepared by CAMET and given to members of the RLPE INSET scheme [vide supra 5.56, Week 19].

The girls had tidied the classroom and stored the surveying equipment and other resources by the time the bell sounded the end of the school day for them. It was not the end of the workday for Barbara because immediately she was summoned by the school secretary;

"Can you come quickly I have Sandra's (the truant) mother on the phone?"

When the author had found his way back to Barbara's office she was unnecessarily apologetic for "dashing off so quickly" and declared;

"I do more social work than anything else. I have more peace in the classroom than out of it."

6.8 Residual Outcomes

Since the RLPE INSET scheme was never designed as a 'means-ends' development, the term 'outcomes' refers to phenomena which were observed as part of the research programme, rather than as goals to be evaluated in terms of their achievement. The previous sections of this chapter describe events which, in the main, took place in the school year immediately following the first phase of the INSET programme. Three 'follow-up' sessions took place in that year [vide supra 6.3, 6.5; 6.6] and 'key' persons began to emerge [vide supra 6.4]. The participation of two of these 'key' persons in a Head of Mathematics Conference [vide supra 6.7] was an important outcome, which held hopes for the future continuation of the programme. Unfortunately the perturbations which took place in Rurishire, at
County Hall and in the Mathematics Inspectorate/Advisory Service [vide supra 6.2] were detrimental to the support which was necessary to sustain a vital continuing, planned INSET provision. These perturbations continued into 1989 with unfortunate but predictable results.

Following the third ‘follow-up’ session of the continuing INSET provision the author adopted a lower profile. It was not possible for Loughborough University to provide the level of input to the provision at the level of the previous two years and, indeed, it was never intended that it should. The author did continue to maintain contact with the Rurishire advisory service and with members of the original INSET scheme, mainly for research purposes, but also to offer advice when requested to do so. In November 1988 Frances Watts contacted the author to inform him that Barbara Charlton was still attempting to arouse support and interest in the continuing INSET programme. An open letter from Barbara to all teachers of mathematics in Rurishire was to be included in a newsletter, edited by Frances Watts, which would be sent to all mathematics departments in schools of the authority. In the letter Barbara briefly described the RLPE INSET scheme and her experiences and impressions of being involved in it.

“Our appetites were wetted from the beginning (with tea I hasten to add), and we were ready to revolutionise the mathematical world or guarantee to increase the number of early retirements of Heads of Maths throughout the county by requests for PRACTICAL Maths.................We not only gained lots of ideas and tested our confidence to try them out by a practical approach to the syllabus, but also extended our own mathematical knowledge.............If anyone reading this gets the opportunity of going on a similar course I would thoroughly recommend it. For past members of "Mathaholics 87" if you would like to continue meeting and discussing current issues in mathematics education please get in touch with Frances Watts at the Maths Centre (Phone...........) as soon as possible.”

Barbara Charlton
(Rurishire Maths Newsletter, December 1988).

When the author spoke to Frances Watts in November 1988 he enquired about plans for future meetings of the INSET group. Frances admitted that she had been too overworked to do much about it. This was not altogether
surprising because the county had no Mathematics Inspector for the last month and Frances was the only secondary mathematics ESG teacher in the advisory service. The author suggested that Frances should contact Joan Warwick, Brian Bird and Roy to prompt them to organise a meeting. The author was aware that Joan and Brian, whom Frances had already contacted, were doing some development of the Practical Mathematics package in their schools and that Roy had possible access to the NERIS (National Educational Resources Information Service) database in his school [Taylor, 1988]. Frances agreed to contact these teachers.

Shortly afterwards, in November, Roy phoned to promise to send the author papers he had prepared on his RSA work. He had been busy organising trips to gardens in connection with a Mathematics Project he was conducting with his low attainers. Roy and the pupils had apparently set up a small business venture growing and selling plants. He said he was more relaxed, happier and confident and "broken a mould" as a result of the RLPE INSET course. Nevertheless, he was still having problems in school with other staff who ignored him. For example, a profiling system had been introduced in the school but he had not been consulted despite the RSA work he had been doing in this area. The author discussed the NERIS database with Roy, who promised to investigate the situation with a view to planning a 'follow-up' meeting of the INSET group.

In December Frances Watts phoned the author to seek advice on the NCC Consultation Report, Mathematics in the National Curriculum. In conversation it emerged that Roy had made no progress with plans for a future meeting. In addition the author had not received the RSA papers promised by Roy. As a result of this apparent inactivity the author suggested that Frances contact Joan and Brian again.

Despite the enthusiasm which is evident in Barbara's open letter she informed the author on 7 July 1989 that she had had no response from any teacher or officer in the county, other than Frances Watts. Barbara had apparently lost touch with other members of the course. She had also been extremely busy with the demands of the Education Reform Act. Much of her work during 1989 had been directed towards Mathematics in the National Curriculum, Management Training and Appraisal Training. However,
Barbara told the author that she was continuing to develop her work on practical mathematics within her classroom. In addition she and the Head of Mathematics were working with other members of the school to develop some cross-curricula activities, which included some practical mathematics and other ideas she had encountered on the RLPE INSET course.

On 5 July 1989, the author spoke, by telephone, to Frances Watts. She was still working from the Midchester Mathematics Centre. She reported that the new Rurishire Mathematics Inspector, who had been with the authority from April 1989, was based at County Hall and had little direct contact with her work. He was fulfilling an 'inspectorial' role rather than acting as an advisor. A CDT advisor had been placed in charge of all INSET activities. Frances thought he was unaware of her own work in INSET Mathematics. He planned to turn the Midchester Mathematics Centre into a Teachers' Centre for Mathematics, Science and English. Frances was still the only secondary ESG advisory teacher in Rurishire but had decided to return to her School permanently from September 1989. She was far from happy with the INSET Mathematics support in the authority.

It would appear that in the absence of commitment from the local authority and the purposeful withdrawal by the outside university agency the task of continuing the INSET provision proved too much for the members themselves. Lines of communication appear to have been inadequate.

Rita told the author that she had never seen the second 'Rurishire Mathematics Link' Newsletter which Frances Watts had circulated to schools. Barbara had not seen Mark's inventory which the county had published. Mark Davis was interviewed during the period he was on secondment and visiting schools around the county. Commenting on a letter about a possible repeat of the RLPE INSET scheme he made some interesting observations on communications within the county.

Mark

...... something went wrong somewhere when they said there was no take up on the repeat of the course because I've met lots of people in schools who said I didn't know it was going to be repeated or didn't know it was going to be offered.
This is when you were going round to schools?

Mark

Yes..........Going back there....I mean my old school, the Head of Department ditched the letter because there was nobody interested and yet somebody in one of the departments wants to change across from games and geography into maths and ......er.... somebody just hadn't thought ....and the other people ........this has been a discussion point because it came up at one of the last meetings that we had that nobody was aware that this letter had gone into school..........Nobody on the course had realised that a letter had gone into school, it hadn't even been discussed. I think a lot of people in schools who would want to do that course but for some reason it just disappeared.

This breakdown in communication links is unfortunate because the analysis of survey, observational and interview data suggests that 18 of the RLPE INSET members favoured some form of continuing provision, even if this meant establishing only a communications network between each other. Apart from Rita and Barbara none of the teachers took steps to organise a continuation and, interestingly, those two 'key' persons and Joan, a potential 'key' person, indicated in interview that they regarded organisation of a continuing provision to be the responsibility of the advisory service.

Roy had shown some interest in a continuing provision, when pressed by the author, but his subsequent inaction suggests that he was not committed to it.

Brenda was rather equivocal.

PKA

Would it be an advantage to have a more formal network.....so that you could communicate with other people?

Brenda

Well, it would be for me..........but...I can only speak for myself.......Perhaps.....I can be accused of being arrogant.......I think....I just...I don't want to be a.......I just want to stay.....be above it.

Austin appeared not to be enthusiastic about joining a 'follow-up' scheme. In
interview he said that his own travelling arrangements, since redeployment, would make it difficult for him to attend the next 'follow-up' session which was being organised and since it appeared not to be very relevant to his teaching he would not be attending. He thought it would be a good idea if contact between members was maintained "to exchange ideas" but, as it was, he had little contact with any of the others. His redeployment seems to have been a major factor in his lack of interest.

Although the perturbations in the Mathematics Inspectorate and Advisory Service appeared to be the major reason why the INSET provision failed to continue in any organised fashion it is also likely that pressures on teachers (for example, GCSE, 'Baker Days' and subsequently the National Curriculum [Department of Education and Science, 1985a, 1988]) and constraints on schools brought about by the Educational Reform Act 1988 played an important part. A potential research programme might investigate how INSET provision for teachers with limited qualifications and experience in mathematics was affected by these pressures and constraints. A more general open research question concerns the adequacy of school-based INSET for mathematics teachers in the 'hidden shortage' [vide infra 7.46, 8.33].

Under the prevailing circumstances the ultimate outcome of the RLPE INSET scheme is likely not to be a planned programme of continuing INSET. Its outcomes are more likely to be found in the changing attitudes and approaches of individuals [vide supra 6.71, 6.72 and infra 8.4] and the incidental effects these have on colleagues in schools.
Chapter 7

THE MEMBERS OF THE RURISHIRE/LOUGHBOROUGH IN-SERVICE EDUCATION SCHEME

7.1 Introduction

In order to interpret the data and its analysis, which has gone before and which will follow, it is important to provide a description of the twenty one teachers who formed the membership of the RLPE INSET scheme. Some description has already been given, as an intrinsic part of the case study, and two 'key' persons have been described in some detail. What follows is a supplementary description of all the members. This description is based on questionnaires, interviews, conversations, participant observation and a variety of documentation. The interview extracts are taken from informal (informant) interviews [Powney et al., 1987] conducted in the members' schools (with the exception of Mark, who was interviewed at his home).

Far too frequently, 'hidden' shortage is used as a blanket term by commentators, who appear to have had little chance to observe and to become acquainted with the teachers concerned. On occasions, researchers and INSET designers are also guilty of making assumptions about the 'hidden' shortage which are not justified by evidence. The following section analyses observational data, so that a naturalistic, descriptive model of a particular set of teachers, who might be identified as members of the 'hidden' shortage, emerges.

7.2 Qualifications

The DES Consultative Document Action on Teacher Supply in Mathematics, Physics and Technology [Department of Education and Science, 1986b] is somewhat vague in its 'definition' of the 'hidden' shortage. The 'definition' reads:

"hidden shortage - where tuition in a subject is given by teachers considered to be inadequately qualified in it or to be lacking the personal qualities required for effective teaching."
One has to seek further to clarify what DES might mean by the 'hidden shortage' in Mathematics. The Consultative Document refers to the 1984 Secondary School Staffing Survey [Department of Education and Science, 1986e], which *indicated that some 13% of timetabled tuition in Mathematics and 18% in Physics was provided by teachers with no higher education qualifications in the named subject*. A clue to what DES mean by "no higher education qualification" is then given by a graphical representation of the data collected in the 1984 Secondary School Staffing Survey. Figure 1(7) below illustrates the graphical representation as far as Mathematics tuition is concerned.

**Fig. 1(7)**

**Level of subject qualifications in the subjects taught**

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>13.00%</td>
<td>England and Wales</td>
</tr>
<tr>
<td>15.00%</td>
<td></td>
</tr>
<tr>
<td>27.00%</td>
<td>Mathematics</td>
</tr>
<tr>
<td>45.00%</td>
<td></td>
</tr>
</tbody>
</table>

Proportion of tuition by teachers with the subject as:
- Main subject of a degree
- Main subject of another qualification
- Subsidiary subject of any qualification
- No higher level qualification in the subject

Under this DES definition 16 members from the RLPE INSET group of 21 teachers would belong to the 'hidden shortage'.

The Cockcroft Report, *Mathematics Counts* [Department of Education and Science, 1982] provides another means of classifying the qualifications of Mathematics teachers in paragraph 625 and in Appendix 1 paragraph A12. Paragraph 625 states, "all those teaching Mathematics were assigned to one of four levels of qualification, 'good', 'acceptable', 'weak', 'nil'." This classification has been used in the following table, which lists the qualifications of members of the RLPE INSET scheme, since it is more appropriate to the group of teachers concerned. The 1984 Secondary
School Staffing Survey was a "snapshot survey of a sample of all types of maintained secondary schools in England during one week in January 1984" [Department of Education and Science, 1986e] and considered only full-time teachers. The RLPE INSET group included full-time, part-time and supply teachers.

Table 1 below summarises the qualifications of the members of the RLPE INSET scheme on 1 September 1987. 'Main subject' refers, in most cases, to the Certificate of Education courses taken by the particular teacher but, in the case of a teacher with a degree, it refers to the main subject of that degree course.

<table>
<thead>
<tr>
<th>Name</th>
<th>Degree</th>
<th>Certificate</th>
<th>Main Subject</th>
<th>Highest Maths Qualification</th>
<th>Cockcroft Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Andrew</td>
<td>-----</td>
<td>CertEd</td>
<td>Biology/Geography</td>
<td>GCE O Level</td>
<td>nil</td>
</tr>
<tr>
<td>Mark</td>
<td>-----</td>
<td>CertEd</td>
<td>Religious Education</td>
<td>GCE O Level</td>
<td>nil</td>
</tr>
<tr>
<td>Austin</td>
<td>-----</td>
<td>CertEd</td>
<td>Physical Education</td>
<td>Ancillary</td>
<td>nil</td>
</tr>
<tr>
<td>Barbara</td>
<td>-----</td>
<td>CertEd</td>
<td>Mathematics</td>
<td>Main</td>
<td>acceptable</td>
</tr>
<tr>
<td>Patrick</td>
<td>BEd</td>
<td>CertEd</td>
<td>Physical Education</td>
<td>GCE O Level</td>
<td>nil</td>
</tr>
<tr>
<td>Glynnis</td>
<td>-----</td>
<td>CertEd</td>
<td>Biology</td>
<td>GCE A Level</td>
<td>nil</td>
</tr>
<tr>
<td>Wendy</td>
<td>BSc</td>
<td>----</td>
<td>Psychol/Zoo/Botany</td>
<td>GCE O Level</td>
<td>nil</td>
</tr>
<tr>
<td>Brian</td>
<td>-----</td>
<td>CertEd</td>
<td>Physical Education</td>
<td>Ancillary</td>
<td>nil</td>
</tr>
<tr>
<td>Rita</td>
<td>-----</td>
<td>CertEd</td>
<td>Theology</td>
<td>GCE O Level</td>
<td>nil</td>
</tr>
<tr>
<td>Jennifer</td>
<td>-----</td>
<td>CertEd</td>
<td>Remedial Education</td>
<td>CSE</td>
<td>nil</td>
</tr>
<tr>
<td>Bill</td>
<td>-----</td>
<td>CertEd</td>
<td>Biology</td>
<td>Ancillary</td>
<td>nil</td>
</tr>
<tr>
<td>Ursula</td>
<td>BEd</td>
<td>CertEd</td>
<td>Languages</td>
<td>Arbitur &amp; OU</td>
<td>nil</td>
</tr>
<tr>
<td>Joan</td>
<td>-----</td>
<td>CertEd</td>
<td>Geography</td>
<td>Ancillary</td>
<td>nil</td>
</tr>
<tr>
<td>Jack</td>
<td>BSc</td>
<td>PGCE</td>
<td>Metallurgy</td>
<td>ONC</td>
<td>weak</td>
</tr>
<tr>
<td>Derek</td>
<td>-----</td>
<td>CertEd</td>
<td>English</td>
<td>Subsidiary</td>
<td>nil</td>
</tr>
<tr>
<td>Brenda</td>
<td>BA</td>
<td>PGCE</td>
<td>History</td>
<td>GCE A0 Level</td>
<td>nil</td>
</tr>
<tr>
<td>Roy</td>
<td>BA</td>
<td>CertEd</td>
<td>Economics</td>
<td>Maths re-trained</td>
<td>acceptable</td>
</tr>
<tr>
<td>Steve</td>
<td>-----</td>
<td>CertEd</td>
<td>Physical Education</td>
<td>Ancillary</td>
<td>nil</td>
</tr>
<tr>
<td>Sheila</td>
<td>BA</td>
<td>PGCE</td>
<td>English</td>
<td>GCE O Level</td>
<td>nil</td>
</tr>
<tr>
<td>Lawrence</td>
<td>BEd</td>
<td>CertEd</td>
<td>Geography</td>
<td>Subsidiary</td>
<td>acceptable</td>
</tr>
<tr>
<td>Bob</td>
<td>-----</td>
<td>CertEd</td>
<td>Design and Craft</td>
<td>Subsidiary</td>
<td>nil</td>
</tr>
</tbody>
</table>

The table above provides a summary but it requires further explanation. For
example, Rita only obtained her GCE O Level Mathematics qualification in Summer 1987, while she was attending the RLPE INSET course. Ursula had studied Mathematics to Arbitur level in Germany and she also had a letter of completion for the Open University course 'Mathematics Across the Curriculum'. Jack claims that his highest qualification in Mathematics is Ordinary National Certificate, although he has a BSc honours degree in Metallurgy and Microstructural Engineering. Roy had not studied Mathematics as part of his degree but he re-trained in Mathematics by following a one year full-time course. Bob left industry in 1974 to follow a one year training course in, what was then called, design and craft.

7.3 Schools

Rurishire is a large county in terms of geographical area. Its secondary school system is divided into four geographical areas, which are themselves divided into districts. Each school in a district has its own catchment area. A child may attend any school in the county as long as that school has room within a planned admission limit (PAL) and, if the school is a grammar school, the child has been selected by testing. Late transfers are possible on the recommendation and agreement of headteachers. Places are given first to children within a catchment area. Places are also given to children from outside the county.

In fact the secondary system in Rurishire is far from uniform. One area is entirely selective, with grammar schools and secondary modern schools. The other three contain some districts which are selective and some which are comprehensive. Strangely one district has grammar schools, secondary modern schools and comprehensive schools. The RLPE INSET group had representatives from all four areas and from each type of school [vide infra Table 2].

There was also a wide variation in the modes of teaching employment of members of the RLPE INSET scheme. In fact, for a number of members, employment situations changed from term to term. During the Spring term 1987 all of the teachers, with the exception of Wendy on a part-time (half timetable) appointment, had a full-time teaching commitment at a school. However, in the cases of Jennifer, Rita and Bob full-time teaching did not mean a permanent, or long-term, appointment. Jennifer was a supply
teacher, while the latter two members were temporary appointments.

Responsibilities which members held in schools also varied. Barbara was a Deputy Head of School and Brenda a Senior Mistress. Brian was Head of a Physical Education Department and Steve and Patrick were 'Second in Charges' of Physical Education. Mark and Sheila were 'Coordinators of Special Needs'. Lawrence was 'Second in Charge' of Careers. The remaining members were Assistant Teachers with no special responsibilities within a school; although Wendy and Austin each had previous experience as Head of Department (Biology and Physical Education respectively).

Table 2

<table>
<thead>
<tr>
<th>Name</th>
<th>Entered Teaching</th>
<th>Age on 26/1/87</th>
<th>Type of school on 26/1/87</th>
</tr>
</thead>
<tbody>
<tr>
<td>Andrew</td>
<td>1979 supply, 1983</td>
<td>30-39</td>
<td>Secondary Modern Mixed 11-16</td>
</tr>
<tr>
<td>Mark</td>
<td>1971</td>
<td>30-39</td>
<td>Secondary Modern Mixed 11-16</td>
</tr>
<tr>
<td>Austin</td>
<td>1968</td>
<td>40-49</td>
<td>Secondary Modern Mixed 11-16</td>
</tr>
<tr>
<td>Barbara</td>
<td>1963</td>
<td>40-49</td>
<td>Secondary Modern Mixed 11-16</td>
</tr>
<tr>
<td>Patrick</td>
<td>1979</td>
<td>30-39</td>
<td>Comprehensive Mixed 11-18</td>
</tr>
<tr>
<td>Glynis</td>
<td>1971</td>
<td>30-39</td>
<td>Grammar School Mixed 11-18</td>
</tr>
<tr>
<td>Wendy</td>
<td>1957</td>
<td>50-59</td>
<td>Grammar School Mixed 11-18</td>
</tr>
<tr>
<td>Brian</td>
<td>1962</td>
<td>40-49</td>
<td>Comprehensive Mixed 11-16</td>
</tr>
<tr>
<td>Rita</td>
<td>1961</td>
<td>40-49</td>
<td>Secondary Modern Mixed 11-16</td>
</tr>
<tr>
<td>Bill</td>
<td>1966</td>
<td>40-49</td>
<td>Comprehensive Mixed 11-16</td>
</tr>
<tr>
<td>Ursula</td>
<td>1967 part-time, 1973</td>
<td>50-59</td>
<td>Comprehensive Mixed 11-16</td>
</tr>
<tr>
<td>Joan</td>
<td>1961</td>
<td>40-49</td>
<td>Comprehensive Mixed 11-18</td>
</tr>
<tr>
<td>Jack</td>
<td>1984</td>
<td>40-49</td>
<td>Secondary Modern Boys 11-16</td>
</tr>
<tr>
<td>Derek</td>
<td>1973</td>
<td>50-59</td>
<td>Secondary Modern Mixed 11-16</td>
</tr>
<tr>
<td>Brenda</td>
<td>1973</td>
<td>40-49</td>
<td>Secondary Modern Mixed 11-16</td>
</tr>
<tr>
<td>Roy</td>
<td>1961</td>
<td>40-49</td>
<td>Comprehensive Mixed 11-18</td>
</tr>
<tr>
<td>Steve</td>
<td>1973</td>
<td>30-39</td>
<td>Secondary Modern Mixed 11-16</td>
</tr>
<tr>
<td>Sheila</td>
<td>1976</td>
<td>30-39</td>
<td>Comprehensive Mixed 11-16</td>
</tr>
<tr>
<td>Lawrence</td>
<td>1974</td>
<td>60-65</td>
<td>Comprehensive Mixed 11-18</td>
</tr>
<tr>
<td>Bob</td>
<td>1974</td>
<td>40-49</td>
<td>Secondary Modern Mixed 11-16</td>
</tr>
</tbody>
</table>
7.4 Experience and Background

7.41 A Typical Case

Austin's teaching career is an interesting case study of a typical member of the 'hidden shortage' in Mathematics teaching. He left school in 1962 with 5 GCE O levels (including Mathematics) and went to work in a bank. After three years he left the bank and went to college to study for a Certificate of Education, in which his main subject was Physical Education and his subsidiary was Physics. During an interview, Austin told the author that he had studied a "basic" course in Mathematics. On qualifying he was appointed to a secondary school in London, where he taught Physical Education and Mathematics. Approximately one tenth of his timetable was devoted to Mathematics.

PKA
Why did you start teaching Maths?
Austin
I think that's what the......the opening......really......that was to fit in the timetable.....er......plus, I enjoyed doing Maths.

After one year in London Austin moved to Wolds County Secondary School, Rurishire as master in charge of boys' Physical Education.

Austin
Taught, again, nine tenths......three quarters, nine tenths PE and..........Maths......as a choice...er......I've never taught Physics....I've refused to teach Physics.
PKA
Although you were qualified?
Austin
Although I was......subsid....Physics at college. I didn't think that the course....really......er......prepared us for teaching....Physics......As I say, I started teaching Maths...and I've carried on teaching Maths ever since.

After eight years as master in charge of Physical Education at Wolds Secondary School, Austin was transferred to the Mathematics Department of that school as an assistant teacher. In September 1987 he was redeployed
to Central School, Ruriston. This was a move with which he was not entirely happy. He preferred the "country child" to the "city child" and his former "country school", which he had never intended to leave for the rest of his career, to Central School.

Austin
It's a different type of pupil in this school from what I'm used to...really is.
PKA
How? What.......
Austin (interrupts)
In a detrimental point of view.......They don't want to settle down and learn...as much as I found the others....the country child did.....It's not such a.....happy atmosphere.

Austin thought that his redeployment had not been conducted satisfactorily and that this was partly because of his lack of qualifications in Mathematics.

Austin
I had one unfortunate interview......at Heron, where the redeployment rules were broken....but I was told at the end...I wasn't qualified enough for the job....although the headmaster changed the criteria halfway through the interview.........up to then I was qualified, from what he said....then I wasn't...but that's by the by..............When I came for this job...............there wasn't really a formal...There was no formal interview at all....It was just a chat with the headmaster and he wanted someone to fill a place where there was a retiring.....I said, "Right! First thing. Here's my CV. I'm not qualified in....Maths.....paperwise."....He said, "You've been teaching for eighteen years, haven't you?"....He said......he said, "You're qualified!"

Austin's redeployment seems to have affected him deeply; so much so that he has seriously considered leaving teaching to start a business. Teaching "no longer is a challenge", at least, not at his present school.

Austin
It's not the teaching......it's....er......it's not the fact....OK I'm not...a
graduate...I've got enough knowledge to do what I'm doing..........I accept the level I'm doing......I enjoy it......It's getting more......trend in education.....It's the general attitude of the kids............To be truthful..........I do my teaching.......and that's it.....That's the way I feel....I mean, I've been trying to get out for the past year.

One hope, which Austin fostered to keep himself in teaching, was the possibility of another post in the county. He was, however, worried once again about his qualifications; seemingly because of his experience in his last redeployment. Happily, in September 1988, he was successful in obtaining a position at the newly merged Northborough School.

7.42 Work Experience Outside Teaching

The majority of the RLPE INSET group had entered teaching immediately after leaving college or university. Steve had some experience (3.5 years) as a BOAC clerk before going to training college. Ursula had divided her career between teaching in Adult Education/Evening Institutes and working in a bookshop. This had been over a period of 26 years before entering school teaching in 1973. Brenda had worked for the Bank of England for an unspecified number of years (she states this was a substantial part of her working experience) before entering teaching in 1973. Bob had fluctuated between teaching, industry and business and continued to do so after the first phase of the RLPE INSET scheme [vide supra 5.6]. He had worked for Rolls Royce after leaving school.

Bob

I came into education from industry in 1974 after a one year Design and Craft course.......it was then.......but it became CDT........erm......and I went out of teaching into business in 1979........I never taught Maths during that time it was all Craft and Design, Tech Drawing, that sort of thing and it was only when I came back into education two years ago that......er.......I came into the area at all........I came into teaching Maths but for only a limited time......a limited portion of the timetable and then this was only the lower school Maths....and low ability stuff.......erm.........the.....it was simply because that was the way it was timetabled for the guy that I took over from.......who left the school through illness.......and so the Maths was,
sort of, foisted upon me.............I quite enjoyed teaching it. and......er........It would have been nice to have got a permanent post in a Maths department. Yes.....I should have made it plainer that Maths was a subsidiary subject on the course I did........although it was only a one year course.....It was a mature students' course and my qualifications for industry were taken as a basis for that.

Just before joining the RLPE INSET scheme Bob had obtained a temporary post for two terms at Parton School. He began to teach Mathematics there, on the strength of his attendance on the RLPE INSET scheme. He failed to find another teaching appointment for the Autumn term 1987 but, with the help of Sheila Sharma, he found a temporary appointment at St Benedict's School, Ruriston, in Spring 1988. He taught no Mathematics at St Benedict's. Bob appears to be a teacher who is asked occasionally to teach Mathematics, when a school finds it convenient. This is a disturbing aspect of the 'hidden shortage' since for over thirteen years Bob had no INSET provision in Mathematics, apart from the RLPE INSET scheme, and little formal contact with the subject or other Mathematics teachers.

Bill followed a three year teacher training course from 1962 to 1965. Unfortunately he failed his Education examination in 1965. He successfully passed it later in 1966. During 1965-66 he found work as a dairy roundsman. He entered teaching in 1967. After 7 years he left to become a factory operative; reconditioning tyres. He returned as a supply teacher in 1981 and then obtained a permanent post as assistant teacher of Science and Mathematics. Although he was teaching Mathematics when he was attending the first phase of the RLPE INSET scheme, he was not timetabled for the subject in the following school year.

Bill

I started teaching in 1966 in a secondary modern school in Birmingham, where half my timetable was Mathematics and half was General Science. I started that school having trained for 3 years at Upper Stepford, where my main subject was Biology my second subject was Mathematics and, of course, we all had to do English.........I worked in Birmingham for a year, then I moved to Market Worth to the Boys' Central School, which is a small secondary modern school, about 300......My timetable was, again, Maths and

PKA
Can I just ask, why did you leave?

Bill
Pre-Houghton!

PKA
That was the main reason?

Bill
Pre-Houghton!......................I came back in 1981......Went on supply teaching.......Did that for 5 years and finally gained a job at St Margaret's...............I found that I was needed virtually full-time, when I was on supply, because I could offer Maths and the Sciences. Now that I am at St Margaret's I have been doing mainly Physics, Chemistry, Biology and up until last September, I taught fourth and fifth year Maths.......I am not on the Maths timetable this year but the Head of Department assures me that he wants me to go on to do Maths with 4c next September. 4c will be the middle group of a five set Maths groups.

PKA
Is this your choice as well that you would like to do Mathematics?

Bill
I want to do some but......em......he wants me on there and I am quite willing to do it.

Jack has been teaching since 1984, when he was appointed as a Physics teacher at Carson Boys School, his only teaching appointment. Before that, for most of his career, he had been employed as a metallurgist by British Steel. In 1981 he was made redundant, when the steel works at which he worked was closed. Taking advantage of his redundancy agreement, which enabled him to re-train, he went to Sheffield Polytechnic and, after two and a half year's study, he was awarded a degree in Metallurgy and Micro-Structural Engineering. Subsequently, "partly because jobs were very scarce", he completed a one year PGCE course at Trent Polytechnic with Physics as a main course and Mathematics as a subsidiary subject Directly following this course he was appointed at Carson Boys School. His Mathematics teaching timetable has been somewhat \textit{ad hoc} since then. His training did not emphasise Mathematics, or prepare him adequately to teach it. Jack's interview comments raise a number of questions concerning the
usefulness of the definitions, of qualified Mathematics teachers, employed by such authorities as DES [Department of Education and Science, 1986b] and the Cockcroft Report [Department of Education and Science, 1982].

Jack

I've been here since then......as a Physics teacher......but in the first year I took one first year class for Maths......After that I didn't. It was Science and Physics......but this past year I've also had a class of Maths......although, in future, I probably will not.................er.................The training I had on the PGCSE.............er.............PGCE course....in Maths.............er.............was very little, really....Concentrated on Physics.............er.................We did a Maths module but.............er.............We didn't do a lot of training, really.....I didn't feel it helped a lot...........Then........since I've been at this school...........I've done no work on Maths apart from the.............the one year course that we did at Midchester (the Loughborough/Rurishire INSET)...........which I thought was very useful.............er.................I think mainly because we met other Maths teachers and discussed things.............er.................partly....we were taught some Maths....I think most of the teachers actually needed some.............er............more advanced Maths....knowledge.............er.................but mainly.............er.................putting it a...........ways of putting Maths across.................and one thing I found useful was being able to see different Maths textbooks.............and schemes.............er.................I'd have liked more of that actually....To see.............er.................far more of the schemes that are available....perhaps have a closer look at them.

This is an interesting observation from Jack. He appears to be seeking information about, and contact with, resources which may not be available to him in his own school environment. He seems to have some difficulty in using new ideas in that environment.

Jack

I can't say it's (the Midchester INSET) helped.............directly.................in my Maths teaching here..........................but I.............probably.............er.............unconsciously it does.............er.................I've done a couple of investigations this
year..............but apart from that........er...........the course is based on a
textbook...and........er............."follow that".

Derek had worked for approximately 16 years in industry before training as a
teacher. His decision to become a teacher and the steps he took to enter the
profession are interesting.

Derek

I was....yes.....I was in...er....From leaving....myself leaving school.....I
went straight into research laboratories....for Courtaulds......and I was
there until National Service....and I came from National Service,
returned to the same firm in the same laboratories...but then there was
the........The process of consolidation had started...so...staff were
being....er....used in other factories belonging to the same group. And
actually I was in line for a promotion and....but that was put to one side
because of a....people drafted in from other factories within the same
company...you see....so I decided then that.....er.....er....seek....other
employment....er....for more opportunities....naturally....er....and it was
very very difficult...er....at the time, because of what was happening in
industry generally to get another position similar to, or....er....at a scale
above. So, I, for a short time,went into another textile firm but this time
on the selling side,which quite honestly I didn't like, so I bided my time
and....er............with the help of my wife, I think, more than anything else,
she said, "You've always been good with children, why don't you go
into teaching."....... and I'd never really considered it.....and....er....I said,
"Well I haven't got the qualifications". The only qualifications I had were
from....er....Manchester and the School Certificates, see......and the
studying I had been doing part-time in Further Education up
to....er...........er...forget what its called....Oh, National Certificate in
Chemistry.....Quite a bit of Maths involved in that...........but that's....the
only further education that I've done, as I say.

PKA
Was that Ordinary National Certificate?

Derek

That was Ordinary National Certificate, yes, and.....er...I.....I followed
that by Intermediate, you see, National Certificate....in
Chemistry......the......that was successful.................But there weren't any
jobs...so my wife encouraged me and said, "Well.....give it a try and see
if you can get into teaching." ......And...I did...and approached the tech there...Oh, approached.............the education authorities, particularly in....Retford....at Aldershalton..and they said that I...They didn't recognise the qualifications that I had...so...if I wanted to enter teaching, I'd have to get the minimum qualifications, which would......I think at the time.......I don't know if was two A levels or one A level....and three O levels....ah...."If you can produce those, then, you're in for teaching". So I went to the tech down here in Northborough and...er....I did A level English and....er...Science, Physics and Chemistry.....and got those within nine months........which was just a....a revision of the work I'd actually done.....but I then.....with the essentials..........came out with the essential qualifications and......er....got into teaching, you see..........and......er.....Inevitably they ask you what sort of things would you like to teach................and because I always read.......avidly...........thought English would be a good.

Derek's experience of Mathematics teaching was fairly recent.

Derek

My position in the school is split between Mathematics and English; English being my main subject, Mathematics the subsidiary subject. How I came to be in the Mathematics department...ermm......about eighteen months.....two years ago we were all asked to submit our qualifications in the subjects that we studied at college and.....er.....I listed mine as being English, Mathematics and General Science and then from September eighty.....six.....I was timetabled into the Mathematics Department.

PKA

Does that mean you hadn't taught Mathematics before that....... Derek

I hadn't taught Mathematics before...no.

PKA

......although you had done Mathematics as a subsidiary subject......

Derek

That's right yes....but I had never taught it before.

PKA

......in your teaching certificate?
Derek
That's right, yes.

Lawrence was the oldest member of the group. He had a long experience as an engineer and as a teacher.

Lawrence
Before the War, the 2nd World War, I hasten to add........emm........I......in my village.......I was the one boy each year, who won a scholarship to....what we then called Secondary School, which was a Grammar School........I went to Grammar School and I just couldn't manage at all........being an elementary type boy, I couldn't manage the grammar school....Which was plain.....so I left. The War started anyway..........I went to a shipyard and worked as an apprentice fitter and turner and I went to night school......in the night..........at dark.....in the blackout......and I did my mathematical training primarily, basically, there.....I.....after the....I was then called up to the Royal Navy and did more Mathematics in the Royal Navy........I left the Royal Navy........I went in the Merchant Navy......and in order to get my certificates I went to College.....you know......full-time.....which was lovely........during leave......and did more Mathematics........So all this time I was learning Mathematics......having actually no idea of being a teacher......far from it.......I was engrossed entirely in engineering......and then over the years I carried on as an engineer at all sorts of places. While I was doing that I ma......I made sure by taking O level in Mathematics and I was quite happy........To cut a long story short I had been working for one firm for 21 years and expected to be working there till I was 65 and I was made redundant at the age of........at about 40.....While I was redundant and unemployed......on the dole.....I then worked like the clappers and got 8 O levels......in as many weeks nearly......but worked hard....Got O levels and got a place at Rurishire College and did a Teachers Training Certificate. I then managed to go one more year and....err.....got the B.Ed. which pleased me somewhat........and that was my training and then.

PKA
What was the B.Ed. in?.........emm......Subject?

Lawrence
Education.......Oh, primarily Geography but the secondary subject was
Mathematics......yes....and..erm.....then, of course, then I was looking for a job as a teacher. But I really came into teaching because, having been made redundant.......about 40 to 45...........jobs were not too frequent.......or common, or thick on the ground, for a man of that age.....I tried several things and I don't know what led me into teaching but it........all other things failed and....but every time I made a step towards teaching it stood up......so I was really directed into it and.......it wasn't really a vocation of choice or anything. Marvellous that.....it was just that everything else failed except teaching. So I got into teaching and I came to this school straight from college......to teaching Maths 14 years ago and.........err.....and I don't see the point in moving at this age, so I intend to stay here teaching Mathematics......Although I do teach Mathematics, I am second in the Careers Department, which gives me quite a lot of work and.......em......and so a lot of my time is divided between Maths and Careers....err....non-teaching time that is..............my teaching time in Careers is only 6 periods a week......maybe 8.......but the rest of the time it is entirely Maths but my non-teaching time.....Careers takes a lot of the time.....err......and so it diminishes the amount of time I have for Maths preparation and marking.

7.43 Mathematics Teaching Experience

The Mathematics teaching experience of this particular group of 'hidden' shortage teachers was very varied. Barbara and Lawrence regarded themselves primarily as Mathematics teachers and both had taught the subject for a considerable number of years, since entering teaching [vide supra Table 1]. Austin, Brian, Joan, Glynis and Steve had also taught the subject since entering the profession, many years previously, but they had initially identified with another subject and had merely "filled up the timetable" with Mathematics. Joan and Glynis had had long periods out of teaching raising families. Like Rita Rigg, whose background is given in detail in Chapter 6 [vide supra 6.71], Joan and Glynis had obtained permanent teaching posts after filling supply and temporary positions in Mathematics. Joan, Glynis, Rita and Austin now see their future as essentially in Mathematics teaching.

Brenda, Ursula and Roy had changed, by choice, from teaching other
subjects, to teaching Mathematics for the first time many years before and
now regarded themselves as Mathematics teachers.

Andrew had obtained his first permanent teaching position in 1983, after
working as a supply teacher (in Mathematics) for four years. He had taught
Mathematics up to September 1987. In the school year 1987/88, immediately after attending the RLPE INSET course, his timetable did not
include Mathematics; much to his annoyance and displeasure. Bill had
taught Mathematics on an irregular basis since 1966 (with a period out of the
profession from 1973 to 1981). He taught Mathematics while attending the
RLPE INSET course, but in the following year he did not.

Jennifer entered teaching in 1972, but her experience as a teacher is
limited. In her first year she held two part-time posts in different schools, one
a junior and the other a secondary. She taught Mathematics in the
secondary school. She followed this by teaching full-time (no Mathematics)
for one term and then left to have a family. Ten years later, in 1984, she
began to obtain supply posts. The following interview extract illuminates a
particular problem of 'hidden' shortage teachers.

Jennifer
And then I was bitting and bobbing on day to day supply, so I did a lot of
junior school work...which obviously Maths creeps in quite a bit.....but
there is always a scheme that they were using, so I was able to follow
on with what they were doing......So that's easier, because I can use a
book.....ermm........and then I was asked by one school to cover a PE
maternity leave which I agreed to.......and then I had a horror, because
it was 4th and 5th year Maths..............It wasn't bottom sets any more,
was it? So.......

PKA
Which sets were they?

Jennifer
It was a panic.......I had a top set, 4th year, 3rd set out of four in the 5th
year.....ermm......so it was a bit of a panic........but the rest of the
staff.....one of the group.....the top set group......I was actually sharing
timetable-wise, so I only had them for part of their Maths week.....so the
other man was a great help and very often.....and he was usually.......I
had my Maths lessons in the Biology lab and he was always in the
Physics lab, so if we got stuck we had a communicating door going...erm...without him we don't know how we would have coped...But it was only for something like nine weeks, because they had got a PE specialist coming...but how they managed, I don't know...because she wasn't Maths either...erm...

PKA
So she took over from you?

Jennifer
So she took over from me at the Easter...erm...and they were obviously sitting their CSE...the fifth group in that term...so I don't know how they got on.

PKA
So the top set were doing CSE?

Jennifer
Yes.

PKA
So it was a Secondary Modern School?

Jennifer
Yes, it was yes.

As a result of this experience Jennifer asked the headmaster for help and he suggested that she attend the RLPE INSET course. He had some difficulty persuading the advisory service that a supply teacher should attend, but eventually they agreed; possibly because the author saw no objection to supply teachers joining the scheme.


Sheila had been teaching since 1976. After two years she went overseas to teach English. Two years later she returned and worked for the Manpower Services Commission (MSC) in Rurishire, where she became involved with some limited Mathematics teaching with Youth Training Schemes (YTS).
Sheila

.................we used to bring groups in from site....... and the Maths was very much based on what they were actually doing on site. So we would spend about an hour and a half a week doing drawings and talking about what they had done.......costing.........

Sheila's highest qualification in Mathematics was GCE O level.

Sheila

.........well I knew that my Maths was considerably better than most of the trainees, because they.........anyone with any sort of academic qualifications would go.......in Easton.......to a college course.......so we were taking, really, the people they didn't know what to do with. You know, the difficult, disruptive or slow learners. So obviously my Maths was ahead of that......

Sheila later added the following pertinent information:

Sheila

Anyyhow I did that, on and off, for several years.......whilst I was having my two children.......and then we moved to Ruriston and.......I decided to come back into secondary education.........And a job came up here.......as Head of Special Needs.......so I applied for it and got it.......and I was given Maths on my timetable.......Bottom 5th, bottom 4th last year.......and so.......when I came on the course.......I had only actually been back in teaching for a couple of months.

Wendy was a very experienced teacher of Biology, having entered teaching in 1957. Since 1973 she had taught Biology, Chemistry and a little Physics; part-time in a grammar school. In 1984 she had begun to teach Mathematics for the first time.

Wendy

..........er...........Oh......let's see.......about three.......four years ago here.......we had some new staff in and...........we also had a three form entry.......Suddenly we got a big bulge.......and we had this three form entry.......We had this three form entry, and they needed somebody else to do Maths.......to the first form.......to one class,
because they were short so...........er...........I was......because I was teaching Physics anyway to Junior forms........so I was asked, "Did I mind doing some Maths, only to first form?"........so I said, "No....no, great, no....if you think I can do it that's fine.".....So I taught them for a year and the Head of Maths was so pleased with them that the following year he gave me the whole of the first year to teach Maths to......and then the following year he said, "Well!"........would I like a change and do 2nd year......and I said, "No....I've just done the entire syllabus with the first year. I'd like to do it again, because I enjoy it, and I like little ones, because I'm used to them.".......And then he asked me would I do a 4th year.....So I did and I've taken them through to the 5th year......And I also had a 5th year class last year......and I get the ones who have some problems, because........perhaps because, I didn't take a degree in Maths......I can see their problems and....ermm......I think that they've done quite well.

Bob and Jack had very limited experience of teaching Mathematics. This has been described above [vide supra 7.42]. Neither regarded himself as a Mathematics teacher.

Mark, Patrick, and Derek had only been teaching Mathematics for a short time, when they first attended the RLPE course. Eighteen months earlier the School where Derek taught had undertaken an internal re-organisation. 

Derek

I was...er..........seconded.......if you like......or timetabled into the Maths department here........and I found that I had a........liking for it. The children I had were the....low ability children........which I found very, very difficult.......because I didn't know how to deal with those children and, quite honestly, I still don't......I need a lot of help in that direction.......I think people..........because I was a mature student....it happened at college as well...because I was mature....and even here in school.....because I am a mature person...."You're all right! You can manage!"........Well, I take the opposite view. I think, when you are a mature...er..person, you need more help, if you are..........doing something new........Anyway, that's beside the point.....But the position here is now that I'm split.....equally divided between Mathematics and English...and the....the pupils I have for Mathematics...year five,...year
four........year three........are........the........bottom children. The ones who need extra help........a great deal of extra help.

Patrick and Mark had only taught Mathematics for one term prior to the RLPE INSET course.

Patrick

My teaching role at Yardley High School is mainly as a PE teacher........er........I was appointed 8 years ago........ermm........my Maths background came from college. I did a professional studies course in Mathematics........ermm........not very detailed, I must admit, and the fact that I have started teaching Maths this year was solely due to the absence of another colleague.

In September 1986 Mark had been redeployed, from a Community Home of Education for delinquent young people, to a school where he was in charge of Remedial/Special Needs.

Mark

I am on the Maths side........I take the bottom groups, where they are streamed, or I take an extracted groups, where they are mixed ability........The 3rd years are streamed and I don't have contact with the 4th years in their Maths..............I do with the 5th years, who are doing a non exam course, which is the City and Guilds course, the 361........whatever it is........course. But, having said that, I do not do the Maths course........No, I do the communications side........so really I am lower school Mathematics.

To summarise, it can be seen that the teaching responsibilities in Mathematics of members of the RLPE INSET scheme varied widely, from member to member and with time. There were a number of important reasons for such variation. The fact that a number of the members were employed as supply, part-time and temporary teachers meant that such variation was to be expected. The secondary school system in Rurishire, which was far from uniform across the county (partly selective and partly comprehensive), also caused variation in teaching responsibilities. Re-organisation affected at least three members personally and many more
indirectly, as the schools of the latter group accepted transferred pupils and re-deployed staff. Internal school policies also resulted in timetables of certain members changing over the two academic years investigated. Those policies sometimes appeared to ignore INSET provision. Although employed in full-time, permanent positions, Andrew and Bill taught Mathematics, while attending the RLPE INSET scheme at Midchester, but not on the following year. Jack and Patrick were also full-time, permanent teachers. They did not teach Mathematics, while attending the INSET scheme, but did so the next year.

Analysis of the data of this research contradicts a commonly held belief, that teachers who belong to the 'hidden' shortage teach only low ability children. Glynis taught Mathematics to a top set and a mixed ability class in a Grammar School. Joan taught a top set in a comprehensive school. Only Barbara, Mark, Sheila, Jack, Patrick and Derek taught only 'low ability' groups. Barbara, as Deputy Head of a secondary modern school did so by choice and because of her position in the school. Mark and Sheila were in effect 'special needs' teachers. Jack (secondary modern school) and Patrick (comprehensive school) taught lowest ability sets, but for only five and three periods per week respectively. Derek and Roy were the members who most closely identified themselves as a teachers of low attainers, although Roy also taught middle sets in a comprehensive school. The remaining members appeared to spread their teaching, fairly evenly, across the lower and middle ability ranges. Glynis, Rita and Wendy had a significant part of their teaching time devoted to mixed ability groups.

An important and interesting element of the analysis of the data collected by interview is that all the members of the RLPE INSET scheme declared that they liked teaching Mathematics. The following comments, from two Physical Education specialists, were typical of the majority of the RLPE INSET members.

Steve
I've always enjoyed...teaching Mathematics......It's great.

Brian
I enjoy teaching Maths.....................I used to enjoy teaching low ability groups.......even lower ability groups.......that I had......before this
The least enthusiastic member, in this respect, was Patrick, another Physical Education Specialist who had only recently begun to teach Mathematics. Even he seemed to enjoy some aspects of teaching Mathematics.

Patrick

I enjoy being in front of the class......ermm......who are all sat at desks, because I find it so much easier than being outside where they are all running about......It is very......I find it a lot easier teaching in that situation.....ermm.......Whether I enjoy teaching Maths, I don't know. I suppose some areas I do enjoy teaching.....Those that I tend to be a lot more familiar with, I do enjoy.....ermm......

The fact that these 'hidden' shortage teachers took a positive attitude towards Mathematics teaching should, perhaps, be noted by all those who are concerned to combat the shortage of Mathematics teachers [vide supra 6.1].

7.44 Previous In-Service Education

Very few of the members of the RLPE INSET scheme had previous in-service experience in Mathematics. Indeed, any previous INSET provision had been limited for these teachers. Roy had been re-trained as a Mathematics teacher. Ursula had attended courses in Mathematics and computing in her own time. Approximately twenty years ago, while she was teaching at a junior school, Joan had attended workshops at another local school. These were after school and took place once every week ("or fortnight") over two or three terms. The Mathematics Adviser brought teachers, from the many junior and secondary schools, together for these workshops; where they used new Mathematics apparatus.

Joan

That was good. because........it was in the sixties and it was a new town...Harlow New Town, in Essex and......there were a lot of Maths workshops.......and lots of new equipment was being introduced....Dienes and Stern and Cuisenaire and...lots of logic games and things.....and......that was really quite.....quite good;
mathematically for me........so I was involved......teaching there for five years....................but that was the only........bit of in-service training.......and it was available to anyone.......This is what now, looking back, I find is a bit........unstructured about the whole thing....Sometimes things are on offer......if you're keen enough and willing enough to go......but there's no, sort of, in-built system of......bringing people up-to-date, or training them..........I think there's a lack of that, really.

Barbara also had a little previous INSET experience.

Barbara
Well when I was at....At other schools I'd done bits.........sort of........odd days here and there and everywhere...but nothing really.......a prolonged thing............Nothing much at all, really.

The odd days had included INSET related to Mathematics and computers. Barbara had taken Mathematics as a main course of her teaching Certificate of Education.

PKA
Did you find that particular qualification was adequate for the work you had to do here (at Midchester County Secondary School)?
Barbara
Not the original one, because Maths has changed so much.

PKA
So what have you done about it, because you haven't been on any in-service courses?
Barbara
Yeah.....er...taught myself(/laughs).

Faced with teaching SMP some time ago, Barbara had taught herself "sets and matrices", which she had not "seen before". Glynis had been in a similar position.

Glynis
I did a modern Maths course when I first started teaching, which was a long while ago.
Who organised that? Was it a local education authority?

Yes.

Glynis, took classes in Mathematics to fifth year GCSE level. She had taught herself the necessary 'Modern Mathematics'.

I would now like a course to take......to go further in Maths...........I mean, I've done a lot of work myself........most of the work...............the higher work in the fifth year is self taught........the Modern Maths.....and I've had to do a lot of studying to do that.......I would like to do....to be able to go on a course to reinforce that.....the actual mathematical content of it not the teaching of it....I would like to take it further.

The necessity to teach one's self Mathematics, prior to attending the RLPE INSET scheme, was common in members. The majority of members reported that they had no previous INSET provision in Mathematics which they recognised as such. The following are typical interview comments:

(a)

Does that mean you have had no opportunity for in-service training........

No!

...since your first initial training.....

No, none at all....None at all.

PKA

.....until you came to us?

Yes! I've had not opportunity at........although, I have actually sought opportunity to retrain, very hard.
PKA
Have you had any in-service provision before our course?

Patrick
None whatsoever.

PKA
That's for no subject at all?

Patrick
Well, all right, PE.......yes I have taken opportunities that have arisen in PE, but........emmm........in terms of another subject....no............

7.5 Relationships: The Head of Department and the 'Hidden' Shortage

As a result of a research programme, which studied the implications of teacher shortage on six Mathematics Departments, Neil Straker formulated the following hypothesis.

"The shortage of well-qualified Mathematics teachers prevents the Head of Mathematics department functioning effectively."


This research programme identifies rather more facets in the relationship between Heads of Departments of Mathematics and members of the 'hidden' shortage.

It is interesting to note that, in the case of the two 'key' persons (Rita and Barbara), who emerged during the RLPE INSET scheme [vide supra 6.7], both were in departments with enthusiastic, supportive Heads. Unfortunately, apart from her own Head of Department, Barbara has a low opinion of Heads of Mathematics in the county. (This was apparently reinforced later when she assisted the researcher in a workshop at the County Head of Mathematics Conference [vide supra 6.7]). Although the following extract from an interview is only opinion, it is interesting that a senior member of a school (a Deputy Headteacher) expresses it. It also echoes remarks expressed by other participants.
Barbara
Because, I found......talking to some other people in the group (the members of the "Pilot Experiment").......that they go back...and their Heads of Departments don't really want to know......you know..........they're probably unintelligible......we're lucky because Ray Oldham will..........if he wants to know about it.......and everything.......He is introducing a lot.......but I think, generally, in Rurishire people have taught in their schools for donkeys' years...I mean, we've got people here who have been at school...twenty five to thirty years....and they don't want to change......they just want to keep going on, as they've been doing..........and I think the hardest thing is that.......probably........these people are going back.........their Heads of Departments are probably teachers who have been teaching........twenty to twenty five years...........and they don't want to change.

It is worth noting that Joan [vide supra 6.3], Wendy and Brian, who were other potential 'key' persons, also had supportive Heads of Departments. Their Heads of Mathematics were interested in the work of the RLPE INSET scheme, and encouraged the teachers to make the best use of the RLPE material and resources, which the latter were given during the scheme.

PKA
Wendy, what INSET opportunities, particularly in Mathematics,...........er...........did you have before the course, which we put on at Midchester?
Wendy
Nothing at all, actually. I have been asking for some time for a suitable course to go on and there is nothing available. Yours was the first one that came up and...........er........Rod Matthews saw it and said would I like to go.
PKA
Rod Matthews is your Head of Department?
Wendy
Yes....Yes.

PKA
How has he reacted to this course?
Wendy
Oh, very favourably......He thinks it's a great idea and he's been very supportive too........I've only had to ask for things and he's either......if he hasn't got them he's had them made or bought them........you know........anything I needed..........particularly on the practical side.

Brian
The Head of Department had a look at the notes that we brought back........and he's gone through them...............and he's been very........constructively critical...............on what he's seen..............................and there have been questions, which I've put to him......regarding the relevance of the material...............and asked him what I would be expected to teach here and what sort of level...........I put that against the material.......He said, "I don't think you would need to use this ", or, "That would be helpful."

PKA
So would you say, then, the course has been a catalyst to make that relationship with him?

Brian
Indeed.

Other members (for example Lawrence and Bill) also had supportive Heads, who were interested in the work which had been done on the RLPE INSET scheme. Such fortunate relationships between Heads of Departments and members of the 'hidden' shortage were not universal.

PKA
The material we gave you at the Midchester course, in Mathematics, has anyone else been using it?

Ursula
Nobody was interested.

PKA
They're not interested?..........You asked?

Ursula
I did..........We had..........We very rarely have a Maths.....I shouldn't tell you that, but I'm just..........I mean that doesn't go any further..........We don't ever have a Maths Department meeting.........At one time we
didn't have them for five years......So everybody just muddles through.................Everything I have done the next morning I came back..... and I've always shown it to the Head of Maths and discussed it..........he found it very interesting and that was end of story.......and nobody ever wanted to know.

Andrew

.....So although I have a lot of......well, I would regard as being..........good new ideas for the teaching of Mathematics....I'm finding that I can't put those ideas into practice any more.

PKA

And does anyone else want to know about these?.......Do you discuss them with other people?

Andrew

Now, this is interesting, because very often......throughout the course......I found that I had come back from Loughborough (sic)..............wanted to have a word with the Head of Mathematics. He would be too busy to really talk about the ideas.

Andrew, without prompting by the author, suggested that external INSET providing agents and LEA advisers should visit school, to support teachers who had been on in-service courses. Sheila, however, saw difficulties in arranging such visits through Heads of Departments.

Sheila

No, I don't think you could.....It depends on you Head of Maths, I think...............and I don't think our Head of Maths would want to take.......in fact, I know he would not want to take that responsibility...........I mean.......when I said to him today, that you were coming in and........emm..........I mean.......I felt it would be polite to tell him that you were coming in and that you might want to talk to him about in-service training..............he backed off immediately.......He said, "Oh, no, no! I couldn't possibly say anything about in-service training, Sheila. You must ask the headmaster about that. I can't say anything".

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Sheila also described how she was isolated from the Mathematics Department and not informed of other INSET activities such as an area-based self-help group, which had been organised to meet the demands of GCSE course work.

PKA
Do they (other members of the Mathematics Department) feed back to you on that?
Sheila
No.......No they don't. They don't really see me as very much to do with the Maths Department........because..........I didn't know they were going on it (the self-help group meetings), until after I had been on the course for quite a long time..........and I said to them.......you know......."I know what an investigation is now."........And they told me they were going on this.
PKA
What was their reaction when you said that?
Sheila
They just laugh.
PKA
They didn't want to know what you had done?
Sheila
..........mm.........................No, not really........No........They don't.

A valuable opportunity arose, during the day of the Summer 'follow-up' meeting of the RLPE INSET scheme [vide supra 6.6], for the author to gather more data on the relationships, which existed in schools between 'hidden' shortage teachers and Heads of Mathematics. This opportunity reinforces the author's view that unstructured interviews are extremely valuable when they are conducted in extremely informal situations. The author travelled by car with Steve, Derek and Roy from King's School to Ruriston College, where lunch had been arranged. During the journey the author told the three of Barbara and Rita's contribution to the Head of Mathematics Conference in June [vide supra 6.7] and asked if the Heads had discussed this with them. Apparently the Heads had not mentioned the Conference to them and this prompted the three to complain about the manner in which they were sometimes treated by their Head of Mathematics Department, and other
senior Mathematics staff.

Roy
I get no response to things I tell them..........It's as if they don't listen.
Steve
Yes....I have told them things and asked for things........but no result.
Roy
Heads of Departments don't want to know.
Derek
I get little support.......They don't want to know.
PKA
I told the Heads about you at the Conference but many didn't seem to
know anything about our INSET activities.
Derek
Well they don't!

On a contrary note, Derek reported that he was now receiving some school
funding to purchase SMP 11-16 textbooks in support of the work he was
doing. He had originally bought his own copies of these texts, which first
came to his attention while he was attending the RLPE INSET programme at
Midchester.

This data must be interpreted in the light of the interviews the author had
conducted at the schools of these three teachers and the conversations he
had with the three Heads of Departments involved. There was evidence that
the Heads were giving some support to the teachers concerned and that the
teachers were aware of this.

For example, although Steve had not been involved in any formal school-
based INSET, he had been receiving friendly help from his Head of
Department. He had also joined two or three interdepartmental "discussion
groups" on GCSE. He thought that formal school-based INSET would be
difficult and, perhaps, not necessary in a small school such as his.

Steve
I could certainly see the benefits of that from a big school, but.you
see.....in a way.........We've only got twenty members of staff
here.......and I mean the Head of Maths is.....probably........one of my
best mates...and we can.......if ever there is a problem we can talk about it.......we do talk about it, quite a lot.......There are only three...well four Maths teachers, actually.......I mean...it's such an informal little school.....and for a call around the staffroom that...er.....that we, perhaps, do discuss things...........during breaks...and...........I don't really think it would be......necessary to structure something like that.

The conclusion must be drawn, however, that consultation and communication in some schools could be considerably improved. Teachers with limited qualifications and experience might be encouraged, and requested, to join in discussions about the work of Mathematics Departments to a greater extent than is the case in certain schools. These teachers, especially if they teach other subjects, are often not regarded as bona fide members of the Mathematics Department. The school departmental structure does not always appear to help in this respect, since teachers of the 'hidden' shortage may not identify (or, be identified) with a particular department. This seems to present a potential breakdown in the communication and consultation system. Perhaps Rurishire schools, in particular [vide supra 6.8], need to consider the advantages of a 'matrix system' of divisions and responsibilities, such as those increasingly found in Further Education Colleges and in large comprehensive schools of some local education authorities.

7.6 School-Based INSET and the 'Hidden' Shortage

Analysis of the data, gathered by interviewing members of the RLPE INSET scheme, suggests that school-based INSET provision, which is closely connected with the organisational structures of schools, may disenfranchise 'hidden' shortage teachers.

Firstly, these teachers are not always covered by INSET which is arranged on a departmental basis, since they are often not identified or identifiable as members of particular departments. This is particularly true of non-Mathematics specialists who teach Mathematics.

Secondly, sensitive problems are not always shared with colleagues from the same school. The neutral environment which agency provision can
accommodate, if it is based in a Teachers' or Subject Centre, enhances confidence and allows a mutual sharing of problems with peers.

Thirdly, 'hidden' shortage teachers often lack the confidence and status to influence school-based INSET.

Fourthly, these teachers have restricted access to resources and limited control over resource availability. These resource constraints include the lack of time to establish personal contacts in other schools. Consequently, 'hidden' shortage teachers are usually unable to organise, or influence, 'area-based' INSET (for example, 'link', 'family', 'cluster' or 'self-help' groups) to meet their own needs.

Analysis of interview data suggest that the majority of the RLPE INSET group were unconvinced that school-based INSET, as they perceived it, would cater for their needs. Joan Warwick, for instance, was not enthusiastic about school-based INSET, which she thought would be too "insular". She thought "you need people coming in with new ideas". She indicated that she preferred to meet other people from other schools and to exchange experiences and ideas. This had happened on the Midchester course. Meeting other teachers was important to Joan and a number of other participants.

PKA
You haven't been involved with any school-based in-service education? Do you do any INSET within the school?

Jennifer
.....ermm........I haven't been involved with any........no....ermm.......What goes on here......I don't know......in the Maths department. I don't know whether there is anything on-going.

PKA
How would you feel if in-service provision was supplied within the school........amongst yourselves........as compared with the way that we provided it as an outside agency?

Jennifer
Well, it would certainly be a good idea but I still think........you know........mixing with other people from other schools is perhaps a better way of finding out how things are going at other places. I know,
when we had our chats over coffee, and what have you.....While we were there, we all learnt something from each other.....and we were all able to help each other....ermm......People would have problems with certain things and knew which books to use..........which were better..........which was a great help....Whereas, I think if you just meet within the school, you are only working with the resources you've got......and I think you can draw a lot from other peoples' resources.

Like Jennifer, many teachers were not convinced that they were provided with any school-based in-service education and training. Brenda Burton, a Senior Mistress, made an interesting observation.

PKA

Do you do any school-based INSET?

Brenda

........er......................No........I'm............Dan is Head of Department here and I would do him an injustice if I......................I just said, "No.........full stop,"..........because he's...............he's got a lot of material.......and he's only too willing to help..........and provide material for anything we wanted in the school...........Now, occasionally, we have these training days, don't we..............which have been inflicted upon us by that caring Mr Baker......and..........we use those as.....as...quite usual........to have a fill up in........computer work and so on.

Patrick Snow was also unsure about his opportunities to take part in school-based provision.

Patrick

The in-service plan for the school is something the Head and the Deputies were planning.....ermm........not for your own personal education but for the education within the school.

PKA

So they are talking about school-based in-service provision?

Patrick

Yes.
PKA
Has that started?
Patrick
Yes, it has. Particularly in areas such as TVEI, CPVE, but I've not been involved in any of those so.....
PKA
Do you think there will be some provision to help you as a Maths teacher?
Patrick
I would like to think so, but I doubt it very much indeed.
PKA
You would like that, would you?
Patrick
Oh, yes.
PKA
Would you prefer that mode to the mode that we had, where you went out?
Patrick
.....ermm....... I would like to be able to draw on people such as yourself.....ermm.......information..........But how much, or how useful, training within the school would be, I don't know, because I think...err.....there are certain set patterns here, which are difficult to break.....ermm.......I don't want to mention individuals, but I don't think change is easily come by, to be honest.

School-based INSET for many 'hidden' shortage teachers seems to be rather sparse and not well-designed, despite the availability of 'directed time'.

PKA
Does that mean you have some form of in-service education within the school, if you are going to other people?
Bill
It's very informal.
PKA
Very informal?
Bill
Very informal arrangement. Well, we do hold regular departmental
meetings as part of our hours of directed time.......I think these come out about every half term......where we have this hour long meeting.......where things of this nature are discussed

PKA
Would you call that in-service education?

Bill
Up to a point, yes.......Because the problems that we have.....our solutions to them.......exchange of ideas, et cetera, are then done more formally.......Plus that fact we have our in-service training day at the beginning of each term. That's done on a departmental basis.

PKA
What do you do in that? What happens in that in-service day?

Bill
That is when we talk through our syllabuses and how we are going to approach it. It's not really training.......It's called that, but it isn't really.......But it gives us a chance to get the term off to a good start.......before the youngsters come in.

PKA
Do you see that you could do.......what might be called school-based in-service education.......in that way.......instead of having what might be called....agency provided?

Bill
I don't see......?

PKA
Which is what we did....... 

Bill
No! I think we would do better to keep to the agency provided.

PKA
Yes?

Bill
I really do think so.

PKA
Are there any reasons for saying that?

Bill
Yes, because it gets us away from the school to meet other teachers......other than our......sort of.......close colleagues.....and as well as that it introduces a fresher outlook.......which I found, when I was at Midchester.........................Meeting different people, talking
different things and getting different ideas...if you like........from the other side of the county...........whereas in school, you probably know what everybody thinks anyway.

Perhaps, Barbara Charlton, a Deputy Headteacher and one of the emerging 'key' persons of the RLPE INSET scheme, made the most enthusiastic response to the ideas of area-based and school-based INSET. She said that she would welcome the opportunity to try out some of her new ideas with children from other schools, through area-based INSET. Nevertheless, she thought there was a need for agencies and advisers to be involved in continuing INSET provision (area-based or school-based), in order to introduce new ideas, to maintain momentum and to take some responsibility for organising programmes.

7.7 Summary

The picture of the 'hidden' shortage, which has emerged in this chapter, is perhaps somewhat different from that which is commonly held. The nature of that shortage is complex and it cannot be described in terms of stereotypes. In fact, the author argues that the picture is not as depressing as many commentators, who see little potential in their stereotyped 'hidden' shortage teacher, would have us believe.

The situation in schools, as far as shortage is concerned, must be improved by attracting highly qualified people to the teaching profession, as entrants or returners. It must also be improved by providing suitable and readily available in-service provision for all teachers. This provision must be accessible to the 'hidden' shortage teachers of Mathematics. Such provision will only be suitable if designers, developers and providers have a clear picture of the 'hidden' shortage. It will only be accessible if the description 'hidden' is re-examined.

The definition of the 'hidden' shortage of Mathematics teachers used by DES [Department of Education and Science, 1986b], recognises that qualifications may not be the only criteria for judging the worth of teachers. Although that definition is phrased in terms of the qualifications and the personal qualities which are required for effective teaching, it does not really
explain why the shortage is 'hidden'. This research has identified other 'hidden' categories, which apply to teachers of Mathematics:

1. Hidden from Government

2. Hidden from Education Authorities

3. Hidden within schools; communication systems, departmental structures

4. Hidden from colleagues, particularly Heads of Departments

5. Hidden from INSET provision

6. Hidden from career opportunities.

Unless these categories are recognised, moves to improve the situation in schools through INSET provision will ignore many teachers with potential to contribute to Mathematics classrooms. The author has been informed by several Heads of Mathematics that, in their particular schools, no mathematics teaching was done by 'unqualified' staff, at that time. Junior teachers at the same schools have stated that 'unqualified' teachers were teaching mathematics in those schools, during the period in question. Further investigation revealed that the junior teachers were, indeed, referring to teachers with 'nit' qualifications in mathematics, as defined by the Cockcroft Report [Department of Education and Science, 1982]. This particular aspect of the problem of teacher shortage in Mathematics is being 'hidden' and, possibly, ignored (or "swept under the carpet") in some quarters.
Chapter 8

ANALYSIS AND THEORY

8.1 Presentation of Theory

The nature and role of theory in scientific and educational research have been discussed in some depth in Chapter 2 in the context of the 'model view' of research [vide supra 2.4]. It is not intended to reiterate the ideas expressed earlier but they are central to what follows. It has been noted that a great deal of educational research is criticised for concentrating on methodology and neglecting theory. The earlier discussion concerning paradigms [vide supra 2.5] suggested that much of this criticism may be ill-founded, mistaking the true nature of research endeavour. Nevertheless, the author admits that many critics are justified and this research has no desire to attract their criticism by neglecting theory. Consequently this section suggests a structure which should serve to ease the task of presenting theory.

In an early draft of this thesis the author, following common practice, included case study in the chapter which dealt with methodology. It is now considered that this was unfortunate because to consider case study as a method of collecting data does not accord with the 'model view' of educational research. Unfortunately, in common with its close relative action research, the term case study is used in different, and often conflicting, senses according to the contexts in which it is employed. In the context of teaching and learning the term may refer not to research but to a simulation or teaching strategy [Walker, 1982]. In the context of research, some authors use case study and action research synonymously, others consider case study to be a subset of action research (and vice versa), while others use the term to mean "illuminative evaluation" or "democratic evaluation" [Simons, 1987]. In their adverse criticism of "case-study practitioners" Atkinson and Delamont [1985] point out that "it is hard to provide any hard and fast definition of 'case study'." One may not agree with all the adverse criticism by these authors but it is difficult to argue against that particular observation. Even Lawrence Stenhouse uses case study in several different senses in an influential paper "Case Study and
Case Records: towards a contemporary history of education" [Stenhouse, 1978]. Despite this, the structure which this thesis adopts in order to discuss analysis of data and development of theory is taken directly from that paper. This does not imply that this thesis accepts Stenhouse's arguments without reservation. In fact the structure is also a convenient device for reconsidering many of the criticisms of case-study practitioners and their approach to theory.

Stenhouse suggests that the organisation of research data should be conceived in two stages:

(i) Representation
(ii) Presentation.

These are subdivided as follows:

(i) Representation
   (a) The Case Data
   (b) The Case Record

(ii) Presentation
   (c) The Case Study
   (d) The Analytical Survey.

Stenhouse suggests that Case Data are usually "too bulky to be analysed repeatedly and in parts are too sensitive for immediate release". This is certainly true of the voluminous data collected by this research. The Case Data of this research may be described as a primary source consisting of all the materials (for example, field notes, official documents and publications from DES, LEA etc., school brochures, letters, reports, diaries, audio and video tapes, timetables, course notes, materials, handouts, resource packages, software, photographs etc.) which the researcher has assembled in order to study the case.

It is possible that Stenhouse, in describing the Case Record as an "edited primary source" or a "theoretically parsimonious condensation of the case data", was referring to a purely descriptive record, which would form part of an archive accessible to historians. The author is not convinced that such a
distillation of the case data, with no attempt to interpret and analyse, is appropriate to this research. However a modified form of Stenhouse's notion of Case Record would be useful. In this research the Case Record is regarded as a representative selection of INSET programmes, resources and interview transcripts, which would be readily accessible to the reader of the thesis so that interpretations might be judged and supported.

Stenhouse's notion of Representation, modified in this manner, is nicely suited to this particular research but his ideas concerning Presentation raise a number of pertinent questions concerning analysis and theory which must be addressed. Stenhouse has suggested that:

"The Case Study is an interpretive presentation and discussion of the case, resting upon, quoting and citing the case record for its justification."

and that,

"The Analytical Survey is an attempt to draw together data from case records to make retrospective generalisations across cases."

Now, although the author regards this thesis as the Presentation of his research, which is supported by accessible but bulky Case Data and Records, he has reservations about the separation of Case Study and Analysis and concerned about Stenhouse's approach to theory. It is interesting to note that Stenhouse pointedly avoids the term theory and instead writes of research data. This could support the criticism that Stenhouse and other members of CARE neglect theory [Atkinson et al., 1985] but, in fact, he seems to be referring to rather more than unprocessed data when he describes Case Study. The author argues that "an interpretive presentation and discussion of the case" should be a model of real world situations and, as such, should constitute substantive theory. Such a Case Study model would address many of the declared aims of theory, although most importantly the aims "to describe" and "to illuminate". In many ways, Case Study could also meet those aims related to explanation, interpretation and understanding but the author believes that such aims would be more likely to be fulfilled if a variety of models was employed. This would also answer the criticism that "the naturalistic
commitment to 'tell it like it is' tends to force the process of analysis to remain implicit and underdeveloped" [Hammersley, 1983].

The nature of educational research also suggests that a variety of models should be sought. Unfortunately, Stenhouse’s ideas on Presentation do not encourage variety. It is true that he supports the development of as many Case Studies as possible but his notion of Analytical Survey appears to be more concerned with cumulation than the analysis of data. The author suggests that, although cumulation and the Stage Two development of theory to which Woods refers [Woods, 1985] is vitally important, much educational study is at an earlier stage [vide supra 2.4]. In many areas there is no substantial body of knowledge, or paradigm, from which theory may be developed and cumulated and there is little likelihood of a 'Kuhnian Revolution'. This is particularly true in the study naturalistic curriculum development and in-service education of teachers. What these areas require is the development of a significant number of candidate theories/models, each of which may be examined for retrospective generalisation, judged critically and accumulated with a view to developing plausible models in the fashion that early scientific theory is developed. Consequently, without departing from the contention that the Case Studies (which are presented in Chapters 4, 5, 6 and 7, of this thesis) already provide important candidate models or substantive theory, it is proposed to analyse these and the Case Data again, to seek further models/theory. To construct such a variety of models it is necessary to investigate and develop suitable techniques of analysis.

2 Perhaps, the reason many case study practitioners leave themselves open to the charge that they neglect analysis and theory is the manner in which they define, or do not define a case [Atkinson et al., 1985]. The author does not wish to become involved in the 'case definition' debate, since many who do so appear to be unaware that it is possible to construct a body of knowledge, such as mathematics, on un-defined terms such as set, element and membership. The more important point concerns the tendency for a case to be 'defined' in macro or structuralist terms so that the subject matter of research is treated, for example, as an organisation, an overall curriculum development or an entire INSET scheme. In doing this the case study practitioner rather limits the number of cases over which retrospective generalisations may be made. The author sees no valid reason why a case should not be taken in this way but argues that it is also reasonable to regard individual persons and events as cases on which generalisations may be based. If researchers did not identify themselves rigidly and dogmatically to camps it would be possible to construct a wider variety of models which might be described variously as rational, systematic, schematic, phenomenological or interactionist. These could then vie for plausibility and acceptance and enhance the process of cumulation.
8.2 Techniques of Analysis

Despite the comments and criticisms of the previous section it must be accepted that the nature of the data of this research necessitates analysis which essentially makes "retrospective generalisations across cases". Stenhouse is rather vague about how this should be made, even across his Case Studies. He suggests that historians have the answers to this problem, especially those concerned with comparative history.

"Comparative history is explicitly concerned with generalisation. It depends upon distinguishing classes of institution or activity which are taken to have some identity and attempting to generalise about them."


There are of course other researchers who stress the need to seek classes and categories and many of these appear to have been more influential in the field of educational research than historians. The sociologists have developed techniques of analysis which educational researchers have borrowed with some success.

8.21 Grounded Theory and Constant Comparative Analysis

One of the sociological techniques which educationalists have used is the generation of grounded theory using constant comparative analysis and theoretical sampling. This was developed and promoted by Glaser and Strauss [1967]. The analytical methods of this research have been influenced by this particular technique because it emphasises the generation of theory from research data rather than its verification by experiment. Constant Comparative Analysis is also attractive to a research programme which had adopted the 'model view' of theory, since Glaser and Strauss appear to regard the technique of constant comparative analysis as a type of modelling process. They acknowledge that one of Kuhn's [1970] basic findings is that "a theory's only replacement is a better theory" and they claim that this "applies more to a grounded theory than a logico-deductive one". Of course, modelling is characterised by the replacement of a model by a better one. The technique of constant comparative analysis is also particularly interesting and relevant to this research because, as Glaser
and Strauss point out, it may be applied to social units of any size.

*Grounded theory* is essentially a model which is refined, not by predicting events, but by an analytical process which compares data with data and data with models produced from that data. In this way a bank of models is produced, relations between models are identified and models are integrated and generalised to become theory. During analysis the models which develop indicate sources of additional, relevant and potentially important data, so that a technique of *theoretical sampling* occurs in parallel with the process of modelling. In essence analysis depends upon the data collected and the collection of data is guided by analysis.

Glaser and Strauss identify two forms of theory; *substantive theory* and *formal theory*. The former corresponds to models produced in the earlier stages of modelling and, although it intersects with the latter, has less generality than the formal theory which may be regarded as a more refined model. In both forms, since the modelling is conducted by comparing data, the theory produced is said to be *grounded in data*. *Grounded theory* may be presented "either as a well-codified set of propositions or in a running theoretical discussion" [Glaser and Strauss, 1967]. In this research the latter presentation is employed in the case studies of Chapters 4, 5, 6 and 7. In Chapter 9 theory is presented in the form of models which is closer to the former style of presentation.

In outline, *constant comparative analysis* consist of four stages:

1. comparing incidents applicable to each category
2. integrating categories and their properties
3. delimiting the theory, and
4. writing the theory.

In stage 1 incidents from the data are coded into as many categories as possible. Glaser and Strauss do seem to deny the need for creativity at this stage because they suggest that categories will "emerge" from the data. When an incident is coded it is compared with incidents previously coded into the category concerned. In this way, it is claimed, theoretical properties of the category will be generated.
Stage 1 transforms into stage 2 as coding continues so that, instead of incident being compared with incident, an incident is compared with the properties of the category. This results in accumulation of "knowledge" about the property and gradually an integration of this knowledge into a unified whole in which elements are related in many different ways. As this process continues properties are related to each other and these become integrated themselves. Glaser and Strauss argue that if data is collected at the same time as analysis occurs (theoretical sampling) integration is more likely to emerge by itself.

The delimiting process of stage 3 occurs as the model/category is modified less and less by each incident compared with properties. Some properties may be abandoned as irrelevant while others may be elaborated and relations made more detailed. Uniformity of categories or properties will allow terminology and concepts to be reduced and generalisation to be developed. A smaller number of categories will be necessary and sufficient to formulate theory. Delimiting also results as new incidents are found not to contribute new aspects to theory and are therefore not coded. Categories become theoretically saturated.

While accepting that the work of Glaser and Strauss has been influential, it is necessary to point out that in a number of ways it fits uneasily into interpretive research. Glaser and Strauss write of the "interrelated jobs" of theory in sociology, which they suggest are:

(1) to enable prediction and explanation of behaviour
(2) to be useful in theoretical advance in sociology
(3) to be usable in practical applications - prediction and explanation should be able to give the practitioner understanding and some control of situations
(4) to provide a perspective on behaviour - a stance to be taken toward data, and
(5) to guide and provide a style of research on particular areas of behaviour.

Their emphasis on prediction, behaviour and control may be thought more reminiscent of positivism than interpretive research but their work indicates that they do regard theory as guidelines to judge the consequences of future
action. When they use the term prediction they usually mean the process of checking facts and categories, not forecasting future events.

Unfortunately, as Faraday and Plummer [1979] have observed "both theoretical sampling and the notion of grounded theory serve to narrow down the focus of exploration very speedily. It does not lend itself at all readily to the exploration of substantive areas; it is only suitable for the development of small scale limited theoretical problems". The view which this thesis takes is that a theory is a model [vide supra 2.4] and while models may be the substantive categories or sensitised categories of Glaser and Strauss they are not exclusively of that nature. Additionally the general nature of analysis is the cyclic process of modelling and the discovery of grounded theory by comparative analysis is a specific example of this process not a unique technique. Consequently, the ideas of Glaser and Strauss are not taken as prescriptions.

8.22 Analytical Induction

A second technique of analysis, with its roots in sociology [Cressey, 1950; Znackiecki, 1934], which appears to have potential is that of analytical induction. There are a number of variations on this technique and, at first sight, they are attractive because they all bear some resemblance to modelling [vide supra 2.4]. One, which Robinson [1951] has outlined as an algorithm, describes analytical induction in six stages, as follows:

1. A rough definition of the phenomenon to be explained is formulated.

2. An hypothetical explanation of that phenomenon is formulated.

3. One case is studied in the light of the hypothesis with the object of determining whether the hypothesis fits the fact of that case.

4. If the hypothesis does not fit the facts, either the hypothesis is reformulated or the phenomenon to be explained is redefined, so that the case is excluded.

5. Practical certainty may be obtained after a number of cases has
been examined, but the discovery by the investigator or any other investigator of a single negative case disproves the explanation and requires a reformulation.

6. The procedure of examining cases, redefining the phenomenon and reformulating the hypothesis is continued until a universal relationship is established, each negative case calling for a redefinition or a reformulation.3

The author is not convinced that the above algorithm would be suitable for the analysis of this research data and argues that it begs many questions. For example, the first step is far too speculative and appears to demand a number of pre-requisites, if it is to be inductive. The algorithm itself, although it is evidently intended to be prescriptive, is extremely loosely constructed so that it could well lead to dead-ends and would almost certainly fail to explore the possibilities of the data adequately. In common with constant comparative analysis it is likely to narrow the focus of study rapidly and waste important data. It would be dangerous to apply the technique, as it stands above, to educational research because it seems not to be aware of the nature and stage of development of theory in that field of study. In particular it apparently confuses the development of early stage candidate models/theories with the process of cumulation. It is, perhaps, not surprising that the technique of analytical induction appears to have met with limited success and has not been widely accepted as a technique [Denzin, 1970; Hammersley et al., 1983]. Bloor [1978] has used a variation of the above algorithm but points out that his analyses were not "wholly inductive". He acknowledges that he had formulated views, in a non-inductive fashion during data collection which he later incorporated into his analysis. Bloor was attempting to overcome a criticism made by Robinson [1951], who argued that analysis by analytical induction cannot produce predictive theory. The author is not perturbed by this criticism, since it has already been suggested that the theory of this research should describe, explain, interpret and enhance understanding and should not claim to predict, but the fact that Bloor and Robinson referred to analytical induction in terms of prediction

3 There appears to be a great deal of confusion among authors about the origins of analytical induction and of this algorithm. Robinson gives the credit for this algorithmic procedure to Cressey and Sutherland [Sutherland et al., 1978]. Cressey points out that Lindesmith used the method in the 1940's [Lindesmith, 1947] and that he, himself, used it in the 1950's. It does not appear to have been used widely or with any significant success.
raises questions about the suitability of the method for this research.

8.23 Other Techniques

The author has referred briefly to constant comparative analysis and analytical induction in order to acknowledge that both techniques have influenced the analysis of this research data. However, neither technique has been adopted in its entirety, since each would appear to move far too hastily from qualitative data to theoretical models and the cumulation of theory. Hammersley and Atkinson [1983] have suggested that:

"This is a long road to travel and there are many way-stations along its course...............Often they (ethnographers) simply provide relatively concrete descriptions or rather more developed typologies and models. While the fact that these are way-stations on the road to theory must not be forgotten, there is no obligation on the part of an ethnographer to travel all the way in any particular study. It can be left to later studies, or other researchers to test the model."

The author welcomes the above observations. In the first instance way-stations, encountered early on the "long road", should be explored in order to identify guidelines for further exploration and theorising. Blumer [1954] refers to these as "sensitizing concepts" which "give the user a general sense of reference and.........directions along which to look". This guidance should lead to exploration of middle ground way-stations so that plausible candidate models/theories might be formulated before cumulation can be commenced in earnest. The issues of plausibility and acceptability seem to be forgotten by some researchers, in their haste to develop formal theory. Cumulation must be undertaken with caution and the"way-stations" should not be "by-passed".

The analysis of this research data proceeded with such caution and, although it reflected certain aspects of the techniques of analytical induction and constant comparative analysis, it investigated the potential of other methods to develop 'middle ground' candidate models/theory. Peter Woods [1986] has reviewed recent ethnographical research and lists the most prominent aspects of data analysis, in an increasing scale of abstraction and generality, as follows:
(1) speculative analysis
(2) classifying categories
(3) concept formation
(4) models
(5) typologies, and
(6) theory.

Ignoring the facts that Woods uses the terms model and concept in an extremely limited and idiosyncratic way (he actually writes that (4) and (5) are roughly equivalent) this list is consistent with the view that analysis and generation of theory is a modelling process.

In what seems to be a criticism of Glaser and Strauss, Woods argues that theory does not simply emerge from data. The model view would lead to the same conclusion since modelling must involve imaginative processes, insight and inspiration. It is a creative process [Woods, 1985]. Speculative analysis is, perhaps, an unfortunate choice of terms by Woods. The author suggests that Woods and Bronwyn Davies [1982], who uses what she calls speculative analysis in developing ethogenic theory, are probably referring to a process more appropriately described as global insight.

The author also concurs with Woods' view that theory does not simply emerge from data because he believes that it is dishonest of researchers to deny the influence that existing theory has on their data analysis. Analysis is not conducted in vacuo and it is unlikely to be conducted by researchers with no knowledge of other research findings. Reflexivity, which is so important a requisite in interpretive research, demands that this be acknowledged openly. In a paper entitled "Doing Life Histories" Faraday and Plummer [1979] declare that:

"The goals of our research harbour three conceptions of the theoretical enterprise; an examination of some already existing theory..............; an exploration of data in order to generate sensitizing concepts, theories and conceptual frameworks ; and a utilisation of symbolic interactionist orientation to interpret data."

While not wishing to over indulge in the method of theory exploration, which
Faraday and Plummer describe as "Ad Hoc Fumbling Around", the author believes that these three conceptions have much to offer data analysis and that techniques of analysis are not as linear as they are sometimes described by other authors.

8.24 Guidelines for Analysis

After investigating a wide range of analytical techniques, considering reports of their respective successes and failures, reviewing criticisms and personally trying out various techniques the author concludes that prescriptive procedures should be used with extreme caution. However, the data analysis of this research has been based on the following guidelines which reflect aspects of a wide variety of relevant techniques, above all, modelling. This process refers mainly to retrospective analysis of the data but it should be remembered that, as data was being collected, it was constantly subject to analysis. "Theory building and data collection are dialectically linked" [Hammersley et al., 1983]. This was essential to provide the theoretical sampling and progressive focusing, which was accepted as an important and necessary aspect of the research methodology.

The first stage of analysis should consist of a thorough examination of the data in order to identify phenomena/subject matter to be described, explained, interpreted and understood. Since this will necessarily involve selection of subject matter this must be acknowledged and not denied or forgotten; especially by those, who unlike this author, seek causal and predictive models/theory. The chosen subject matters will sometimes be selected because they are unusual, unfamiliar or unexpected patterns and events but sometimes because they have similarities to familiar matters such as existing theories, with which they may be compared. The process will almost certainly involve a great deal of insight.

The second stage is to formulate a model or theory which will serve to describe and/or explain the subject matter identified. It is important here to remember the selection which has already occurred and to take steps to enable the model to be judged and interpreted. Data must be made readily available for scrutiny to provide reflexivity and indexicality (for example, in the form of case records and case data).
The model or theory should then be compared once again with the data to examine if it describes and/or explains the selected subject matter to an acceptable degree. If the model/theory is judged not to be acceptable as description and/or explanation it may be modified or the selection of subject matter may be revised.

It is at this stage that the process is unlikely to be adequately described by a linear, algorithmic process such as constant comparative analysis of inductive analysis. As Hammersley and Atkinson [1983] suggest:

"Theoretical ideas, common sense expectations and stereotypes often play a key role. Indeed it is these that allow the analyst to pick out surprising, interesting and important features in the first place."

The development of theory is not as systematic as many techniques of analysis suggest. Lacey [1976] describes it as a "spiral of understanding", as insights are "escalated" by "moving backwards and forwards between observation and analysis and understanding". On the other hand, analysis is not as random a process as Faraday and Plummer [1979] conjure up in their description "ad hoc fumbling about". In this research the "spiral of understanding" and "escalation of insight" were guided by the techniques of analysis described above, but these techniques were selected to match the subject matter selected in the initial stages of analysis. No particular analytical technique was regarded as unique and universally applicable.

As has been explained earlier, a great deal of the theory of this research has already been presented in previous chapters in the form of case study models. These are not purely descriptive since they have been constructed from case data to describe and explain. They include extracts from the case data to illuminate and interpret and to enhance understanding. These case studies have been constructed by analysis of the data in the manner described above but, since the model view [vide supra 2.4] suggests that models should be investigated and manipulated to reveal theoretical possibilities, it is now intended to continue along the "long road" of analysis to seek other models/theory which, although more abstract and focused, should increase this understanding further. It is, perhaps, worth remembering that models are simplifications of the real world and that they should not be confused with reality.
Chapter 9

A MODEL AND THEORY OF IN-SERVICE EDUCATION AND TRAINING

9.1 Introduction

"It is an oversimplification (but a useful one) to say that there are two kinds of curriculum theorizing. One type of theorizing sees the curriculum processes as essentially technological enterprises, the other as essentially human political enterprises. There are also two types of curriculum theory - systematic, sometimes called 'rational' or 'scientific', and naturalistic. The aim of the first is to provide 'prescriptive guidance' for curriculum practices. The aim of the second is to provide description, explanation, understanding and, if possible, prediction. The second takes curricular practices as they are. The first strives to move curricular practices toward a desired pattern."


The above is an oversimplification but, since the design and development of the RLPE INSET scheme is regarded as a curriculum process, it is an extremely useful starting point from which to conduct the analysis which will furnish the models/theories of this research. The 'theorizing' of this thesis certainly regards the design and development of the RLPE INSET scheme as a human political exercise and not as a technological enterprise and as such belongs clearly to the second category described above. Its models/theories also appear to belong to the second type of curriculum theory (that is, 'naturalistic') which Taylor and Richards identify. The analysis and the formulation a model of INSET design and development in this section reflect the second type of 'theorizing' and theory.

Before proceeding, however, there are certain observations which must be made about the classifications which Taylor and Richards outline above.

Firstly, care must be taken when describing theories as scientific for the reasons outlined in Chapter 2 [vide supra 2.5]. In discussing prescriptive models Taylor and Richards concentrate on (i) The Objectives Model and
its variants (vide Bobbitt [1924], Tyler [1949] and Wheeler [1967]), (ii) *The Situational Model* (vide Skilbeck [1982]) and (iii) *The Process Model* (vide Stenhouse [1975] and Simons [1987]). None of these appears to have been developed scientifically in the manner which Kuhn has described [1970].

Secondly, Taylor and Richards link prescription and guidance, as if the latter implies the former. They are probably correct in describing the *Objectives, Situational and Process* models as prescriptive, since the use of each would appear to direct curricular practices toward desired patterns. All the same, the author does not accept the contention that guiding frameworks necessarily constitute prescription. The dividing line between guidance and prescription is extremely fine but this research will attempt not to cross that line in developing its models/theories.

Thirdly, Taylor and Richards suggest that the aims of naturalistic curriculum theory are "to provide description, explanation, understanding and, if possible, prediction". Once again, for reasons expounded at some length in Chapter 2, the author does not believe that naturalistic curriculum theory, which necessarily is developed through research with a non-positivistic perspective, could provide or would seek prediction.

A fourth observation is prompted by analysis of this research data. At first sight, the classical, prescriptive models [Tyler, 1949; Skilbeck, 1982 and Stenhouse, 1975] and, indeed important naturalistic models such as that proposed by Decker Walker [Walker, 1971], may lead one to suppose that the design and development of a curriculum are activities undertaken by an organisation, capable of thought and autonomous action. Such an organisation would analyse, make decisions, plan, formulate goals, act, evaluate, change and generally perform independently of individual people. Analysis of this research data suggests that a simple macro-model of an organisation would not be appropriate as a theory of INSET design and development. T. Barr Greenfield came to similar conclusions about educational administration and management.

"Most theories of organizations grossly simplify the nature of the reality with which they deal. The drive to see the organization as a single kind of entity with a life of its own, apart from the perceptions and beliefs of those involved in it, blinds us to its complexity and the variety of
organizations people create around themselves."


Although data analysis indicates that there is little benefit in regarding the RLPE INSET scheme as an organisation or system, it is possible to identify patterns related to the way in which individual participants approach the development of INSET provision. It is also possible to 'merge' these patterns to build models/theories of the manner in which individuals interact so that a scheme develops. It must be said that these patterns do reflect certain aspects of classical prescriptive models. To some small degree individuals do approach INSET development in a similar fashion to that which classical models prescribe for organisations. The merged patterns are similar to classical models, where there is evidence of consensus, or where privileged, powerful groups or individuals dominate design and development. Acknowledging this, and in order to maintain reflexivity, the author must admit that the Situational Model [Skilbeck, 1982a] influenced his approach to design and development and that his position as a providing agent meant that he, in turn, influenced others to work in a fashion which reflected that model. A modified form of the diagram which Skilbeck uses to describe his Situational Model is presented in Appendix 4.

The inherent weaknesses of many prescriptive, "means-ends" models of curriculum design and development are that, in attempting to simplify, they suggest that; (i) developers work in a linear fashion which is not always apparent when actual processes are observed and (ii) ends are fixed at a very early stage of development. Elliott Eisner summarises this nicely when he claims that, for a number of prominent curriculum planners:

"......the essential characteristic of curriculum and instruction is that it be a planned, sequential series of steps that lead to ends that are known in advance and are realized with a maximum of pedagogic efficiency."


These weaknesses are particularly noticeable in models which employ system diagrams of curriculum development. Steps which are taken by modellers to remedy deficiencies by making models "repetitive and/or cyclic" [Further Education Curriculum Review and Development Unit, 1981; Bolam, 1982a] do not altogether address the problems.
Despite the ordered diagram, which Skilbeck employs to describe his model [vide Appendix 4], he hints that curriculum design and development does not proceed quite so linearly. He qualifies the use of the *Situational Model* by commenting;

"There is a temptation to suppose that there is a logical order in the five stages of the model, and in designing a system, whether for manual or computer use, this temptation can easily be succumbed to.......in practical planning operations the different stages can be developed concurrently."

M. Skilbeck, 1982.

Analysis of this research data supports Skilbeck's contention that different stages can be developed concurrently but suggests that these are not necessarily the stages described by him. The data of this research suggests that Skilbeck may over emphasise *Goal Formulation* and *Objectives* and underestimate the part which problem identification plays in the process of curriculum development.

9.2 A 'Naturalistic' INSET Model

The model, which is now presented, is 'naturalistic'\(^4\) in the sense that, as analysis took place, it emerged from data collected by observing the design, development and implementation of the RLPE INSET scheme. The model, in fact, constitutes theory which is grounded in that data. In addition the model was constructed by comparing the development of the RLPE INSET scheme with that of other INSET provisions, such as the AIMEC Project [vide supra

\(^4\) In 1971 Decker Walker presented a well known model of curriculum development [vide Appendix 4], about which he commented;

"It is a naturalistic model in the sense that it was constructed to represent phenomena and relations observed in actual curriculum projects as faithfully as possible with a few terms and principles."


The curriculum projects on which Walker's model was based were large scale Research, Development and Dissemination (R,D and D) projects, such as the School Mathematics Study Group (SMSG), in the USA [Wooton, 1965]. This is in contrast with the 'naturalistic' model of In-Service Education and Training which will be developed in this thesis. The data of this research was gathered by observing projects which (i) stressed research and development rather more than dissemination and (ii) were rather smaller in scale than those considered by Walker. Nevertheless, the model and its associated theory are 'naturalistic' in the sense that Walker intimates above.
4.2], which the author had observed as a participant developer.

The model is presented in two parts. The first part concerns 'phases' of INSET design and development. The second takes the form of an evaluation structure, which the research suggests is constructed by designers and developers as an INSET scheme progresses. It must be emphasised, however, that the two parts are mutually dependent and together form the 'naturalistic' model, or theory, which has emerged from the data [vide infra Fig. 9(9)]. Because of this, and to provide a 'scaffold' for further discussion, diagrammatic representations [Figures 1(9) and 2(9)] and outline introductions of the two parts of the model are now presented. Later sections of this chapter will discuss specific elements of the model in greater detail and, most importantly, will explain how the model was developed by analysing the observational data.

The first part of the 'naturalistic' model identifies four phases, through which designers and developers tend to pass as an INSET scheme progresses. This part of the model differs from variants of the 'Objectives Model', since it suggests that INSET design and development is not a "mean-ends' process. Although it includes situational analysis, it differs from rational-analytical models (for example Skilbeck's Situational Model) by emphasising the problem solving nature of INSET design and development. It suggests that INSET developers are constantly gathering data, which they analyse to identify new problems. Developers also take steps to become familiar with problems by gathering more data. The process involves a significant aspect of decision making, as particular problems are selected and others are rejected. Throughout, what are described as near and far influences are at play. These influences result in directional changes in the development of the INSET provision concerned and make prediction difficult. For this reason the author suggests that a 'naturalistic' model, used as a set of guidelines to enhance judgement and decision making, has greater usefulness than a rigid prescriptive model of INSET design and development.

In developing a 'naturalistic' model of INSET design and development from

5 A slight concern about the term 'naturalistic' is caused by the contention [Hammersley et al., 1983] that the influence of naturalism causes a neglect of reflexivity in much educational research [vide supra 3.10]. The author has noted this criticism and has taken steps to include reflexivity in the development and presentation of the model and theory described in this chapter, by referring constantly to the case data and case studies.
this research data, the author was well aware of the temptations and problems described in the previous section [vide supra 9.1]. As a result the Part I of the model is described in terms of 'phases' of development rather than stages.

Fig. 1(9) Part I: The Four Phase Developmental Model

Although the phases are roughly in the order shown by the arrow marked Procedural Tendency, there is significant overlap between the four phases and elements of each phase may be conducted concurrently, or in an order which is heavily dependent on prevailing situations and observed events. Later sections [vide infra 9.3] will explain that each phase includes elements of others and, in particular, that the Progressive Development phase contains the essences of all the other phases. Thus far, Part I of the model does not explicitly include an evaluation phase, in the fashion of many analytical-rational models. The overall INSET model which will be developed, however, does include evaluation, as an intrinsic part of each phase and not as an end point. Throughout the development, participants are identifying aspects which they evaluate. In this way each participant is constructing a structure of evaluation which constitutes Part II of the overall model. This part is represented diagrammatically as follows [Figure 2(9)].
Fig. 2(9)  Part II: The Evaluation Structure Model

CLASSROOM PRACTICE

COGNITION
- Mathematical Competence
  - facts, conceptual structures, appreciation, judgement
- Pedagogic Competence
  - skills, general strategies, judgement
- Awareness
  - resources, practices, methods
  - facts, mathematics: procedures, techniques

ATTITUDES
- Roles and Social Interaction
  - INSET Group, School, Support Groups
- affective level in mathematics

CONFIDENCE
- Classrooms
  - use of: mathematics resources, methods
- Schools
  - status, respect, responsibility, opportunity

EVENTS AND PHENOMENA
- attendance, timing, supply, cover
- location, environment, resources
- organisation, methods and perspectives, roles and relationships

CONTINUING SUPPORT
- Agent: roles
- Inspectorate
- LEA: Advisory Team
- School/Department
It may be seen that the *Evaluation Structure* consists of six categories:

1. Events and Phenomena
2. Continuing Support
3. Confidence
4. Attitudes
5. Cognition
6. Classroom Practice.

The overall structure depends on the support which these categories provide for each other. Each category itself is made up of mutually dependent and supportive sub-categories. Later the author will argue that developers evaluate by investigating each component of the structure and by 'standing back' to consider the entire structure. In this sense they do not evaluate by measuring the degree to which pre-determined outcomes are achieved. The structure is evaluated by examining the 'bricks', the 'walls', the 'roof' and the overall 'building. Furthermore, at the outset of INSET development the nature of those components is not open to prediction.

The following sections discuss, in greater depth, the nature of the 'phases' and 'categories' which make up the overall 'naturalistic' INSET model which has been developed from this research data. The manner in which this model emerged from that data is also described in detail.

9.3 Part 1: The Four Developmental Phases

9.3.1 Phase 1: Exploration and Problem Identification

In the original and very early phase of the RLPE INSET scheme the data relating to the Rurishire Mathematics Inspector and the author furnishes interesting and important patterns. The case studies of Chapters 4, 5, 6 and 7 will support the contention that these patterns emerge from the evidence and this is further supported by the case records and case data. Both parties appear to have been involved in a number of activities and were pursuing simultaneously a number of 'parallel' courses.

In contradiction to a number of classical models there appears to have been little attempt to formulate precise aims, goals or objectives in this initial
phase of INSET development. In the very early part of the phase the individual actors searched for data and familiarised themselves with situations. It is tempting to describe this early activity as brainstorming [Parnes et al., 1963] or, more appropriately synectics [Gordon, 1961] but, in fact, it appears that it was not the generation of speculative hypotheses and problem solving which was the main concern but, rather, the identification of a set of candidate problems. Consequently it has been decided to call the first phase of this 'naturalistic' model Exploration and Problem Identification. This exploratory phase involved selection, sampling and progressive focusing. It also involved much deliberation between the principal actors (that is, the Rurishire Inspector, Professor A.C. Bajpai (Director) and the author) and with others (for example, Heads of Schools and Mathematics Departments, Members of the Advisory Team, LEA Officers, Teachers, University Staff).

While this exploratory phase did not follow strict guidelines, and at times was somewhat ad hoc, there is evidence that each actor was directed to some extent by what the author chooses to call far influences (for example, local INSET requirements, national teacher shortage, professional demands) and near influences (for example, pre-occupation with current and recent activities and work, professional responsibilities). In many respects far and near influences correspond respectively to the external and internal factors of Skilbeck's Situational Model [Skilbeck, 1982], but these terms have not been used because they are better suited to school-based curriculum development rather than to INSET provision. To enhance interpretation the author prefers to separate the data related to resources and needs from the influences which act on the developer as data is gathered and analysed. The Situational Model tends not to distinguish these elements since it is prescriptive rather than interpretive.

The author had considered using the terms macro and micro pressures rather than far and near influences. Macro pressures would be those which resulted from organisations or systems whereas micro pressures would result from (and in) individuals themselves. However, this analysis has taken the view that all influences on a developer are interpreted by that person, whether they be from organisations, systems or individuals. As such they should be described as micro interpretations. Consequently the terms
near and far were preferred. Perhaps, more importantly, the author considers that the chosen terms describe the nature of the influences extremely well and are well suited to INSET provision.

The first phase of our model is represented diagrammatically as follows [Fig. 3(9)]:

9.32 Phase 2: Problem Selection and Familiarisation

The next phase of the model is described as Problem Selection and Familiarisation. In many ways it is a reprise of the first phase since it involves all the elements of that phase [vide supra Fig.3(9)], but these are directed towards selecting from the set of candidate problems, rather than towards increasing the number in the set. It also involves taking steps to become familiar with the selected problem and to understand it. There are a number of important factors which are at play in this phase. Problems are chosen which are considered important, relevant, feasible and amenable to solution. This means, of course, that the principal actors need to exercise judgement and this necessarily involves the beliefs and values which are
crucial elements of Decker Walker's *Naturalistic Model* of curriculum development.

"The curriculum developer does not begin with a blank slate. He could not begin without some notion of what is possible and desirable educationally. The system of beliefs and values that the curriculum developer brings to his task and what guides the development of the curriculum is what I call the curriculum's *platform.*"


Analysis of the data of this research supports Walker's contention concerning the crucial roles of beliefs and values, but the notion of a *platform* is perhaps a little misleading. It suggests a rigid fixed foundation based on unchanging beliefs and values. Walker's platform has components which he describes as *conceptions* (beliefs about what exists and what is possible), *theories* (beliefs about what is true), *aims* (beliefs about what is educationally desirable), *images* (specifications of what is desirable) and *procedures* (specifications of desirable courses of action). Data from this research suggests that beliefs and specifications are components of INSET design and development but that these constitute influences rather than a platform on which to build. Furthermore these influences, although identifiable at all phases of the development, are more significant at certain junctures than at others. Unlike Walker's 'naturalistic' model of curriculum development [vide Appendix 4] the four phase model does not include a platform of beliefs, images and procedures. Far and near influences affect the manner in which individuals develop INSET in all four phases. These influences act more like vertical constraints than platforms and their natures and potentials change as the development proceeds.6

6 In fairness, Walker argues that a curriculum designer may make relatively minor changes to a platform as work progresses. To cater for these he includes a set of *precedents* which he calls *policy.* This appears to be a rather unnecessary complication, which the vertical structure of the influences in the four phase model makes redundant.

Walker also takes the view that the major part of the data is collected by a curriculum developer in order to "seek empirical confirmation of his beliefs."; in other words, to justify decisions made on the basis of the platform. This may be true of large scale Research, Development and Dissemination curriculum projects in the USA. The author's research analysis indicates that, in smaller scale INSET development, there is rather more emphasis on collecting data at early stages to identify relevant problems. In fact, in dealing with problems, a developer tends to be rather more rational and analytical than Walker suggests; even though the overall development process should not be identified too closely with prescriptive, analytical-rational models. As we have argued earlier [vide supra 9.1], the latter are more suited to systems than to individuals.
The previous, personal experience of the developers played another important role. In this respect there are similarities with certain problem solving heuristics [Polya, 1957; Kantowski, 1979]. In this instance, however, the first time the developers asked themselves Polya's question "Do you know a related problem?" it was to select a problem which they considered would be amenable to solution rather than to solve a given problem. For example, the author's experience with the AIMEC Project, Mathematical Workshops and MSc Courses influenced his selection, since he had a set of successful solutions and acceptable theories related to these. The Inspector was also very familiar with this work and, as the case studies show, had taken steps to acquaint himself with it once more.

As selection focused on INSET provision for Mathematics teachers with limited experience and qualifications, a more intense and focused review of resources and perceived needs commenced. The Inspector revisited schools, where he and the staff of the schools discussed possible INSET provision and began to identify suitable candidates. This necessitated an investigation of the availability and acceptability of supply cover. Financial resources were reviewed by the Inspector and by the providing agency. The author and Professor Bajpai, who by this time had agreed to be Director of the INSET scheme reviewed resources as providing agents. The availability of tutors, administration and office facilities were important resources to be considered. The author visited the Midchester Mathematics Centre to research resource availability. The University and the Local Education Authority, mainly through Professor Bajpai and the Inspector respectively, negotiated financial support and funding.

Figure 4(9), below, summarises the principal features of the second phase of development which the actors pursue. This phase, Problem Selection and Familiarisation, shares many characteristics with the first, Problem Identification. These have been indicated in 'hollow' type. However the two phases overlap considerably and the figures should be regarded as summaries rather than precise definitions or rigid sequences.
9.33 Phase 3: Outline Planning

The analysis suggests that developers tend to construct an outline plan or working solution in this phase (or sometimes earlier), whether it be a formal, prescriptive model, a modification of a classical model or an ad hoc design. The author has chosen the term Outline Planning to describe this third phase. An Outline Plan may be compared with what Decker Walker calls a "curriculum's explicit design", consisting of a set of design decisions "made with forethought and after a consideration of alternatives" [Walker, 1971].

Familiarity with other models of curriculum design and development is an important factor which influences these decisions. In fact one decision may be to adopt a prescriptive model as an outline plan of action. The data of this research suggests that developers tend to use analytical-rational models in this way, rather than as overall prescriptions. Taylor and Richards [1985]
argue that Skilbeck's *Situational Model* [vide Appendix 4] encourages curriculum developers:

".....to take into account different elements and aspects of the curriculum-development process, to see the process as an organic whole, and to work in a moderately systematic way."

The author used the *Situational Model* in this way, although he did not regard it as a rigid prescription. It acted as a set of guidelines for further design and action and the author felt free to modify it, as new data was gathered and analysed. Indeed, no model was considered unique and the outline plan of action was formulated using several other models. For instance, the author also used two simple *analytical-rational* models as guidelines. These are represented diagrammatically in Appendix 4. The first is a model devised by the Further Education Curriculum Review and Development Unit [1981] and was related to the evaluation of Technician Education Council (TEC) programme development in colleges. Ray Bolam [1982] suggested that the second model should be used as an "aide-mémoire" by designers and developers of 'school-focused' in-service education and training. The author regarded all models as such.

Although a developer may choose to adopt simple models such as these to formulate an outline plan of action they do not necessarily describe the development which actually takes place. In an implied criticism of other models the Further Education Unit [FEU, 1981] claim that common usage restricts much curriculum development to the first two stages of their own model [vide Appendix 4]. The author suggests that the Further Education

7 In a recent programme note for a performance in the 95th season of Henry Wood Promenade concert it is argued that all large-scale musical designs need to create some sense of symmetry, or balance, if they are to satisfy a listener's instinct for unity. The writer continues, however, to explain that only the routine minded rigidly attach the terms 'exposition', 'development', 'recapitulation' and 'coda' to 'sonata', the most influential of the great harmonic forms. The similarity of these terms to those employed by the Herbartians [Herbart,1891], and subsequently by the teacher trainers of yester-year, causes one to ask if the similarity of many prescriptive models of the curriculum process results from a search for symmetry and balance rather than from analysis of data. In the *Non-Statutory Guidance* which the National Curriculum Council have provided for 'Mathematics in The National Curriculum' [DES, 1989] we find another similar form:

"Effective delivery of the National Curriculum will require schools to move through a cycle of planning, implementing and evaluating..................It is through this process that schools will develop and refine their approach to meet the requirement of the National Curriculum."
Unit model, in common with many prescriptive models, is restricted to the Outline Planning phase.

In the Outline Planning phase the developer might also formulate aims, goals and objectives. Walker argues that:

"In most cases when teachers or subject matter specialists work at curriculum development, the objectives they formulate are either a diversion from their work or an appendix to it, not an integral part of it."


This appeared to be the case for all individuals involved with the RLPE INSET scheme. They did use aims and objectives but not as targets and not as outcomes to be tested by observing performance. Aims and objectives were used either; as 'token' responses to far influences (for example MSC funding bids [vide supra 4.41]) or; as devices which would, in Robert Gagné’s terms, "establish expectancy", "arouse attention" or "select perception" [Gagné, 1977]. The cover sheets, issued to participants of the RLPE INSET scheme, used aims and objectives in the latter manner [vide Appendix 6]. Aims and Objectives can be useful tools but should be regarded as navigational instruments (beacons, signposts, maps) and not as outcomes to be tested by the degree to which they are achieved.

The developer may also consider his or her own role in the design and implementation of an INSET scheme as part of Outline Planning. This will include the self-perceived role and that which other participants might perceive. This consideration will again be tentative because it is likely that perceptions will change as the scheme develops. Outline Planning is also likely to involve consideration and selection of acceptable and suitable principles of procedure, strategies, methods and techniques. Once again such selection would be subject to modification as new data was gathered to enhance judgement in respect to suitability and acceptability.

An important element of Outline Planning is likely to be the formulation of plans for the preparation and production of resources and materials which will be used during the implementation of an INSET scheme. This may involve the design, preparation and production of specific resources and material but will usually be far more general. It will necessitate a review of
existing data and further analysis. The feasibility of these plans will be considered in the light of this analysis. This planning will probably be firmer than most aspects of the Outline Planning phase because production facilities and financing need significant advance planning. Nevertheless, this research suggests that even these outline plans will be modified considerably as development continues.

Analysis, then, suggests that Outline Planning is likely to be tentative and not prescriptive. It refers to the construction of a map rather than a rigid itinerary. Figure 5(9) summarises the important aspects of this particular phase.

Fig. 5(9)

### Outline Planning

- Formulate Tentative Plan of Action, Working Solution, Outline Design
- Consider Possible Roles
- Consider and Select Principles, Strategies, Methods, Techniques
- Plan Preparation and Production of Resources and Materials

Influences

- Near: Beliefs, Values, Preferences, Experience
- Far: Resource Availability, Education System, Government, Society
Incidentally, analysis of data, which is given later [vide infra 9.4] indicates that, if the Outline Plan is formulated from a model which includes aspects of summative evaluation [Scriven, 1967], such evaluation is likely to be included in the overall development. The Outline Plan of the Rurishire Mathematics Inspector certainly included summative evaluation [vide infra 9.42]. Since this was welcomed and, indeed, encouraged by the author, the plans of the latter also included summative aspects.

9.34 Phase 4: Progressive Development

The fourth phase of this model is the most difficult to describe, since it consists of a set of activities, which includes design, action, observation, analysis and revision, and a set of relationships between those activities. What we shall attempt to do is to formulate a simple model of an extremely complex situation and, as always with modelling, acknowledge its inherent simplicity. Since there appears to be no generic term which would describe this complex phase adequately it has been decided to call it Progressive Development. This description was first recorded in 1861, when it was applied to the evolutionary stages through which societies and nations pass "their later manifestations being potentially present in the earliest elements" [Williams, 1976]. It is argued that the description is appropriate because the fourth phase of our model is potentially present in the other phases.

The association of the term evolutionary with the description is more problematic. Evolutionary suggests a somewhat uncontrolled, random development but the evidence, which is contained in the case data of this research and which analysis reveals, suggests that individuals modify their INSET activities in the light of their actions and observations. This means that there is significant formative evaluation included as part and parcel of the process. In this respect this research analysis differs from that of Decker Walker who concludes that "the curriculum developer adopts some courses of action automatically, without considering alternatives" and suggests that "unconsidered choices make up the curriculum's implicit design" [Walker, 1971]. The author argues that Walker has underestimated the power, capacity and speed of human information processing and that alternatives are considered and decisions made through a process of rapid feed-back. The data gathered by studying individuals, including the author himself,
suggests that, in the light of the Outline Plan formulated in the previous phase developers gather and deal with information either in a parallel process, or in such rapid, short cycles as to be equivalent to parallel processing. It is not the purpose of this research to develop models of cognitive learning but, perhaps, the Information Processing Skills (IPS) model might be re-examined and modified, by the inclusion of some form of 'transputer', to account for the apparent speed and power of human processing [Gross, 1985].

A simpler notion of the processes which individuals undertake in this fourth phase may be developed by first considering a classical design model, related to Action Research, developed by Kurt Lewin (a father figure of Social Psychology, Cognitive Field Learning Theory and Action Research) [Lewin, 1946]. This model consists of a spiral of steps, each of which is composed of planning, action and the evaluation of the results of that action. Lewin appears to have recognised that humans may be capable of some parallel processing since to make his action plans flexible and responsive he deliberately overlapped action and reflection on that action. A development of Lewin's model by Kemmis and McTaggart [Kemmis et al., 1988] also seems to recognise this aspect but the diagrammatic presentation of the modified model still appears to underestimate it [vide figure 6(9)].

Fig. 6(9)
Although the diagram above [figure 6(9)] refers to action research, it might be taken as a 'macroscopic' model of INSET development. The data which was gathered by observing individuals, as part of this research programme; suggests that by the time INSET developers find themselves in the fourth phase they are in a position to plan and that they do act, observe and reflect. The weaknesses of the spiral model are that; (i) like many other prescriptive cyclic models, it implies that development always proceeds sequentially from one cycle to the next in a never ending process; and (ii) it represents the long term activities of an organisation rather better than the short term actions of individuals.

Analysis of this research data suggests that the process of action, observation and reflection may or may not lead to a revision of existing plans and a continuation of the spiral. In many cases a review may lead the individual to identify new and more important problems or to conclude that the activities have been satisfactory. This means that the model must include analysis and decision making, as indicated in figure 7(9). Since these processes will involve a high degree of judgement it is likely that, once again, far and near influences will come into play. These should not be ignored in a theoretical model.

Fig. 7(9)
In addition the individual is more likely to be working simultaneously with a number of development spirals. The time periods and lengths of these spirals, which we might call sub-spirals, are likely to vary considerably. Despite this, the manner in which sub-spirals interact, and the decisions made within each of them, appear to be guided by the Outline Plan of the previous phase, so that their aggregation is modelled by a super-spiral with a reasonably long time period. This aggregation is represented in figure 8(9). The activities identified in the super-spiral will be heavily influenced by the Outline Plan. These activities are not included in figure 8(9), since they will differ according to the particular Outline Plan which is adopted by the developer. However, the activities are likely to be appropriate modifications of those given in figure 6(9) and of those in models which themselves have influenced the Outline Plan [vide Appendix 4].

Each cycle of a sub-spiral will be represented by figure 7(9). This means that Progressive Development will include planning, action, observation, review, analysis and problem solving. The latter aspect has been recognised in The Open University Pack 536, 'Making School-centred INSET Work' [Easen, 1985], which encourages teachers to explore mutual professional problems with colleagues. Although the authors of that pack for teachers provide an algorithm for assisting teachers to develop School-centred INSET along problem solving lines, they wisely comment that the process may not be linear in practice. This agrees with the analysis and theory of this research but the author suggests that the pack fails to recognise that problems are not always fixed, pre-determined entities. The nature of problem is constantly changing and new problems may be added to the process or they may replace those previously identified.

Fig.8(9)
Evaluation appears to be inherent in the *Progressive Development* phase. The author had considered calling the fourth phase *Organic Development*, since he was tempted to compare its processes with those of genetic growth. In some ways the *Outline Plan* seems to act as a 'genetic' code, so that developers undertake *sub-spirals* in such a way that they interact and aggregate to a particular *super-spiral*. The following section indicates that participant developers may indulge in some form of *summative* evaluation by judging how closely practice conforms to the *super-spiral* or 'code' [vide infra 9.42]. This type of evaluation would not adhere strictly to Scriven's description of *summative* evaluation. He argues that *summative* evaluation is concerned with assessing the worth of a programme in its final form. The author argues that the validity and reliability of any form of *summative* evaluation are questionable, since overall goals change and the 'genetic' code appears to be less robust than that involved in the growth of organic life-forms.

Scriven's notion of *formative* evaluation appears to be far more relevant to a 'naturalistic' INSET model than *summative* evaluation. The review and analysis involved in the *sub-spirals* of the *Progressive Development* phase may be compared with *formative* evaluation since they assist the developer to make design decisions. However, the second part of this 'naturalistic' INSET model suggests that this evaluation is based on categories and an overall structure, which developers build as the scheme progresses, rather than on outcomes fixed in advance. The *super-spirals* of our model and overall INSET development are, thus, subject to modification and change. They are not intractable, monolithic commandments.

9.4 Part II: A Structure for Evaluation

9.41 Introduction

This section presents data, which consists of criticism by developers and participants of the RLPE INSET scheme, together with analysis and comment by the author. However, the case studies, which are found in Chapters 4, 5, 6 and 7, have also been used as data from which second part of the 'naturalistic' model has been developed. It is further argued that those
case studies should be regarded as evaluation exercises in their own right. To consider those earlier case studies and this section as separate entities would hinder the pursuit of reflexivity and indexicality, which are so necessary for an interpretive study.

In addition to serving as data from which the 'naturalistic' model emerged, the criticism and comments, which follows in this section, together with earlier case studies, should enable the reader to judge the worth of the RLPE INSET scheme. Nevertheless, the author argues that the most important aspect of this section is that it adds to the data concerning the manner in which individuals design and develop an INSET scheme and thus enhances the model which is developed by analysis. That analysis focuses on:

(i) the manner in which developers evaluate an INSET programme

(ii) the characteristics of an INSET scheme which individual developers choose to evaluate.

Thus the following sub-section studies the evaluation, by the Rurishire Inspector of Mathematics and his colleagues, in order to identify suitable categories on which to focus. These categories will be investigated further as data gathered from other participants is analysed.

9.42 The Rurishire Inspectorate and Advisory Team

The Rurishire Inspector of Mathematics, Owen Eastwood and his colleagues had been evaluating the programme throughout its life [vide supra 5.52, 5.55 and Appendix 8] and at the beginning of the Autumn term, 1987 the Inspector prepared the following report.

"There is a well documented shortage of qualified teachers of mathematics in secondary schools. The size and rural nature of many Rurishire schools has resulted in this shortage being concealed by the use of non-maths-trained colleagues in the teaching of groups of children. These groups tend to be of lower ability, containing pupils who, in fact, need the benefit of carefully constructed conceptual experiences. These are not easily provided by untrained teachers."
Loughborough University was approached to provide a part-time course of some twenty afternoons to allow the teachers described above access to current classroom practice and methodology in mathematics.

The sessions have provoked much discussion, have given confidence to colleagues and, most importantly, have affected practice in mathematics classrooms. Reports from course members and from heads of departments indicate that the experiences have been effective in allowing teachers to approach mathematics teaching in a manner more likely to produce the transferable skills so necessary for the pupils.

Clearly it is too early to form any hard conclusions but a programme of evaluation is planned for this academic year. I am entirely confident that the initial findings will be borne out. I am equally confident in suggesting that the Loughborough model could be of tremendous value in addressing the "hidden shortage" of mathematics teachers and in improving the school experience of many otherwise neglected mathematics groups."


This report was prepared shortly after the main RLPE INSET 'course' at Midchester and the 'residential element' at Loughborough had been completed. It indicates an intention to continue an evaluation process over a longer period. In fact, the Inspector was party to the planning of 'follow-up' sessions. He had arranged that other colleagues in the Rutishire Inspectorate and the SEG mathematics advisory team would assist in this evaluation. The author had discussed this evaluation exercise with the Inspector and was pleased that this was to be undertaken. Subsequently the author discussed plans for this evaluation with two other Rutishire Inspectors (an Inspector of Languages and Clive Peat, the other Inspector of Mathematics). The perturbations described in Chapter 6 [vide supra 6.2] caused these plans to be modified and the author found that he had to encourage the Rutishire Local Education Authority to continue evaluation rather more than he had at first imagined. Evaluation data from that source was not in abundance, although what existed was freely offered to the author. These events are, of course, important data in their own right since they indicate that INSET development does not always proceed in the
manner which classical design models predict [vide Appendix 4].

It is interesting to note that, in his evaluation report, Owen Eastwood chose to comment on the following aspects:

(i) access to current classroom practice and methodology
(ii) discussion
(iii) confidence
(iv) effect on practice in mathematics classrooms
(v) the development of skills and concepts in pupils
(vi) improving school experience for neglected mathematics groups.

One way in which we might analyse the data, which the above report provides, is to compare it with other research findings and theory [vide supra 8.24]. For instance, the Inspector's evaluation appears to be concerned with teacher development and this might be compared with a definition by Eraut (1977).

"So I prefer to define teacher development as: 'the natural process of professional growth in which a teacher gradually acquires confidence, gains new perspectives, increases in knowledge, discovers new methods and takes on new roles'........"  


Another useful comparison may be made with a study by Joyce and Showers (1980) in which they classify the outcomes of teacher training into 'four levels of impact':

(i) awareness
(ii) concepts and organised knowledge
(iii) principles and skills
(iv) application and problem solving.
In the light of these comparisons the categories (or, the characteristics of INSET provision chosen for evaluation), which emerge from the Inspector's report are:

(a) for teachers:
   (1) increased awareness
   (2) enhanced confidence
   (3) knowledge and familiarity with new methods and current practice

(b) for classrooms:
   (4) changed practice

(c) for learners:
   (5) improved conceptual experience.

Frances Watts, an ESG advisory teacher in Owen Eastwood's team, also refers to confidence and changes in classroom practice in her evaluation of the RLPE INSET scheme. This evaluation is important because Frances became more involved with the programme as the departure of her immediate superior became imminent and as perturbations in Rurishire affected the evaluation plans made by senior colleagues. In November she wrote the author:

"You will be pleased to know that people who attended your course at Midchester are speaking very highly of the content of the course and particularly of the efforts of your team in building up their confidence as teachers of mathematics.

Many have appreciated the opportunity of working with other teachers in similar situations and are grateful for the patience, support and encouragement from the Loughborough team.

A request has been made to the Maths Inspector for regular meetings to be held during the school year thus providing continuous support for these teachers."
Frances chooses certain aspects of the INSET programme, as important to her evaluation, which reflect the Inspector's report (namely, enhanced confidence and changes in classroom practice), but she includes some which are rather different. These may be analysed into the following categories:

(6) course content  
(7) opportunities to work with other teachers in similar situations  
(8) patience and encouragement  
(9) support.

The inclusion of course content may refer to mathematical content, since it seems to be associated with "teachers of mathematics". This is not really clear but it raises the interesting point that the Inspector was not concerned with mathematical content in his evaluation. He had always stated that he thought the INSET scheme should "concentrate on process aspects rather than content". Philip Dean disagreed [vide 5.3].

Category (7) lends support to conclusions drawn by the author from the analysis of other data [vide supra 7.6] that agency provision has certain specific advantages over school-based or school-focused INSET for teachers belonging to the 'hidden' shortage.

Categories (8) and (9) are extremely interesting because they introduce the notion of 'participant roles' into the study of evaluation. The latter category also identifies the perceived needs and expressed desires for continuing provision and support. The use of the term 'team' and the 'ironic' quotation marks around 'students' suggest that the natures of the relationships and roles which had been established by the RLPE INSET programme were compatible with the design philosophy of the author [vide infra 9.45].

8 '26th November' refers to a meeting of the teachers at the Mathematics Centre, which had four significant purposes; (i) to initiate and promote regular 'follow-up' sessions, (ii) to present certificates to members (iii) to collect more data by questionnaire, interview/conversation and observation and (iv) to bid farewell to members of the Rurishire Team who were moving to other authorities [vide supra 6.3].
For reasons described earlier [vide supra 6.2] data related to evaluation was limited from other members of the Rurishire Inspectorate but, as the RLPE INSET scheme continued into 1988, Clive Peat became more involved [vide supra 6.5]. He was the only Inspector of Mathematics remaining in Rurishire following Owen Eastwood's departure. Clive was able to observe teachers, who had attended the RLPE INSET scheme, in classrooms and at 'follow-up' sessions. In conversations with the author he indicated that he was pleased with the outcome of the scheme, in terms of changes in teacher attitude and classroom practice. He had also written letters to two Head Teachers, requesting the release of the two 'key' persons, Rita and Barbara, to attend the Heads of Mathematics Conference in June 1988. In those letters he had stated that he wanted the two teachers to demonstrate examples of "good practice" to the heads. His support for Rita, when she obtained a permanent, full-time teaching post in the county, also referred to her "good practice". It appeared that Clive Peat approached evaluation in terms of observed changes in classroom practice. His comments support the conclusion that the RLPE INSET scheme was successful in improving classroom practice.

9.43 The Loughborough Team

It is appropriate at this stage to compare the above evaluation data with comment from members of the Loughborough team. The author had discussed the RLPE INSET programme at considerable length with his colleague Maureen Green. These discussions and conversations were extremely valuable for collecting data and might be regarded as exemplars of good informal interviews. Much of what Maureen concluded agreed closely with the analysis of the data which the author had gathered as a participant observer of the INSET programme. Shortly after the first 19 sessions at Midchester the author requested Maureen to summarise her conclusions and observations in written form, which she did as follows:

"The attendance at the Course has been extremely good. Only illness, lack of supply cover or some unavoidable occurrence has been able to keep them away. It is true that they have looked forward to their afternoons off school, but it also meant coping with long journeys in bad
weather and many other pressures.

The tremendous variety of background and experience of the participants has been extremely valuable and has enhanced their response to one another and to many aspects of the Course. They were willing to participate very actively right from the start, and their enthusiasm has not decreased as the Course progressed. They became extremely talkative! There were many digressions from the main theme of the programme! The opportunity to discuss with one another and share experiences has been greatly appreciated and fully used; in fact this has been one of the most important side-effects. Several members have volunteered to lead parts of Sessions on subjects from their own interest or expertise.

Some participants had never touched the microcomputers in their schools before the course began. A few were already quite confident in using software and were writing their own simple programs. Gradually this confidence has been communicated to the others who have begun to see ways to incorporate the use of these aids into maths lessons. I suspect that still more needs to be done in schools about this.

Many participants are concerned with slow learning groups. There has been ample opportunity to discuss the problems of these groups with regard to maths and together to discover a greater variety of approaches to topics both old and new.

The participants were already good teachers with many strong points. However many had gaps in their own mathematical knowledge, and others needed some updating. They frequently teach the more difficult classes and complained of feeling isolated in their schools. Gradually their eyes have opened to see that there is much good material to be used and plenty of colleague support. It is gratifying to hear comments from several of them that they feel themselves to be growing in confidence about using their maths and finding that they are treated with more respect in their departments. Some are being given opportunities by their Heads and HOD’s to share their experiences and course material with the rest of the department. Most have been able to try out
some of the ideas and material from the Course with their classes, and have been pleased with their pupils' response. For them the Course seems to have been able to set their own maths in a 'modern' context, filled some of the 'gaps' and let them see the syllabuses they teach in perspective as part of the whole maths curriculum. Their total cooperation at all stages, and acceptance of us, not only as Tutors, but as friends and colleagues has made the Course both easy to run and very enjoyable as well."

Maureen Green, July 1987.

Unlike Owen Eastwood, Frances Watts and the author, Maureen's evaluation was not based on data gathered by visiting schools and classrooms. The evaluation above is that of a participant observer of the INSET activities at Midchester Mathematics Centre. Consequently some of the evaluation categories which emerge from Maureen's comments are specifically related to phenomena and events observed at Midchester. These include attendance figures [vide supra 5.5], levels of enthusiasm and active participation, cooperation and the ease with which the INSET scheme was implemented. Many of these characteristics also featured in informal comments made to the author by Owen Eastwood and his colleagues. In particular the Rurishire and Loughborough teams were extremely pleased by the attendance figures [vide supra 5.52 and Appendix 8]. The Rurishire Authority Team were also surprised that attendance figures were so high and that not one teacher 'dropped out' of the scheme during the first 19 weeks. Their surprise followed experience with, and knowledge of, other INSET courses [Lynch and Burns, 1984].

Maureen Green's commentary agrees with the author's own analysis of the sessions at Midchester [vide infra 9.45], but this match must be interpreted in the knowledge that both parties had worked closely together on INSET projects for many years and, hence, shared similar philosophies and beliefs. Nevertheless, the shared conclusions do match those of their Rurishire colleagues. The positive effects of enhanced teacher confidence, mutual support and changing practices in classrooms and schools seem to have been recognised and approved by all the above commentators, as well as the author.
The comments and criticisms of the other members of the Loughborough team tended to relate to their own involvement in planning and implementing particular sessions. This is to be expected, since they had commitments to other work and were not as deeply involved in the design and development of the RLPE INSET scheme as Maureen Green and the author. The specific observations of the other members of the team have been included previously as a 'running theoretical discussion' [vide supra 8.21, Glaser and Strauss, 1967] in the Case Studies, which comprise Chapters 5 and 6. Philip Dean, however, made some interesting comments of a general nature shortly after his visits to Midchester.

"My overwhelming comments about our work are positive and I believe those of most of the group are also."

Philip Dean, June 1987.

In his overall comments on the INSET provision at Midchester Philip Dean made some interesting observations on timing and location. Firstly he suggested that a "ten day course (a day a week over ten weeks) would have been more effective". The Mathematics Inspector, Maureen Green and the author did not agree with Philip Dean, since their observations of the programme indicated that the changes in confidence and awareness of the members was achieved as a gradual, long term process, which the timetable and weekly structure of the provision facilitated.

Philip also commented on the length and timing of the Midchester sessions.

"I feel 2 p.m. to 6.30 p.m. after more than half a day teaching and a long journey is wasteful."

Philip Dean, June 1987.

The author concluded that Philip had raised important points of evaluation which should be investigated further. The author discussed these points, and other evaluation issues, with Philip and other members of the Loughborough team. Maureen Green and the author then collated the points, which had been raised in these discussions, and included items in the first questionnaire [vide Appendix 1] to investigate the evaluation issues involved. These related to the timing and location of the RLPE INSET scheme [Q8], organisational aspects [Q9], changes in teaching [Q10],
mathematics content [Q11], balance of process and content [Q12], attitude changes in colleagues and in teachers themselves [Q13], the philosophy of the INSET programme [Q14], methods [Q15] and improvements to the programme [Q16-18]. Subsequent interviews also furnished data on these matters [vide infra 9.44], which enabled the author to check and interpret data.

It is encouraging to note that the Director, Professor Avi Bajpai, referred to the positive effects of the RLPE INSET scheme in a talk at Midchester Mathematics Centre in November, 1987 [vide supra 6.3]. In fact, the talk itself almost certainly enhanced these positive effects, by enthusing the teachers towards Mathematics and its applications, and by encouraging them to help develop the INSET scheme themselves as an on-going venture. Professor Bajpai had been involved with the INSET scheme from its inception and he had been in constant contact with Owen Eastwood, Maureen Green and the author throughout its development. His support and encouragement had ensured that the programme had developed smoothly and in the absence of constraints, which might have hindered progress. Maureen Green and the author had also worked closely with Professor Bajpai on the AIMEC Project, of which the latter was also Director, and their philosophies and approaches had been heavily influenced by him. They were always well aware of the Professor's unswerving support and had constantly sought and accepted his invaluable advice at every stage in the development of the RLPE INSET scheme. It was particularly pleasing to the principal developers, therefore, to hear Professor Bajpai tell the participant teachers, the Rurishire Inspector and members of the Rurishire Team that, as a result of his own investigations, he judged the RLPE INSET scheme to have been a most successful venture, which had benefited the participant teachers and Rurishire. The participant teachers and the Rurishire Team indicated that they entirely agreed with the Professor, during his talk, and afterwards when they exchanged views with him at the reception to mark Owen Eastwood's much regretted departure from Rurishire. Later Professor Bajpai told the author that all the teachers (participants and a number of Heads of Mathematics) and advisers had expressed extremely positive views about the INSET scheme. "We have never had anything like this in Rurishire before. It should be available to more teachers in the County", was a typical comment made to the Professor during the reception.
The approaches, perspectives and philosophies of the principal developers of the RLPE INSET scheme meant that, in many ways, the participant teachers themselves were regarded as developers; particularly in the continuing phase of that INSET development. It is appropriate, therefore, to continue this analysis by examining evaluation data furnished by the participant teachers. This data was gathered mainly through questionnaires and interviews but it must be interpreted in the light of other data, which was collected by observing the members during the implementation of the INSET scheme, at follow-up meetings and in their schools.

The interviews, which the author conducted with participant teachers, and the first questionnaire [vide Appendix 1] provide some interesting and important data, which enables the worth and success of the RLPE INSET scheme to be evaluated. At the same time, analysis of that data identifies evaluation categories, which the participant teachers considered to be important and, hence, continues the process of formulating the second part (that is, the evaluation structure) of the 'naturalistic' INSET model.

The participant teachers appeared to evaluate confidence levels, attitude changes, awareness, mathematical competence and effects on teaching practice as one inseparable category. Interview data certainly provides evidence of this. In practice, the open-ended nature of many items of the first questionnaire [vide Appendix 1] also furnished data to support this conclusion. It also appears, from triangulation of this data, that the RLPE INSET scheme contributed considerably to the improvement of all of these aspects for the majority of participants. Observation of the increased use of the Midchester Mathematics Centre was an encouraging sign. The Rurishire Team's reports and comments also indicate that members of that team believed that classroom practice had generally improved. The author had himself observed good classroom practice by the 'key' persons [vide supra 6.7]. The work produced by pupils of Wendy, Joan and Brian suggested that those three teachers had changed their classroom practice significantly. Mark had certainly increased his own confidence, attitude and cognitive levels by successfully completing his Mathematics Resource Directory and giving a talk about it to the Rurishire Head of Mathematics Conference [vide supra 6.7]. Generally, if questionnaire and interview data are interpreted in
the light of the overall data, analysis suggests that there had been an
improvement in attitudes, confidence levels, cognition and classroom
practices.

Brian (questionnaire: item Q10)
Now prepared to leave the chalk-face, in order to present
investigations to the class. With the new booklet to hand, have taken
more modelling lessons than hitherto. My own self-confidence has
been improved with the help of the new 'Bible' and the material
supplied during the Midchester sessions.

Brian (interview)
......I think the biggest "spin-off", really, is the........inner confidence it's
given me.

Andrew (questionnaire: item Q10)
Up to recently I have tended to lack confidence as a teacher due to
my lack of experience in teaching the subject and lack of qualification.
I feel happy to attempt to develop work so that we can use more
investigative methods.

Andrew (interview)
........So I think, originally, the course catered for........or I thought the
course catered for...........those teachers that had very little
background in the teaching of mathematics at all........but in fact you
seemed to have to cater for........err...........a large range in terms
of........well........ability of the teaching of mathematics and experience.

PKA
How did that affect you?
Andrew
It gave me a lot of confidence........I rather felt at the beginning of the
course that it would be a bit like sitting down in the classroom......and
there would be a lot of chalk and talk......on the blackboard......and
you would be saying, "Right, how might we find the answer to
that?"...and........err.............It wasn't like that at all !
Jennifer (questionnaire: item Q10)
The course has given me more confidence as well as helping me with some Maths which I have never been taught myself. It has given me chance to try some new ideas and resources, to try some assignments, and in general to improve my teaching of Maths.

To discuss difficulties and identify solutions, in a neutral location, with peers, who were not school colleagues, was crucial for increasing confidence. Jennifer Hall told the author that, as a result of the programme, she would often telephone Rita Rigg to discuss teaching problems, which she did not care to discuss with fellow teachers at her school. Jennifer always held temporary or supply positions and the support she obtained from other members of the RLPE INSET scheme was invaluable to her.

PKA (interview)
Did our course have any effect on you?

Jennifer
I think so because I felt that I could cope with it, whereas before I don't know that I would have been able to....ermm..... I picked Rita's brains well and truly. She had some ideas. And it went very well.

Jennifer (later in the same interview)
Yes, Rita and I..... We often have a chin wag on the telephone.......

PKA
So that's a support?

Jennifer
..........and, if I was stuck, I could always ring up and say, "I'm coming over."............."I'm coming over. Can you help me?"...........It is a support...... Yes....... I think it is support you need.

Wendy (questionnaire: item Q10)
I have adopted a much more practical approach, especially towards Geometrical Topics. The course has made me more confident to use new methods, some of which I had been reluctant to try before, preferring the well tried "chalk and talk".

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PKA (interview)

Do you find advantages, then, in meeting other people... in the same sort of situation... from other schools?

Wendy

Oh yes,... very much...... ermm............ For a start, I think you tend to feel very isolated......... You're teaching a subject that isn't yours... You feel you're the only one........... and it's lovely to see these other people....... and see how they tackle things....... and what problems they find with pupils....... I don't mean behavioural problems. I mean problems in getting the things over........... and to hear what they've done....... ermm........ Apart from the more formal work, that we did with you....... and the practical work....... I think it would be great....... It's given me a lot more confidence.

As a result of Philip Dean's comments [vide supra 9.43], it was decided to include an item in the first questionnaire addressed to the acceptability of the timing of the RLPE INSET scheme and its location in the Midchester Mathematics Centre. Seventeen of the twenty one members completed and returned the questionnaire and of the respondents thirteen replied that the time and location had been satisfactory as far as they were concerned and they had no suggestion for better arrangement in this respect. Derek Castle had found the time and location unsatisfactory and would have preferred a full normal working day. Brenda Burton had only attended for half a session each week and hence found the time and location "not totally" satisfactory. Two members, Jack Connelly and Steve Bow, replied that the time and location had been satisfactory as far as they were concerned but suggested that a full working day would have been preferable.

"A full working day would be better. Concentration could lapse towards the end of the evening."

Jack Connelly.

Subsequent interviews provide data which suggest that many teachers (in addition to Jack and Steve) found a four and a half hour INSET afternoon/twilight session, after completing a morning teaching in school, extremely tiring. This evidence has led the author to conclude that a full-day (morning and afternoon) would have been a more suitable attendance
pattern for the RLPE INSET scheme. A typical interview comment was:

Bill
I found the afternoon was.........sort of.........everyone just come in from taking 5th year groups..........they were a bit shell shocked anyway..........but if they could have started at 9 o'clock in the morning that might have been better.

Austin Matthews gave a different reason for preferring a full-day session, which echoes comments made by participants following the residential week-end INSET at Loughborough [vide supra 5.7]. It appears that teachers appreciate the opportunities to tackle problems and work in group activities, without interruption, for fairly long stretches of time.

Austin
.........perhaps, we could have gone in a bit more........deeper............and spent a bit more time on some of the topics........er...........so a full day, perhaps, would be better, if the authority would wear it.

There was, however, no support (apart from that of Steve Bow) for changing the once per week pattern of attendance. Although Steve had found the course had been "good, certainly educational, pleasant to attend and valuable" he thought a two week concentrated course might be better, since he had found it difficult to "tune in" from week to week because he had had "so many other things" on his mind. Others disagreed with Steve on this point and indicated that they saw advantages in attending INSET once a week.

PKA
What about the time?.......We met once per week.......one afternoon, once per week. for nineteen weeks........

Lawrence (interrupts)
Oh yes that was marvellous... Oh, yes... I would prefer that to....shall we say........emm.......nineteen afternoons on the trot.......it was much better to do some work.......er.......come away and let it sink in...........
Andrew Young did not always order his comments, or stay to the point, in his interview, but his comments are probably amongst the most significant of all the data collected on the timing and location of the Midchester programme. As one of the youngest, least experienced and less confident teachers he valued the support of other teachers and the opportunity to discuss with them, and the Loughborough team, ideas he had tried out in his classes from week to week. He did not welcome the idea of a short, concentrated, full-time course.

Andrew

But then you see.......err........you do a full block of work.......you have a lot of ideas there.......but you get rid of the time that we had to get together.......to mix.......to formulate ideas.......to find out if our ideas had actually worked in school........So what you would be doing really........you would be........err.......taking away the time that we had to form new ideas between ourselves........and you would be emphasising your own role over and above the communication between the various teachers..................Not a good idea.......I don't think........because I think that a lot of the........err.......the good that came out of the course came from the communication between the various teachers.

Joan Warwick found that a weekly break from teaching routine was stimulating and that she was able to try out new ideas, and think about them, between the weekly INSET sessions:

Joan

I must admit that the once a week thing........is a terrific.....sort of.....boost to your ordinary teaching week.....really.....I don't mean just a break every Thursday afternoon.....but it is a stimulus to keep you going.....and, in teaching, I think you can get awfully bound up with the routine of day in and day........and I think that was good...it gave you chance to.........go back and try things out.....and think about them........and then go back to the course......Not necessarily to discuss them formally.....but it gives you a.........In a way, I think, a week apart.....gives you a time in which to try them. If you'd got weeks and weeks, you might not get round to doing things...but it's quite nice to
try them and then go back, I think...I liked it.

The availability of supply cover had been a factor in determining the responses of some teachers. For instance, the time arrangements for the Midchester course had worked well for Joan Warwick and "very satisfactory" cover had been provided, through special funding, arranged by Owen Eastwood, the Rurishire Inspector of Mathematics.

Supply cover was not so easily found in the case of some teachers with specialities other than mathematics.

Patrick

..............There are no supply PE teachers in Rurishire......men anyway......and, to be honest, you have got to be a specialist to be a supply teacher in PE.........So my head of department filled in for me all the time and, over nineteen weeks, I would think it became a bit of a bind.

Even when supply cover was available it did not always solve problems which teachers faced. Jennifer Hall was concerned that long, sustained periods of INSET away from school would cause difficulties for herself and her pupils:

Jennifer

...........It is very difficult to actually leave school for long periods because even though you set work, you've still got it to mark and sort and what have you...particularly if you're maths...and you get back.... the kids don't understand it.... you've got to have somebody who knows what they are doing. So I think once a week like that was ideal.

The organisation of the INSET scheme, the preparation, production and availability of resource material resources and the methods used by the Loughborough team all appeared to be important aspects, which attracted comment and criticism from participants. Again participants tended to group these aspects together when making criticisms, which emphasises that these factors are dependent upon each other. This dependency was well recognised, from the outset, by the Loughborough team, who made considerable efforts to organise efficiently, prepare materials to a
professional standard and to use a variety of methods to match situations
[vide supra Chapters 5 and 6]. It was particularly rewarding, therefore, that
participants were more than willing to inform the author, through
questionnaire and interview that they thought that the aspects in question
were of a high standard.

Mark (questionnaire)
Excellent pre-planning. The most professionally presented course
that I have attended in many years.

Mark (interview)
Do you want my comments on the course?
PKA
Yes, please.
Mark
Thoroughly enjoyed it! Thoroughly enjoyed it! The most useful
bit I felt...not only for myself though, having done the special needs
course........we covered some areas, which I have done before and I
enjoyed the refreshment of it.......It was......was the philosophy
aspect......not philosophy in its kind of.......inverted commas
sense.......but looking at the processes of mathematics as they affect
the ideas and the development of children.

Mark had recognised that influences such as GCSE were having an effect
on mathematics teachers. This was making demands upon teachers to
change teaching approaches and to consider process aspects as well as
content. Mark thought that the RLPE INSET scheme had helped the
participant teachers to recognise and meet those demands in a special
manner. His comments are an interesting evaluation of the methods and
perspectives adopted by the Loughborough team, and especially of the
approaches to include a wide variety of process aspects in the programme.

Mark
but you couldn't just teach it in isolation, because it's something
which..........I think..........grew as the course went along............Nothing
was, kind of, said as such......to itemise it............It was just the way in
which people talked........the way in which we..........There was
almost a sense of wonderment at times........"Oh, that's what's
happening!".......You know......a realisation.........of understanding the processes of......of learning......and failure.

Mark's comments should be compared with those of Rita [vide supra 6.71].

Rita

......I didn't rethink it..........er...... it evolved within me......One day it came over me like a cloud......."Oh my God, I'm being taught in the way that modern teachers are supposed to teach and so this is how it feels to be a pupil."

Although there was general agreement amongst the participants that the RLPE INSET scheme was well organised, resources were of high standard and methods were appropriate, this must be tempered by a wide variety of comment on the mathematical content of the Midchester sessions. The nature of the 'hidden' shortage makes selection of content for an INSET scheme particularly difficult. This is, apparently also true of courses with more homogeneous student groups. For instance, Marsh researched the perceptions of teachers who had followed a specialised, full-time, one year course entitled Diploma in the Education of the 14-19 Age Group. He comments, "You can't please all the people all of the time" [Marsh, 1988]. Pleasingly questionnaire and interview data suggest that the RLPE INSET scheme met the content needs of the majority of the teachers, for most of the time. However, amongst the RLPE INSET participants there was a recognisable group of teachers, who appreciated mathematical content (they mentioned, in particular, sets, functions, vectors, matrix algebra and statistics) rather more than the other members, and indicated they would have liked more academic content of this type in the course. On the other hand, some members found such content too difficult for them and required very basic mathematical content. Nevertheless, the participants were well aware of the varying needs of the group as a whole and acknowledged that the programme contained mathematical content to cater for a wide variety of needs. Perhaps Andrew summarises the general feeling of the members.

Andrew (interview)

One thing I did find is......some of the more academic work that we did did tend to leave some of us behind.......Ah-ha.........and the better qualified teachers obviously.......I think they were quite happy with
it.....but there were three or four afternoons that didn't really do a lot for us, in all honesty.

PKA
Yes?

Andrew
And I think it was difficult for you and the other lecturers, because you had to deal with such a wide range of ability......because you, basically, had non-mathematicians such as myself...........You had people like you, who had dealt with Mathematics over a number of years........so......you know.......great...........But I think, overall, you gave a little bit to everybody throughout the course......So......very, very good from that viewpoint.

Andrew (later; in concluding the same interview)
The course itself will always be a good memory........It reflected the human side of building relationships. It seems, perhaps, sentimental but, I believe that teaching should be that.......and what I hope is......that, if I get the chance to teach Mathematics again, I hope that the children feel the same about the Maths.......that I do about the course that we did at Loughborough (sic).

Finally, it is gratifying to note that (with the exceptions of Brenda and Austin, who appeared, understandably, to view the future only in terms of the school re-organisation which had, and would, affect their teaching careers) interview and questionnaire data indicated that there was universal agreement amongst the participant teachers that the RLPE INSET scheme should be a continuing venture. A number suggested that it should be continued for other teachers as well as for themselves. This makes the perturbations within the Rurishire Authority, which resulted in a lack of continuing support, extremely regrettable.

9.45 The Author: Principles, Roles and Strategies

The research perspective adopted for this research [vide supra Chapter 2] required that the author, acting as a participant observer [vide supra 3.4,3.5], also acted as an insider evaluator [vide supra 3.2, 3.7]. This means that theoretical categories, which emerge in this analysis, will be grounded to a significant extent in data collected from the author's personal observations.
In many respects the author was better placed to collect observational data than other developers of the RLPE INSET scheme, since he was able to observe almost all the provision as a participant and to observe teachers in their schools and classrooms.

At this juncture the author wishes to honour his commitment to provide reflexivity by stating that his own INSET experience, in acting as a providing agent for mature teachers on such programmes as the AIMEC Project, CGLI 730, various LEA INSET Provisions and MSc Courses [vide supra 4.2], has led him to define teacher development in the same way as Michael Eraut [vide supra 9.42]. This may appear contradictory to some parties, since Eraut is an advocate of school-based innovation, whereas the author has worked mainly as an external providing agent. It must be noted, however, that the author has always advocated that teachers, with whom he has been involved in INSET situations, continue the development themselves in their own environments: perhaps as 'key' persons or 'animators'. The author supports and advocates INSET which is environmentally or situationally orientated, but reserves the right to promote agency provision in suitable circumstances. He also recommends that, for 'hidden' shortage teachers and some other groups, 'situationally orientated' should mean school/college-focused, school-centred or area-based rather than school-based. For instance, the AIMEC Project could not have been conducted as a school-based innovation. Likewise, the analysis which is described in Chapter 7 [vide supra 7.6] suggests that the perceived needs of members of the 'hidden' shortage of mathematics teachers would not be served by school-based or school-focused INSET.

It should not be surprising, therefore, that the author appears to have formulated Outline Plans which took cognisance of a statement from an advocate of school-focused INSET.

"Traditional, course-based methods in in-service education and training (INSET) for teachers have been widely criticised as being over-theoretical, over-generalised and as ignoring the problems faced by course participants when they try to implement the new methods in their own classrooms and school contexts."

Ray Bolam, 1982b.
The author's INSET experience over many years had influenced him to reject such traditional courses as unsuitable for the teachers, with whom he had been involved [vide supra 4.1]. Owen Eastwood's comments, when he first mooted the possibility of the RLPE INSET scheme, reinforced the views of the author in this respect. The Inspector had approached Loughborough University to provide the RLPE INSET scheme because he was dissatisfied with other INSET courses, which had only provided "tablets of stone" for teachers in Rurishire. He was familiar enough with the work of the Loughborough team to know they eschewed such approaches. The Outline Plans of the Inspector and the author, therefore, included the principles that the provision would not be over-theoretical or over-generalised and that school situations would not be ignored. Their approaches to evaluation was guided by these plans.

The author did not regard evaluation in terms of establishing the existence of direct causal links between INSET provision and the behaviour of teachers, although his own evaluation and that of Owen Eastwood and the Rurishire Team did include observation of classroom practices. Interpretation and analysis suggests that the RLPE INSET scheme was successful in bringing about changes, which led to 'good practice' in classrooms, but the author suggests that this should not be taken as evidence of direct 'cause and effect'. The research analysis suggests that the process was more complex and indirect. The RLPE INSET scheme is more closely linked with those changes in awareness, cognition, confidence and attitude, which may subsequently affect classroom practice.

In the light of the comments of the last paragraph, and observations in Chapter 2 of this thesis, the author has reservations about the validity of the training investigations studied by Joyce and Showers [1980]9. These tended towards an experimental approach, which the non-positivistic perspective of this research eschews. (For instance, many of those training

9 Joyce and Showers (1980) classify "outcomes of training" into four levels of impact; (i) awareness, (ii) concepts and organised knowledge, (iii) principles and skills, and (iv) application and problem solving. Their "components of training" are (i) presentation of theory or description of skill or strategy, (ii) modelling or demonstration of skills or models of teaching, (iii) practice in simulated and classroom settings, (iv) structured and open-ended feedback (provision of information about performance) and (v) coaching for application (hands-on, in-classroom assistance with the transfer of skills and strategies to the classroom).
investigations used experimental control groups of teachers). Indeed these reservations extend to the analysis which Joyce and Showers themselves undertook. They attempted to relate "outcomes of training" and "components of training" in a causal manner\textsuperscript{10}, by revealing "what conditions help teachers to learn". The author has little objection to the "four levels of impact" which Joyce and Showers identify, since his experience prompted him to include these in his own Outline Plans: although he possibly gives more significance to "awareness" than those two authors.

He has more serious reservations about their "components of training", which his experience with mature students suggests may place adults in those threatening and potentially embarrassing situations, which it is better to delay until relationships of trust and friendship have been established between all participants. The "components of training" indicate a tendency towards Behaviourism, which neglects certain aspects of the human condition.

Nevertheless, the methods employed by the Loughborough team shared certain aspects with the "components of training" of Joyce and Showers, but these were not regarded, in any sense, as 'behaviouristic' training. The participant teachers were able to observe a variety of models and demonstrations of teaching styles and approaches. The author must admit that his own Outline Plans, beliefs and principles almost certainly influenced other members of the team, but the latter brought their own methods, styles and approaches to the scheme. The Loughborough team

\textsuperscript{10} It is interesting to note that a research programme, undertaken into INSET provision for Oxfordshire teachers, argued that to include the five "components of training" would be expensive in terms of time and money. A less elaborate programme was devised for that research, which entailed 'trying out and reporting back':

- presentation of rationale and material at one session
- trial in school
- follow-up by discussion at the next session of the course.

The programme is reported in a paper entitled 'Changing Teaching Methods through INSET' [Backhouse, 1988]. Despite the title and a suggestion, which the paper makes (that the study of Joyce and Showers [1980] was influential in the formulation of Oxfordshire study), the latter appears to have been more inclined to interpretive research than to scientific experiment. It used questionnaires and interviews. A study of teachers' perceptions of an in-service course [Marsh, 1988] also used interviews in an interpretive fashion. However, a number of INSET studies in the UK, as well as the USA, tend towards more positivistic perspectives and gather quantitative data, which is subsequently analysed by statistical techniques [Moore, 1988, Lynch et al., 1984].
also decided that teachers would be encouraged to experience, as learners, all the mathematics teaching opportunities described in Paragraph 243 of the Cockcroft Report [Department of Education and Science, 1982]. These opportunities were supplemented by role-playing exercises (a strategy which Maureen Green and the author had developed and used successfully with AIMEC Project over a number of years [vide supra 4.1, 5.51]) and 'resource browsing' activities. The latter opportunity was enhanced by the location of the RLPE INSET scheme in the Midchester Mathematics Centre. The subsequent 'follow-up' sessions of the scheme, together with visits to members' schools by the author, provided feedback and advice to teachers, not only about classroom practice, but also about general aspects of teacher development such as, resource availability, careers and social issues.

The author's approach to evaluation has been influenced by experience as a provider of INSET and by the beliefs which, consequently, formed over many years. These 'near influences' have caused him to prefer particular methods and to adopt certain principles and perspectives. Nevertheless, the 'far influences' of other parties and authorities must not be denied [vide supra 4.3]. The latter have resulted in the emergence of some categories of evaluation, which tend rather more to summative evaluation than the author would have preferred. However, in the main, the evaluation categories related to the author reflect his belief that INSET cannot force changes in teachers. What it can do is to provide environmental conditions, experience, knowledge, resources, support and advice which will encourage change and give teachers a 'tool-kit' to facilitate changes which they decide for themselves.

Michael Eraut has suggested that in-service courses:

"........need to be participant-centred rather than expert-centred and that they should usually aim to fulfil four functions.

1. To meet an immediate need.
2. To develop longer term thinking.
3. To encourage self-evaluation.
4. To build social links which encourage mutual visits and consultation.

To prepare such courses is a difficult professional task.........."

The author is in broad agreement with Eraut’s suggestion. In fact, the author argues that INSET evaluation should judge how well a programme has fulfilled that "difficult professional task". This should be an important aspect of the process of data analysis which builds theories and models which, to paraphrase Lawrence Stenhouse [1978], will enhance the judgement of INSET designers and developers rather than replace it.

9.46 A 'Naturalistic' Model of the INSET Evaluation Process

By comparing the evaluation categories, which have emerged so far, it is possible to identify categories of a more general nature. The data suggests that developers do not necessarily evaluate in terms of the attainment of predetermined targets or goals. It does suggest, however, that individual developers tend to have loosely formed notions of desirable outcomes (such as improved classroom practice, although they do not evaluate solely in terms of that particular category). In addition they do not appear to evaluate in terms of the relation between cause and effect (or input, output and efficiency). The following second part of the 'naturalistic' INSET model [vide supra Fig.2(9)] describes the evaluation which was observed in the RLPE INSET scheme, as a set of categories and sub-categories.

1 Confidence

This category relates to the confidence of individual teachers. Its sub-categories are:

(a) confidence in classrooms

(b) confidence in schools.

These sub-categories may be further sub-divided as follows:

(a) confidence in classrooms
   (i) confidence to use mathematics [for example, new topics, different perspectives]
(ii) confidence to use resources [for example, computers, calculators, apparatus]

(iii) confidence to use new pedagogic methods [for example, investigations, practical work, discussion].

(b) confidence in schools

(iv) status
(v) respect
(vi) responsibility
(vii) opportunity.

Evaluation concerns the degree to which all of these confidence sub-categories are enhanced.

2 Cognition

This category relates to cognition. This bears comparison with 'the four levels of impact' described by Joyce and Showers [vide supra 9.42] but it is somewhat different. In this secondary category the INSET developers evaluated the level of awareness of teachers in respect to existence and availability of resources, classroom practices, methods of teaching and learning, mathematical facts, procedures and techniques. Awareness was regarded as a precursor to the process in which teachers increase their own levels of mathematical and pedagogical competences. These latter levels might be compared with the elements of competence to which Paragraph 240 of the Cockcroft Report refers. These are facts and skills, conceptual structures and general strategies and appreciation. Margaret Brown has discussed the hazards of applying these latter categories to assessment, without considering individuals and circumstances [Brown, 1978]. The

11 In Mathematics from 5 to 16 [Department of Education and Science, 1987] HM Inspectors are, in effect, referring to this 'cognition' category, when they list the Aims of Mathematics Teaching and then follow these with a set of Objectives. The Aims given are (i) Mathematics as an Essential Element of Communication, (ii) Mathematics as a Powerful Tool, (iii) Appreciation of Relationships within Mathematics, (iv) Awareness of the Fascination of Mathematics, (v) Imagination, Initiative and Flexibility of Mind in Mathematics, (vi) Working in a Systematic Way, (vii) Working Independently, (viii) Working Cooperatively, (ix) In-Depth Study in Mathematics and (x) Pupils' Confidence in their Mathematical Abilities. The Objectives listed are (a) Facts, (b) Skills, (c) Conceptual Structures, (d) General Strategies and (e) Personal Qualities. Although the author would prefer to forgo the use of the terms Aims and Objectives, the elements in these lists would fit nicely (although rearranged) into the Evaluation Structure, which has been formulated as a result of this research programme.
author argues that, in order to avoid similar hazards, care must be exercised in applying such categories as 'the four levels of impact' to INSET evaluation.

3 Attitudes

This evaluation category relates to Attitudes. This again bears comparison with other theory\textsuperscript{12}. Krathwohl and others [1964] group attitude and awareness together in an Affective Domain of Educational Objectives. Other models connect confidence with attitude. The observational data of this research suggests that attitude should be placed in a different evaluation category. It has more connection with those roles, which participants perceive in themselves and others, and with social skills. Sub-categories include roles and social interaction within; (i) the participant group, (ii) the participants' schools and (ii) mutual support groups. Analysis also identifies a sub-category which concerns teachers' affective level in mathematics [Krathwohl et al., 1964]. For example, evaluation in this research suggests that the participants came to the INSET scheme with good attitudes towards mathematics, despite their limited qualifications and experience in the subject, and that their affective levels improved during the programme. Similar evaluation findings applied to participants' attitudes towards each other and members of the Loughborough team.

4 Classroom Practice

The three categories identified so far are related to changes in classroom practice. Since classroom practice was evaluated by the Rurishire Team and by the author this forms a fourth category. These four categories form part of a model which, rather than indicating cause and effect, suggests what aspects of an INSET scheme might be subject to evaluation. The model takes the form of a structure illustrating how categories depend upon each other. For example, enhanced cognition, attitude and confidence levels in teachers might be envisaged as supporting changes in classroom practice.

\textsuperscript{12} In this analysis the author compared the emerging model with other theoretical studies. The latter included the Taxonomies of Educational Objectives [Bloom, 1956, Krathwohl et al., 1964]. Those studies describe Cognitive and Affective Domains and moot a Psychomotor Domain [Simpson, 1969]. The author concludes that these domains are rather too behaviouristic to have significant relevance to the evaluation categories, which emerged from the data of this research. Nevertheless the comparison was a helpful technique of analysis.
(and long term teacher development) while, at the same time mutually strengthening each other. This is not the same as the claim that increases in these three levels necessarily cause improvement in classroom practice. It should be emphasised that the model simply (i) reminds evaluators that all the categories are mutually dependent and (ii) indicates what might be evaluated. In fact, if the data is analysed further, two more categories emerge.

5 Events and Phenomena

A fifth evaluation category is grounded mainly in those aspects of evaluation which featured in the criticisms of members of the Loughborough team and in the comments by participant teachers. This category relates to a variety of events and situational phenomena. Attendance, location, timing and the availability of supply cover concerned both the participant teachers and the Loughborough team. Those phenomena are closely related to environment situations, resources and organisation. The category also includes evaluation of the methods and perspectives adopted by the Loughborough team during the implementation of the RLPE INSET scheme and to the roles and relationships which were established.

6 Continuing Support

A sixth evaluation category is grounded in the data which the author gathered, as he observed the continuing RLPE INSET scheme [vide supra Chapter 6]. This category concerns the quality and availability of continuing INSET support for participant teachers by the local authority, schools and departments (usually the Head of Mathematics) and by the providing agency (in this case the author). This research identifies this category as the weakest element in the overall structure of the RLPE INSET scheme despite efforts to bolster it by the author. For instance, in January, 1988, the author suggested to the Rurishire Team, that a possible structure for continuing INSET support might include the following activities.

(i) Setting up school-based INSET groups at those schools in which committed members of the original RLPE INSET work. Organisation of these groups would be by a partnership of the trained 'key' teacher,
the Head of the Mathematics Department and the Rurishire Mathematics Advisory Team. Advice and support would be provided by Loughborough University as required.

(ii) Establishing area-based and school-focused INSET, in the form of 'self-help' groups, with trained 'key' teachers from the original experiment acting as 'animators', assisted by the Rurishire Mathematics Advisory Team. The 'key' teachers would meet at regular intervals (say once every school term) with the Loughborough team to review and update their work and to exchange ideas and experiences.

Unfortunately, the perturbations within Rurishire [vide supra 6.2] resulted in the erosion of this part of the structure.

The fifth and sixth categories, which may be regarded as foundations of the structure, complete the second part of the 'naturalistic' model. This part of the 'naturalistic' model describes an actual INSET evaluation, but it is hoped that it might serve as a set of guidelines, or as an aide mémoire, for other INSET evaluators. The author suggests that it provides a new and different perspective of evaluation, which would be more appropriate for 'insider' or participant observer evaluation than many 'means-ends' orientated models [Stufflebeam, 1971] and 'accountability' models [Parsons, 1981]. It might also supplement the evaluation techniques of many 'illuminative evaluators' or 'case-study practitioners' [Parlett et al., 1972, Simons, 1987, Walker, 1982]. The 'wall-like' nature of the model may, perhaps, remind evaluators that structures should be evaluated (i) by examining each specific, supporting component and (ii) by observing the edifice as a whole. Evaluation ought not to concern only the uppermost parts of the structure. As an analogy, engineers do not conduct constructional surveys of buildings by examining the roof only. INSET evaluators should not concern themselves only with ends or final outcomes.

9.5 The Overall 'Naturalistic' INSET Model

On their own, the Four Phase Developmental Model and the Evaluation Structure, which have emerged from the data of this research, describe, explain and enhance understanding of the process of INSET design and
development. However, the author suggests that by combining the two parts a much more powerful 'naturalistic' model may be constructed. This composite model unifies design, development and evaluation in a different manner from other models which are to be found in the fields of curriculum and INSET development. It contributes to the notions of formative evaluation and summative evaluation [Scriven, 1967] and supports the contention that the distinction between these two types of evaluation is "rarely clear cut" [Stake, 1976]. The model also explains (i) why there is likely to be considerable overlap in respect to the four foci of evaluation (context, input, process and product) suggested by Stufflebeam and colleagues [Stufflebeam, 1971] and (ii) why the 'means-ends' nature of the 'product focus', in particular, may render it unsuitable for evaluating 'real world' INSET schemes [Henderson, 1978, Bolam, 1980]. A particularly important aspect is that the model illuminates possible dangers in subscribing to the four foci of evaluation. Such hazards might lead to evaluation in vacuo and a neglect of interacting forces and dynamics.

A diagrammatic representation of both parts of the 'naturalistic' INSET model may be seen in a previous section [vide supra Figures 1(9) and 2(9)], but it is, perhaps, important to emphasise again that the two parts are mutually dependent. To this end both are represented in diagram [Figure 9(9)] as a composite, or overall, 'naturalistic' INSET model. The diagram illustrates the inherent nature of formative evaluation. This formative evaluation was not based on rigid, pre-determined outcomes. It was, in essence, a dynamic process based on feedback and interaction between the two parts of the 'naturalistic' INSET model. This feedback was not as direct a process as many other theories and models suggest. The activities of each phase of design and development contributed to the construction of the Evaluation Structure. In turn the Evaluation Structure determined the nature of the near influences, which constantly acted upon the design, development and implementation of the INSET scheme. The author argues that many theories and models of INSET (and curriculum) design and development underestimate (or ignore) the importance of the influences which constantly act on individual developers. Models and theories which do acknowledge the significance of influences such as beliefs and values [for example Decker Walker's 'Naturalistic' Model, 1971], perhaps, do not emphasise the dynamics and the changing nature of these influences as well as the model represented in Figure 9 (9).
Fig. 9(9) A 'Naturalistic' INSET Model

EVALUATION STRUCTURE

CLASSROOM PRACTICE

COGNITION
- Mathematical Competence
  - Tests
  - Conceptual Structures
  - Appreciation
  - Strategies
  - Judgement
- Awareness
  - Mathematics: Procedures
  - Techniques
  - Practices

ATTITUDES
- Interpersonal Interaction
  - INSET Groups
  - School
  - Support Groups
- Effective Teaching in Mathematics

CONFIDENCE
- Classrooms
  - Use of Resources
  - Methods
- School's
  - Status
  - Respective
  - Responsibility
  - Opportunity

EVENTS AND PHENOMENA
- Attendance
- Lining
- Supply
- Cover
- Environment
- Resources
- Organisation
- Methods
- Perspectives
- Roles
- Relationships

CONTINUING SUPPORT
- Agent: Roles
- LEA: Inspection
- Advisory Team
- School/Department

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Chapter 10

SUMMARY: GUIDELINES FOR ACTION AND FURTHER RESEARCH

10.1 The Purpose and Nature of Guidelines

The non-positivistic perspective, which has been adopted in this research, has rejected the goal of establishing relations between causes and effects and has challenged the validity of making predictions. Consequently this Chapter seeks to summarise the findings of this research programme and to provide guidelines for INSET provision, design and development (particularly for teachers of mathematics with limited qualifications and/or experience in the subject) rather than to formulate a rigid set of rules.

Earlier chapters of this thesis have identified a number of important influences which have acted on this research programme. These have been used critically and no single school of thought has been followed dogmatically, as if it provided a unique and ideal approach. Indeed, ideas have been modified, extended and merged judiciously and critically with a wide variety of pertinent and powerful arguments and theories. One of these influences has been the argument for the development of retrospective generalisations along the lines of historical research, which Lawrence Stenhouse used to promote "descriptive-analytical" studies in education.

"Retrospective generalisations are attempts to map the range of experience rather than to perceive within that range the operation of laws in the scientific sense..........While predictive generalisations claim to supersede the need for individual judgement, retrospective generalisations seek to strengthen individual judgement where it cannot be superseded"

Lawrence Stenhouse, 1979.

The author suggests that this research, "through the refinement of judgement, not the refinement of prediction", can provide guidelines which should assist other INSET providers, designers and developers in a similar manner.
In fact, if the 'model view' [vide supra 2.4] of research is adopted, the following guidelines should be accepted as models and, as such, they should neither be regarded as unique nor confused with the 'real' world. However, they are useful, since they are grounded in data and have emerged through a process of analysis [vide supra 8.2] which seeks to relate them to the 'real' world as closely as possible. They are not speculative. They are supported by research evidence.

10.2 Guidelines for INSET Design and Development

In itself, the 'naturalistic' INSET model, which has been constructed from this research and which is described in Chapter 9, constitutes a set of guidelines for INSET development. However, if this model is considered in combination with the Case Studies of Chapters 4, 5, 6 and 7 (and with the sets of Case Data and Case Records related to the RLPE INSET scheme and other developments, such as the AIMEC Project) it is possible to make retrospective generalisations, which would provide guidelines to enhance the judgement of INSET designers and developers. Such guidelines are now listed.

1 Although implementation of an INSET scheme must be such that all participants have an understanding of the roles and actions required of them (for example by using aims and objectives as directional indicators [vide Appendix 6]), the development of the scheme is likely to be a complex process. The use of simple 'means-ends' models with pre-determined outcomes, tested in terms of achievement, are unlikely to describe the INSET provision adequately or to enhance judgement.

2 Variants of the 'Objectives' model of design and development are adversely criticised because they tend to encourage the formulation of aims, objectives and goals before situational analysis has taken place. 'Rational-Analytical' models should also attract adverse criticism, if they neglect the data collecting process which is necessary for analysis to take place. Data do not simply emerge. Due regard must be paid to the concepts of validity, reliability [vide supra 3.10] and reactivity [vide supra 2.7]. Interpretive techniques are more
appropriate in assessing needs than are quantitative surveys (especially if the latter are used in isolation), but the former must be supported by data to provide reflexivity and indexicality [vide supra 3.10] and, if survey is one of a variety of techniques employed, it is extremely useful in facilitating triangulation [vide supra 3.8]. Data must be gathered by suitable pluralistic methods, which must be subject to judgement in research terms.

3 INSET development has rather more characteristics of problem-solving and modelling than is sometimes recognised or admitted. Adverse criticism that many INSET schemes are directed at short-term solutions of limited and specific problems must be tempered by the acceptance that long-term general INSET provision must also seek to solve problems, which have been adequately investigated, identified, selected and analysed. Aims should not be formulated in vacuo. Familiarity with problem-solving strategies and modelling techniques are likely to enhance the INSET developer.

4 The information processing power of individuals should be recognised. The capacity of humans to use feedback, to assimilate, to adjust, to modify and to interact must be utilised as an INSET scheme develops. This capacity enables humans to work as individuals at the same time as they co-operate in teams. Development is rarely an ordered, linear process. Many of its component activities are conducted in parallel and this should be recognised and used to effect rather than denied. Development models should be flexible enough to take advantage of many styles of working and should not unnecessarily constrain individuals in a manner which fails to match their preferred and optimum styles.

5 INSET development is not a mechanical process undertaken by automatons. Beliefs, values, attitudes, preferences, prejudices, fears and aspirations play important roles in INSET development. The developer and the INSET provision benefit if these are acknowledged, analysed and utilised. The changing nature of these influences should also be recognised and the dynamic process associated with change should prompt questions about the
usefulness, or otherwise, of rigid plans and pre-determined outcomes. The near and far influences, which act on individual developers, must be acknowledged, identified and used to maximum advantage.

6 Although this research mainly studied individuals, it did gather data about systems (for example, about schools and departments). Its data and analysis suggest that INSET design and development must pay regard to individuals and to systems. Hence, local and national government systems, schools and their departments, roles, relationships, beliefs, values and attitudes should be considered as mutually interacting forces, rather than as separate entities to be evaluated in isolation.

7 Design, development, implementation and evaluation are mutually interacting elements of an INSET scheme. The 'naturalistic' INSET model, represented in Figure 9(9), indicates that this interaction is not as direct a process as many other theories and models suggest. The activities of each phase of design and development contribute to the process of evaluation and, in turn, the evaluation determines the nature of the near influences, which constantly act upon design, development and implementation. Arbitrary division of the evaluation process may be misleading and may encourage evaluators to adopt a 'blinkered' approach.

8 Although improvement in classroom practice (or more importantly enhancement of learning) is of prime importance, this should not be

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\[13\] The notions of near and far influences may help to dismantle, or at least to bridge, some of the barriers which are erected by rival camps, when the questions of macro and micro influences are discussed. Although this research mainly studied individuals, it did gather data about systems (for example, about schools and departments). Its data and analysis suggest that INSET design and development must pay regard to individuals and to systems. If it is accepted that near and far influences both act constantly on all participants (including teachers) in INSET development, the debate on whether "the whole school (c.f. Hoyle) or the individual teacher (c.f. Stenhouse) holds the key to successful curriculum development (or INSET development)" [McCormick et al., 1988] need not be as controversial or divisive as it sometimes turns out to be. Robert Chin and Kenneth Benne [Bennis et al., 1985] have identified three types (or groups) of strategies for effecting change in human systems; (i) Empirical-Rational Strategies, (ii) Normative-Re-educative Strategies and (ii) Power-Coercive Approaches. These are much quoted in curriculum theory but they are rooted in the behavioural and social sciences. The existence of near and far influences supports the view that these three types of strategies may not be as distinct or as limited to macro and organisational levels as is sometimes thought.
the sole focus of evaluation. The Evaluation Structure [vide supra 9.4] indicates that changes in classroom practice depend on the mutual support and interaction between a number of elements, all of which must be evaluated. Evaluation should indicate which parts of the structure need to be strengthened and, hence, how support for the INSET programme might be improved.

10.3 Guidelines for INSET Provision Related to the 'Hidden' Shortage in Mathematics

In a report of the second phase of a six year comparative study of national INSET practices the Centre for Educational Research and Innovation (CERI), which functions within the Organisation for Economic Co-operation and Development (OECD), describe the characteristics of three types of INSET provision which are commonly found in the United Kingdom. These are: (i) Long Course, (ii) Short Course and (iii) School-Focused Schemes [vide Table 2: Centre for Educational Research and Innovation, 1982]. The RLPE INSET scheme appears to be a somewhat innovative programme in comparison to the examples, which are given by CERI to illustrate these three types. At first sight the nature of the RLPE INSET scheme seems to match that of a 'Short Course' but, on closer examination, its characteristics have a different flavour from those which CERI describes as typical.

The pattern of attendance of the RLPE INSET scheme did not match that of a 'Long Course' ("lasting up to three years") or that of a 'Short Course' ("last for no more than one term of ten weeks.....10 weekly two-hour sessions") as described by CERI. The RLPE INSET pattern was:

1 9 weekly four and a half hour sessions
2 10 weekly four and a half hour sessions
3 a residential week-end
4 a follow-up programme of meetings (half or full day) once per term.

The location was a Mathematics Centre but, as the Case Studies indicate
[vide supra Chapters 5 and 6], the staffing, design and development roles were rather different from those of the typical 'Short Course'.

The participants were individuals from different schools and this aspect matched a 'Short Course' but the 'aims' and context of the RLPE INSET scheme appear to have been concerned both with individual teacher development (not simply vocational development) and with the short-term and long-term needs of individuals and systems (teachers, schools, local authorities, Government and society). The Content and Methods were much wider than any type of provision described by CERI.

The fact that evaluation and research were intrinsic characteristics of the RLPE INSET scheme also suggests that the programme was not typical. Its 'follow-up' programme and the attempts, although thwarted by events, to continue the INSET provision were also atypical.

There are a number of reasons why the RLPE INSET scheme was different and innovative. The design and development of the scheme, as the 'naturalistic' INSET model [vide supra 9.5] shows, did not subscribe to a traditional or classical model. There was close co-operation between the Rurishire Advisory Team and Loughborough University. The Loughborough team, which was drawn from the Department of Education and from CAMET (with its close associations with the Department of Engineering Mathematics), adopted a particular approach to Mathematical Education. The distinction which INSET programmes of CAMET (such as the RLPE INSET scheme, the AIMEC Project and the MSc Courses in Mathematical Education and Computer Education [vide supra 4.2]) make between system needs and individual needs is arguably not so marked as that made by CERI [vide 'Purposes of Continuing Education for Teachers', CERI, 1982; pages 11, 12 and Diagram 1].

One of the most important reasons why the RLPE INSET team was different from the norm was that it was matched to a group of mathematics teachers (the 'hidden' shortage) which does not appear to be recognised by typical classifications. INSET needs are often considered in terms of (i) individual teacher's needs, (ii) needs of functional groups within the school and (iii) the needs of the school as a whole [ACSTT, 1978, Morant, 1981]. The variations in the qualifications, experience, backgrounds and perceived needs of the
teachers who participated in the RLPE INSET scheme suggest that the 'hidden' shortage could not be described as a functional group, and certainly not one within a school. Common classifications do not match the 'hidden' shortage at all well. Indeed, as Chapter 7 [vide supra 7.7] has pointed out, the definitions commonly used for the 'hidden' shortage have serious limitations and need to be revised along the lines suggested in the summary to that chapter.

This research programme suggests that teachers of mathematics with limited qualifications and experience in the subject require specially designed INSET programmes, which do not follow conventional and traditional lines. The 'hidden' shortage is not a homogeneous group whose members have uniform needs and aspirations.

The research data also suggests that insider evaluators, outsider evaluators and participants judged the RLPE INSET scheme to have been successful and that they valued it highly. This suggestion appears to be particularly valid if evaluation is considered in terms of the structure outlined in Chapter 9 [vide supra 9.4]. There were, however, weaknesses, such as the lack of support for a continuing programme, which need to be addressed.

In the light of this research the following suggestions for action and implementation are proposed, with respect to the INSET provision for the 'hidden' shortage of mathematics teachers.

1 Far too often 'lip-service' is paid to the well known aspect of teacher shortage termed the 'hidden' shortage [Department of Education and Science, 1986b]. This particular shortage is likely to continue for many years to come [Woodrow, 1982]. Government promises (at national and local levels) to support programmes to deal with the problems created by the 'hidden' shortage of mathematics teachers should be honoured. Promises should be fulfilled in terms of resources and goodwill.

2 This research indicates that many teachers with limited qualifications and experience have a genuine desire to teach mathematics and to learn more about the subject and its pedagogy. The Case Studies of this research illustrate the potential which many members of the
'hidden' shortage have to become good and effective teachers of mathematics\textsuperscript{14}. These teachers will be in post for many years to come [vide paragraph 715, Mathematics Counts, Department of Education and Science, 1982]. They should not be regarded as dispensable, or worthless commodities, but as teachers who should be given specialist and adequate INSET provision in order to fulfill their potentials.

3 INSET design and development should not be restricted by arbitrary classifications. The evidence of this research is that in Rurishire, although many Heads of Departments are extremely supportive, a significant number of Heads of Mathematics Departments spend very little time supporting teachers with limited qualifications and experience. Because of this, it is proposed that INSET provision for the 'hidden' shortage should include appropriate aspects of school-based, school-focused, area-based and agency-provided INSET and should not subscribe dogmatically to one particular mode\textsuperscript{15}.

\textsuperscript{14} Although some members of the 'hidden' shortage would be content to be re-trained as 'managers' of individualised learning schemes, of the type developed and researched by the National Council for Educational Technology (Gilbert et al., 1988, Humphries, 1988), others would not be happy in this role, preferring instead to become "proper mathematics teachers".

\textsuperscript{15} A member of a Local Authority's 'Schools In-Service Unit' writes:

"Some of the rhetoric associated with approaches to INSET along school-based lines tends to assume too easily that actual conditions inside schools provide a climate hospitable to professional development"


An evaluator of the Schools and In-Service Teacher Education (SITE) Project writes:

"A school INSET policy needs to avoid excessive introversion and it must balance school, group and individual needs to attain these results".

Keith Baker (SITE Project), 1980.

The data of this research [vide 7.5] prompts the author to question the generality of the following statement, which forms part of a wider hypothesis proposed by another research programme.

'....because of shortage difficulties, heads of departments were required to spend a substantial proportion of their non-contact time giving support to individual teachers whose content and methodology was limited.'

Michael Eraut argues that there is often a "power and authority gap between teachers and providers" of INSET [Eraut, 1977b]. INSET providers and developers should strive to break down the communication barriers and to close this gap if it exists. The Case Studies, which form part of the substantive theory of this thesis should be taken as models to assist developers to develop the skills and techniques required to establish roles and relationships which will match the characteristics of the 'hidden' shortage of mathematics teachers.

Particular consideration should be given to the needs of members of the 'hidden' shortage of mathematics teachers in respect of confidence, attitudes, status and competence levels. There is evidence in this research [vide supra 7.4], and elsewhere, that teachers particularly resist change if they "lack confidence and underestimate their own abilities and expertise" [Denvir et al., 1982]. In order to meet these particular needs it is recommended that 'hidden' shortage mathematics teachers should meet frequently outside their own schools, with other teachers of that group, to exchange ideas and to discuss mutual problems [vide paragraph 725, Mathematics Counts, Department of Education and Science, 1982]. A member of the 'hidden' shortage should not be restricted to an INSET programme in her/his own school.

10.4 An INSET Model for the 'Hidden' Shortage

The author suggests that the RLPE INSET scheme, suitably modified in the light of this research, would form a suitable and useful model of provision for 'hidden' shortage mathematics teachers. The wealth of resource material, which has been produced and tested by the RLPE INSET scheme, would provide a facility from which others might develop INSET provisions. The following model, based on the RLPE INSET scheme, is advocated as a set of guidelines for action in this respect.

1 The pattern of attendance (10 week block, 10 week block, residential session, termly 'follow-up' sessions) should be maintained.
2 The four and a half hour afternoon meetings should be reduced to a three hour afternoon meeting or changed to a full-day pattern.

3 The venues for the 10 week blocks should be variable, with meetings taking place in Teachers' Centres (Resource/Mathematics Centres) and in members' schools. This would serve to raise the awareness of other staff in the members' schools and departments. It would highlight the participant teachers' involvement in INSET and facilitate a continuing programme, which was supported by schools and departments.

4 Heads of Mathematics Departments in members' schools should be encouraged to play a greater part in the design, development, implementation and evaluation of the scheme, but the 'neutral ground' element of the provision should not be abandoned because of this. To ensure the latter, a preliminary meeting between Heads of Departments, the Advisory Team and the external agency might discuss the nature of the 'hidden' shortage in the light of this and other research. Small groups of Heads of Departments should be encouraged to attend INSET sessions as participants. They should also provide specific input to the programme as groups or individuals.

5 Although the main programme would benefit by the involvement of a varied, but closely co-operating, agency team, the continuing programme should be supported, and mainly developed, by the Local Authority Advisory Team, Participants and Heads of Departments. Regular 'follow-up' meetings should be arranged in members' schools on a rotational basis. These should be supplemented by visits to specialist interest centres.

6 The continuing programme should be integrated with other school-based INSET (for example with IT-INSET and self-support groups) to the mutual benefit of all parties.

7 The Local Authority should consult with Heads of Schools to ensure that adequate supply cover is available to support the initial stages of
the INSET provision and the continuing programme. It is likely that Heads and Governors will need advice and support in this respect. All parties should advise National Government of the implications of providing adequate INSET for 'hidden' shortage teachers.

8 The Local Authority Advisory Team, with the help of the external providing agency, should consult with all Heads of Mathematics Departments to ensure that no teachers of mathematics with limited qualifications and experience remains 'hidden' from INSET provision. Initial stages of the INSET provision should be repeated, as necessary, until a healthy, self-maintaining 'follow-up' programme is catering for the needs of the whole 'hidden' shortage.

10.5 Further Research

Chapter 3 included a discussion of the concepts of validity and reliability and how these might relate to the methods of non-positivistic research. [vide supra 3.10]. The author finds that the methods of collecting data and analysis, which were employed and refined in this research programme, solved the problems of reactivity and enabled subject matters to be selected and correspondences to be established between real world phenomena and models. These models constituted theories which did not significantly distort reality. The decision, taken when designing this research, to use plural data-gathering methods has facilitated a process of triangulation which has indicated high levels of ecological validity, inter-judge reliability and intra-judge reliability. The Case Data and Case Records support this indication by providing, what the author believes are most acceptable levels of reflexivity and indexicality. An important factor is that the research methods used by the author, supported by skills and techniques which were honed as the research proceeded, gathered extremely useful and pertinent data which would not have been collected by other methods. Informant interviews and participant observation, in particular, proved to be rich and fruitful methods of research.

The author believes that there are a number of open research problems which have been identified by this research programme. These would lend themselves to research which employed the methods which were practised
and developed during the research of this thesis. The first of these, naturally, is a continuing longitudinal study of the teachers who were participants of the RLPE INSET scheme. The author is already involved in such a programme. Indeed, certain data have been used in this research which form part of this on-going investigation [vid supra 6.7]. However, it is proposed that future research might study residual aspects of the RLPE INSET scheme following the hiatus caused by the cessation of the supportive continuing INSET provision. Once again, this would involve informant interviews and participant observation in schools and classrooms.

The longitudinal study outlined above would also furnish more data on the nature and problems of the 'hidden' shortage of mathematics teachers. More quantitative research methods have been used by various parties (for example Northamptonshire and Hertfordshire Local Education Authorities [Darby, 1988], Teachers' Unions [National Union of Teachers, 1989] and Neil Straker [1987a]) to investigate the 'hidden' shortage, but the author believes that the nature of that shortage needs to be studied in a more interpretive manner and on a wider geographical stage. There is some preliminary evidence, gathered by the author and others [Smithers et al, 1988], that Local Authorities, Head Teachers and Heads of Departments sometimes deny the existence of a 'hidden' shortage, although closer investigation readily reveals that shortage [vide: the discussion question on "camouflaged shortages" raised by the Chairman of the Headmasters' Conference / Secondary Heads Association at the Foundation of Science and Technology Lecture, Royal Society, 13 January, 1988].

This leads to other research problems. The author has suggested that teachers of mathematics with limited qualifications and experience in the subject are 'hidden' in several ways [vide supra 7.7] and that, perhaps, the shortage should be re-defined. Future research might study the relations between (i) fashionable forms of INSET provisions (for example, school-based and school-focused schemes), (ii) the organisational structures of schools and (iii) teachers' roles. This should attempt to discover if members of the 'hidden' shortage are isolated from INSET and from career opportunities.

Since the 'naturalistic' INSET model, developed by this research, is promoted as a candidate theory which contributes to the body of educational
knowledge, the author advocates that it should be compared with other INSET schemes and used as guidelines for future development and research. In this way generalisation, and hence cumulation, should be facilitated and this should produce a greater wealth of plausible and acceptable theories.

Finally, irreverently and in a spirit of healthy iconoclasm, it is suggested that, perhaps, the commonly held view that members of the 'hidden' shortage detrimentally affect learning in mathematics classrooms should become a focus of research, rather than being accepted as an incontrovertible truth. In common with others [vide supra 5.7] it has been the author's privilege to observe 'good practice' in classrooms where the teacher belonged to the 'hidden' shortage.

10.6 Postscript

The opportunity, which the author has been fortunate enough to have been given to develop and research a scheme of in-service education and training for teachers of mathematics with limited qualifications and experience in the subject, has convinced him of the vital importance of tackling the problems associated with the 'hidden' shortage in mathematics. It has also convinced him that it is possible to provide INSET, which will cater for the needs of teachers who belong to this shortage and which, subsequently, will enhance the mathematics learning and classroom experiences of children in the schools of this country. If that INSET provision is to be adequate and suitable it must be supported by resources, made available by National and Local Government, and developed in a manner which eschews dogma and embraces informed and critical innovation.
References and Bibliography


Paper presented to *International Study Association on Teacher Thinking*, Tilburg University, Netherlands.


EVALUATION SURVEY

The purpose of this Survey is to help us to design future INSET Courses of this nature, based upon your observations of the programme in which you were involved. The questions have been designed to focus on particular aspects of the programme, but we hope that this will not restrict the answers that you give in any way.

If you wish to expand any of your answers further than the space allowed, then attach extra sheets of paper.

If you wish to consult the Tutors in order to discuss any of your responses to these questions, then please feel free to do so.

Q1 Are you male or female?

Q2 What is your age in years?

Q3 (a) Give details, including dates, of all your academic and/or teaching qualifications.

(b) What is your highest qualification in mathematics?
Q4 Give a brief summary of all your previous teaching experience
(Schools, dates, positions held)

(b) Give details of training, qualifications and dates.

Q5 Has a substantial part of your working experience been outside
(teaching?)

If the answer to the question above is "Yes"

(a) What was your previous employment? If more than one, list them

(c) When did you enter the teaching profession?

(d) Did you receive any further full-time training at this stage?
If so, give details.
C6 Have you been on any other INSET Courses?

Give details e.g. description of course, dates, duration, etc.

C8 Have the time and location of the INSET Course been satisfactory so far as you were concerned?

If not, what would have suited you better?

C9 Have the organizational aspects of the Course been satisfactory?

Please comment.

C7 List your main interests, both within and outside teaching, and your hobbies.
Q10 In what ways has the Course affected your teaching?
   e.g. your attitude to your teaching, your style of teaching, the
   methods you use, the resources you use, etc.
   Can you give some examples of any changes or relate some
   anecdotal instances which might illustrate your answer?

Q11(a) Has the mathematics content of the Course, as a whole, been
   suitable for you? (Please comment)

   (b) List the mathematics topics included which have helped you most.

   (c) Are there other mathematics topics you would have liked to
       have discussed?
Q12 Has the balance between mathematics content and the consideration of the processes of teaching/learning been satisfactory? If not, which should have been given more emphasis?

Q13(a) Have the attitudes of other Staff in your School changed towards you since you began the Course? Give details.

Q14(a) If you had to describe in a few words the underlying philosophy of this INSET programme, what would you say?
(b) What do you think the philosophy of this Course ought to have been, if it is different from what you have described in (a) above.

Q15 Do you consider that the methods used by the Tutors on this INSET programme have been appropriate for the participants? Can you suggest any improvements?

Q16 Is there anything else you would have liked to have included in the Course?

Q17 Is there anything you think should have been excluded from the Course?

Q18 Can you suggest any ways in which the INSET Course should be followed up in the coming year(s)?
Are there any other comments which you feel would be helpful?

Please complete one of the accompanying sheets for each teaching appointment you have held during the period September 1986 - September 1987.

If your position (or timetable) changed radically within a school during any appointment, please complete a separate sheet for each.
Details of TEACHING APPOINTMENT 1

1. Title/Brief description of appointment

2. Dates
   From                   To

3. Type of School:
   State whether the School is
   (A) Comprehensive   (B) Grammar   (C) Secondary Modern
   (D) Other (give details)

4. State whether the School is
   (A) Single sex      (B) Mixed

5. What is the age range of the pupils in the School?

6. Give a breakdown of your teaching timetable

<table>
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<tr>
<th>Class</th>
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3. On which scale was your appointment on 26 January, 1987?
(If relevant, please indicate "special" by placing s in box)
Head Teacher
Deputy Head Teacher
Senior Teacher
Scale 4
Scale 3
Scale 2
Scale 1
Other (please specify)

4. On which scale was your appointment on 16 November, 1987?
Head Teacher
Deputy Head Teacher
Main Scale
Other (please specify)

5. What was your highest responsibility on 26 January, 1987?
- Head Teacher
- Deputy Head Teacher
- Head of Faculty or Department
- Deputy Head of Faculty or Department
- Head of Year (or House or similar pastoral position)
Other (please specify; including none)

6. What was your highest responsibility on 16 November, 1987?
- Head Teacher
- Deputy Head Teacher
- Head of Faculty or Department
- Deputy Head of Faculty or Department
- Head of Year (or House or similar pastoral position)
Other (please specify; including none)
7. What is your highest qualification?
- Trained Graduate with Honours or Higher Degree
- Trained Graduate
- BEd Honours
- Other (please specify) (e.g., HNC/HND/CGLI)

8. If you are a trained teacher in which phase were you trained?
- Infant
- Primary/Infant
- Primary
- Middle School
- Secondary
- Other (please specify) (e.g., FE/Handicapped)

9. What was the classification and age range of the school in which you were teaching on 26 January, 1987?
- Comprehensive 11-16
- Comprehensive 11-18
- Comprehensive 12-16
- Comprehensive 12-18
- Secondary Modern 11-16
- Secondary Modern 11-18
- Grammar 11-18
- Grammar 14-18
- Other (please specify)

10. What was the classification and age range of the school in which you were teaching on 16 November, 1987?
- Comprehensive 11-16
- Comprehensive 11-18
- Comprehensive 12-16
- Comprehensive 12-18
- Secondary Modern 11-16
- Secondary Modern 11-18
- Grammar 11-18
- Grammar 14-18
- Other (please specify)

11. In which type of school were you teaching on 26 January, 1987?
- Mixed
- All Girls
- All Boys

12. In which type of school were you teaching on 16 November, 1987?
- Mixed
- All Girls
- All Boys

13. What is your age on 16 November, 1987?
- Less than 25
- 25-29
- 30-34
- 35-39
- 40-44
- 45-49
- 50-54
- 55-59
- 60+
Please enter the information requested by the following questions in the appropriate box.

14. What was the approximate number of pupils in the school in which you taught on 26 January, 1987?
   
15. What was the approximate number of pupils in the school in which you taught on 16 November, 1987?
   
Please respond to the following questions using the boxes below each.

A In the timetabled week of your school commencing 26 January, 1987
   How many days were in the timetabled week?
   How many periods were in the timetabled school week?
   How many periods did you teach?
   How many periods did you teach mathematics?
   How many periods did you teach mathematics to lower ability students?
   How many periods did you teach mathematics to middle ability students?
   How many periods did you teach mathematics to higher ability students?
   How many periods did you teach mathematics to mixed ability students?

B In the timetabled week of your school commencing 16 November, 1987
   How many days were in the timetabled week?
   How many periods were in the timetabled school week?
   How many periods did you teach?
   How many periods did you teach mathematics?
   How many periods did you teach mathematics to lower ability students?
   How many periods did you teach mathematics to middle ability students?
   How many periods did you teach mathematics to higher ability students?
   How many periods did you teach mathematics to mixed ability students?

C What subjects did you study for the award of your highest qualification and at what level (ie main, subsidiary, ancillary etc.)?
   (NB. If Remedial Mathematics etc., list under main)

<table>
<thead>
<tr>
<th>Main Subjects</th>
<th>Subsidiary Subjects</th>
<th>Ancillary Subjects</th>
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The shortage must be tackled on a national basis by means of a carefully constructed plan. Solutions to the complex problems of teacher supply initiated the idea of forming a working group of eminent mathematical educationists to consider the problems highlighted by the University of Technology from 15-17 December 1986.

The Working Group endorsed these statements and agreed that panic measures and ill-conceived schemes would result in a worsening situation of teacher supply and a waste of resources. They emphasized that any steps taken to improve teacher supply must be investigated by careful pre-planning and evaluation research to optimize solutions.

As a result of discussions and consultations conducted by the signatories the following recommendations have been formulated. Copies of these are being forwarded to the Secretary of State for Education and Science, University Grants Committee, Committee of Vice-Chancellors and Principals, National Advisory Board, Confederation of British Industry, Manpower Services Commission, Teachers’ associations, main political parties, the Press and other interested institutions and organizations.

Recommendations

1. The Mathematics Working Group recognize and applaud the contributions which teachers have made to the curriculum. There is much evidence which suggests that, in general, the curriculum is developing along lines which are appropriate to the needs of the nation and society; albeit under difficult circumstances. It is essential that the educational system itself is regarded by government and society as an important and national priority. Teachers in all sectors of education should be encouraged to regard themselves as highly-valued professionals.

2. The perception which teachers hold of their own professional status is one of the major causes of the shortage. In order to improve the supply of teachers in shortage subjects urgent steps must be taken to make school teaching in general more attractive. This important aim will only be achieved if more money is made available to improve salaries of teachers and to increase resource provision in schools.

3. Students over the age of 16 should be given further motivation to stay on at school/college through statuary grants comparable with those available to school leavers under present training schemes. This would also help to extend the pool of qualified young people thus enabling them to enter the teaching profession in shortage subjects.

4. Basically mathematics in schools is developing in the right direction but the content of many mathematics syllabuses could be reduced without serious consequences for children or the nation. This would allow more time to be spent on the essential fundamentals and the understanding and appreciation of the subject through relevance and applications. The mathematics that is taught through other subjects should be investigated. Cross-curricula, practical and relevant mathematics and the impact of calculators and computers should figure more prominently in future curriculum development, backed by research initiatives.

5. In the recent past, new practices and consequential expectations from teachers have been introduced in the school curriculum without adequate training programmes and the necessary back-up. Teachers have thus lacked the self-confidence so essential for good teaching practices. The development of the mathematics curriculum in the next decade should be based on natural evolution and consolidation. Innovation which would drastically change the natural development of that curriculum should be avoided.

Plan needed to solve the national problem—of shortage of mathematics teachers

Recommendations of the Working Group which met at Loughborough University of Technology from 15-17 December 1986

A number of eminent mathematical educationists and others have been considering the problems highlighted by the DES Consultative Document: Action on Teacher Supply in Mathematics, Physics and Technology. It became clear from their deliberations that there were no ready and simple solutions to the complex problems of teacher supply. Professor A. C. Bajpai, who initiated the idea of forming a Working Group, said in a keynote address at a meeting held at Loughborough University of Technology that the problem of teacher shortage must be tackled on a national basis by means of a carefully constructed plan.

The provision of increased financial resources will certainly help as an initial step. If the system is allowed to continue, as it operates today, it will not only result in a further shortage of teachers in these areas but also fail to produce the graduates needed by the nation.

The Working Group endorsed these statements and agreed that panic measures and ill-conceived schemes would result in a worsening situation of teacher supply and a waste of resources. They emphasized that any steps taken to improve teacher supply must be investigated by careful pre-planning and evaluation research to optimize solutions.

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The shortage of mathematics teachers

(6) New technology, particularly computers and videos, should be employed to encourage teachers of mathematics to present their subject in a relevant and exciting manner. In order that this technology be used effectively, it is absolutely essential that resource centres are established and support schemes of in-service education and training, including distance learning, are provided as a major priority.

(7) New pools of potential teachers should be investigated seriously and plans should be formulated to take advantage of promising sources. Although the implementation of such plans could be regarded as a short-term measure it is important and should attract adequate funding and support.

(8) Partly because of its present content and partly because of the shortage of suitably qualified teachers, it is more difficult, and more importantly, it is thought to be more difficult, to gain high grades in Advanced Level Mathematics than in many other subjects. To reduce this disincentive, universities should explicitly take a more encouraging attitude to applicants whose mathematics grades are not of the highest.

(9) It is important that the many initiatives now in progress should be well coordinated, that unnecessary duplication should be avoided and that lessons learned should be widely disseminated. Selected responses should be conducted in collaboration, in a spirit of cooperation, by a limited number of providing institutions over a fixed period, in order that available funds are not spread too thinly.

(10) Funding should be made available to provide evaluation of approved schemes, which aim to tackle the problem of teacher shortage, and to allow information retrieval and research to take place. Databases which would be useful for future developments in the field of teacher supply and resource provision should be constructed.

(11) There is an urgent need to mount training programmes which will enhance the performance of existing teachers of mathematics in post, particularly those with limited qualifications and/or experience in the subject. Such a programme should be subsidised to offset the high fees which have to be charged.

(12) The problem of teacher supply in mathematics has been serious for some time but it is now critical. In these circumstances a fresh and energetic look at a wide range of approaches is indicated.

Signatories:

Professor A. C. Rajpai  
W. F. D. Ashworth  
Doctor C. Bondi  
Sir Hermann Bondi FRS  
Doctor M. A. Brown

Comment: Loughborough University of Technology  
Rapporteur: Loughborough University of Technology  
Unilever Research  
Teacher, Burleigh Community College, Loughborough  
Chairman of The Royal Society Working Party/Report on Girls and Mathematics  
Master, Churchill College, Cambridge  
King's College, London

Reply from The Secretary of State for Education and Science

Dear Professor Rajpai, Thank you so much for your letter of 20 March 1987 and the copy of the recommendations of your Working Group. I am sorry you have had to wait so long for a reply. My colleague Angela Rumbold [sic] has already written to Steven Dorrell MP, to whom you also sent your report, to express our gratitude for the interest and concern you have shown in putting forward proposals to improve supply of maths teachers. I too welcome the Working Group's Report and would hope that you and your colleagues would agree that we have already taken very positive steps along the road you have signposted. And applications for initial teacher training this year are up as a result—by over 40% so far for maths.

I am confident that the new pay package with higher pay levels, a new salary structure and improved career opportunities will prove attractive to teachers at all levels. Better and more systematic in-service training with £5.5 m set aside in 1987-88 to help train maths teachers should provide good training programmes and the back up essential for good teaching practices. A further £3 m has been made available for the development of new types of training courses specially designed to attract mature entrants or returning teachers of the shortage subjects. And we are now making a positive effort to attract teachers in to the profession through publicity.

These initiatives are part of a larger overall action programme which reflects many of the recommendations made by your Working Group.

Your proposal for a national conference is extremely interesting. However you may be unaware of the series of regional conferences my Department has arranged specifically to bring industry and education closer together. The principal objective is how industry can help improve teacher supply in the shortage subjects, including maths. Angela Rumbold will attend the third conference at Gloucester early in June which we believe will bring schools and firms closer together at local level in a practical way. A further programme of conferences is under consideration.

I would not wish to discourage you from your proposal. A national conference could provide a real contribution. But I must leave it to you to decide, in the light of the considerable range of initiatives we have now taken, whether such a conference

† Angela Rumbold MP is Parliamentary Under-Secretary of State for Schools.
could contribute new insights. I know that George Walden has written to you separately to offer to discuss this and other issues with you. I look forward to hearing what you conclude.

Yours sincerely
Kenneth Baker
Secretary of State for Education and Science
Elizabeth House
York Road
London SE1 7PH

George Walden MP is Parliamentary Under-Secretary of State for Higher Education.

Stephen Dorrell MP
House of Commons
London
SW1A 0AA

Dear Stephen,

Thank you for your letter of 23 March addressed to Kenneth Baker enclosing a copy of the conclusions of a Working Group convened by your constituent Professor A. C. Bajpai on the shortage of mathematics teachers. I am sorry that it has taken so long to reply.

We are extremely grateful to those such as Professor Bajpai who have taken so much trouble to respond to our consultative document on teacher shortages in such a practical way. I welcome the Working Group's report. I hope you will agree that we have already gone a long way to tackle the problem of teacher shortage on a national basis by means of a carefully constructed plan involving local government, central government, industry, and all those concerned with the problem as the Working Group recommends. We have:

1. Offered a £1200 tax free bursary (£1230 in 1987) for trainee teachers in mathematics, physics and craft, design and technology.
2. Set aside £16.5 m (of which £5.5 m for mathematics) in 1987/88 to support the costs to local education authorities of inservice training in the shortage subjects made available £5.5 m to higher education institutions and the Open University for new types of training courses specially designed to attract new or returning teachers of the shortage subjects some involving part-time and distance learning elements in order to help, for example, housewives retrain.
3. Set up a new unit (TASC) to publicise teaching as a career.
4. Set in hand a review of how greater use of new technology could improve supply of shortage subject teachers.
5. Intensified a programme of collaboration with industry to the same end.

I hope that Professor Bajpai will agree that this represents an energetic attempt to help solve the problem. Turning to the particular recommendations in his Working Group, we have taken steps, foreseen above, to make the teaching profession a more attractive career with the introduction of higher pay levels, a new salary structure, and improved career opportunities. We are prepared to consider the notion of grants for sixth-form students though we have thought it best to concentrate scarce resources so far in a more targeted way. The shape of the mathematics curriculum will be under scrutiny in the new national curriculum proposals which have recently been announced. I believe that the other recommendations are a large extent covered by the action programme which I have outlined above.

May I repeat our gratitude to Professor Bajpai and his colleagues for their interest in the problem and willingness to propose practical solutions. We have a common aim. I am glad to report that initial applications for teacher training in mathematics in 1987 are up some 35% over 1986, as compared with a general increase of some 13% in all subjects, and that recorded vacancies of mathematics teachers in January of this year showed a decrease of around 18% over 1986. I do not pretend that the problem is solved, but we seem to be making some impact.

Yours ever,

Angela Rumbold
Minister of State, Department of Education and Science
Elizabeth House
York Road
London SE1 7PH

References
Appendix 4

Models of Curriculum Design and Development

'OBJECTIVES' MODELS

Ralph W. Tyler (1949)

1 What educational purposes should the school seek to attain?
2 What educational experiences can be provided that are likely to attain these purposes?
3 How can these educational experiences be effectively organised?
4 How can we determine whether these purposes are being attained?

D.K. Wheeler (1967)

1 Aims, goals and objectives
2 Selection of learning experiences
3 Selection of content
4 Organisation and integration of learning experiences and content
5 Evaluation
'SITUATIONAL ANALYSIS' MODELS

The 'Situational' Model: Malcolm Skilbeck, 1982

Analytical Model: Further Education Unit, 1981

School-Focused INSET Model: Ray Bolam, 1982a
A 'Naturalistic' Model: Decker F. Walker, 1971

Design

- Policy
- Precedents

Deliberation

- Data

Platform

Conceptions
Beliefs about what exists and what is possible

Theories
Beliefs about what is true

Aims
Beliefs about what is educationally desirable

Images
Desirable entities or classes

Procedures
Desirable courses of action or decision

Desirable entities or classes
Desirable courses of action or decision
Modelling in GCSE Mathematics

P. K. ARMSTRONG and A. C. BAJPAI, OSE, FIMA
Department of Engineering Mathematics,
Loughborough University of Technology

Synopsis

The paper argues that important aims, which are included in the National Criteria GCSE Mathematics, are unfulfilled in the implementation of the new examination. It suggests that these aims should become more easily assessable coursework more easily and revision of its aims. It should be remembered that over the last 50 years, attitudes in the mathematics community have changed as mathematicians have recognised that the methods of discovery in their subject bear a close resemblance to those used in the physical sciences. In 1971 Orwell argued that the logicist, formalist and intuitionist schools of mathematics were no longer relevant in a computer age. He suggested that the new outlook in mathematics might be called the “Model View.” Attitudes in school classrooms could and should reflect this.

One of the major disappointments of GCSE Mathematics is that many texts, syllabuses, coursework schemes and assessment programmes ignore the possibilities of the mathematical model and the learning opportunities provided by simple mathematical modelling. Models and modelling are sometimes mentioned but the former are often interpreted as concrete geometrical objects and the latter as the construction and manipulation of these objects (polyhedra, tessellations, etc.). Surveying and packaging exercises, although employing many modelling techniques, do not often raise the wider aspects of the mathematics in favour of measurement skills. The ubiquitous exercise in “planning a kitchen” neatly illustrates this narrowness in approach. In fact, such exercises might cause pupils to forget the mathematics behind them.

The implementation of GCSE Mathematics has been fraught with difficulties over the last 2 years. Inadequate provision, curricular action and traditional teacher resistance to curriculum change have caused many teachers to seek the “safe” options. The 1991 “get out clause” has provided an opportunity to the school maths teacher to avoid the implementation of new schemes in schools to adopt a “wait and see” policy. The plethora of GCSE Mathematics schemes enables those departments to choose programmes which, at the moment, do not include coursework or centre based assessment. However, or perhaps more fundamentally, schools which have commenced coursework also exhibit a tendency to seek the safe, familiar harbours of the deductive mathematical world and to avoid the “threatening” real world. Any examination of the work being conducted under GCSE Mathematics coursework will highlight a preoccupation with number theory and practical work in conventional geometry. Problem solving seems to produce greater diversity, relevance and applicability but these qualities often seem counterintuitive. Semantics, of course, do not help and these tend to provide a ready made excuse to compartmentalise along familiar lines.

The mathematics classroom needs to expand its domain and revise its aims. It should be remembered that over the last 50 years, attitudes in the mathematics community have changed as mathematicians have recognised that the methods of discovery in their subject bear a close resemblance to those used in the physical sciences. In 1971 Orwell suggested that the new outlook in mathematics might be called the “Model View.” Attitudes in school classrooms could and should reflect this. One of the major disappointments of GCSE Mathematics is that many texts, syllabuses, coursework schemes and assessment programmes ignore the possibilities of the mathematical model and the learning opportunities provided by simple mathematical modelling. Models and modelling are sometimes mentioned but the former are often interpreted as concrete geometrical objects and the latter as the construction and manipulation of these objects (polyhedra, tessellations, etc.). Surveying and packaging exercises, although employing many modelling techniques, do not often raise the wider aspects of the mathematics in favour of measurement skills. The ubiquitous exercise in “planning a kitchen” neatly illustrates this narrowness in approach. In fact, such exercises might cause pupils to forget the mathematics behind them.

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Despite being central to the recommendations of "Mathematics Counts" and "Mathematics from 5 to 16" and figuring prominently in the aims and objectives of "The National Criteria: GCSE Mathematics" and the subsequent syllabuses of all examining groups, the Cockcroft Report argues that "pupils of all ages and abilities can benefit from the opportunity for appropriate practical experience" and states (par 241) that effective mathematics teaching must be connected to the elements: (a) facts and skills, (b) conceptual structures and (iii) general strategies and attitudes. It is the third element which is ill-served by current interpretation of practical mathematics.

Appropriate practical work according to Principle 7 of "Mathematics from 5 to 16" is of three main kinds:
(a) There is practical work which enables pupils to understand mathematical concepts. Without sufficient practical experience the pupils are unable to relate abstract mathematical concepts to any form of reality.
(b) There is the practical work of measurement which needs to be done with a particular purpose in mind... (c) The activity itself might be conducive to a particular learning experience.

The possibilities provided by practical work of a modelling nature are suggested in paragraph 241 and principle 7 but they might easily be missed. Indeed most GCSE syllabuses and coursework requirements have apparently failed to recognise them. Many mathematics teachers, assessing the importance of such activities are inclined to interpret practical work as only "hands-on" experience. The manipulation of concrete resources is an important and necessary aspect of learning mathematics but when science teachers talk of practical work they are usually referring to more than that. The term "modelling" is one which makes it more likely that such work is understood as having value that is not about applying mathematics in a practical situation. These teachers were obviously interpreting practical mathematics in a modelling sense.

Classroom material for practical work with a modelling nature is available but it is not used to the extent which the aims of GCSE Mathematics require. The Spode Group, the Numeracy Group and the Practical Mathematics in Secondary Schools Group have all produced valuable material. The CAMET package, for example, has been designed to provide opportunities for appropriate practical work according to Principle 7 of "Mathematics from 5 to 16" but it might easily be missed. Indeed most GCSE syllabuses and coursework requirements have apparently failed to recognise them. Many mathematics teachers, assessing the importance of such activities are inclined to interpret practical work as only "hands-on" experience. The manipulation of concrete resources is an important and necessary aspect of learning mathematics but when science teachers talk of practical work they are usually referring to more than that. The term "modelling" is one which makes it more likely that such work is understood as having value that is not about applying mathematics in a practical situation. These teachers were obviously interpreting practical mathematics in a modelling sense.

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Many pioneer undergraduate courses in mathematical modelling and books on the subject have been critical of the appropriateness of the approach and, as a result, have suggested that it is changing teaching styles and principles. Although this criticism was entirely justified in most cases we should not allow it to hide the fact that there is much to be gained by discussing the nature and role of the mathematical model. Teachers and pupils should discuss the complexity of the real world, with its infinite set of variables and relations, and the need to produce a simplified version called a model which mathematicians and others can analyse and examine for possibilities. The question of the essence of a model, "reality or simplicity?", should promote much fruitful discussion in mathematics classrooms. This discussion would not only satisfy "Paragraph 241" but would also lead naturally to many of the important criteria related to the application and role of mathematics in other disciplines and in everyday situations. The cycle nature of modelling and evaluation, together with the notion that no model is unique and that any model can be improved, could lead to a "relatively unstructured situation" can then be "translated into an appropriately structured form." The modelling process now, temporarily from the real world into the world of mathematics; the latter being a construction made by humans, the former much more to do with other models (vide Kromer).
discussion of significance, estimation, accuracy and usefulness.

It is apparent that many teachers do not realise that they often use mathematical structures as models. We have mentioned earlier that a major aim of the Loughborough/ Lincolnshire "Pilot" Experiment, the water tank designed for teachers of mathematics with limited qualifications or experience in the subject, was to acquaint teachers with the nature and usefulness of the model. One particular exercise, which was tested as part of this experiment, was designed to illustrate the use of geometrical vectors as a model of the behaviour of stretched rubber. The teachers involved received this exercise with enthusiasm and it apparently produced a high level of interest. Since the exercise, was designed to illustrate the use of mathematical statements expressed in words or symbols should be tested.

Communication skills:

One of the deficiencies of traditional mathematics teaching was the failure to stress the importance of communication. A mathematical modeller almost always needs to discuss the nature of a problem with others (engineers, managers, planners, etc.) at the induction stage of modelling (Fig. 3).

Identification and analysis of problems have always proved difficult for mathematicians. Is this because communication skills have been neglected and considered unimportant in the mathematics classroom? Has the development of mathematical facts, skills and conceptual structures been the sole aim of mathematics teaching?

Having understood the problem, mathematicians often report that the production and manipulation of the model is not difficult and that the mathematics involved is often trivial in the deductive stage.

Interpreting the result and communicating this to the "client" may be more difficult. Teachers should recognise this by encouraging students to describe solutions in language which is easily understood by the layperson and not as, for example, \( \theta = \cos^{-1}0.707 \). Assessment objective 3.10 suggests that the ability of candidates to "interpret, transform and make appropriate use of mathematical statements expressed in words or symbols" should be tested.

An important aspect of communication suggested by the National Criteria is that what is proposed should be used sensibly and conventionally and solutions should be expressed to an appropriate degree of accuracy. This is not always evident in mathematics classrooms or, for that matter, in some textbooks.

Far too often, apart from checking that deductive logic has been followed correctly, evaluation has been considered no part of the mathematics curriculum. The GCSE criteria suggest that it should be included in mathematics classrooms. The development of the appreciation of mathematics by students demands its inclusion. The communication skills required of the evaluator are often overlooked.

Problem solving, investigating and modelling:

An understanding of the modelling process and the concept of the mathematical model has much to offer the teacher and student involved with investigative work and problem solving. It might help considerably in those thorny discussions of the semantics of Investigations and Problems.

Many "heuristics" and general procedures, which are advocated for problem solving and investigating, stress the need to look for "psychologically familiar" and similar cases. The search for similarity is also an important aspect of modelling. This can be demonstrated easily in the mathematics classroom by borrowing ideas and apparatus from other subject areas. Radioactive decay, population changes, fermentation, drug concentrations, cooling bodies, discharging capacitors and coin throwing are examples of real world events which can be observed in classrooms and which demonstrate similarity through the exponential function (Fig. 4). These, used as modelling exercises, would enable students to meet and rehearse virtually all the qualities, abilities and skills described in the assessment objectives of the National Criteria for GCSE Mathematics. The recognition of pattern and the use of graphs would avoid the need for higher mathematics, such as ODEs, which some of us might be tempted to employ immediately, owing to hindsight. Empirical techniques and graphical models are part of the...
modelling process and these can be used to simplify the mathematics at GCSE levels. The coin throwing exercise would allow simple simulation techniques and probabilistic models to be introduced into the mathematics classroom. Of course these particular models could be used as a reprise at GCE A-level where they should enhance the teaching and learning of calculus by providing relevance and applicability to a topic which far too often pays only "lip service" to the real world.

Using modelling exercises of this kind a workable cross-curricula approach might be developed in which territorial boundaries and discipline jealousies were eroded. An appreciation of patterns and relationships in mathematics and the production and appreciation of creative work would certainly be achievable through exercises of this nature. Incidentally a model of water emptying from a container provides a useful alternative to the exponential models mentioned earlier and comparison should lead to useful discussion (Fig. 5).

Continuity and discreteness
Some "discussion between the teacher and pupils and between the pupils themselves" resulting from the practical work suggested above, as well as satisfying the recommendations of the Cockcroft Report, would allow consideration of the role of continuous mathematical models in describing discrete events of the real world. Misinterpretation of models has always been a danger to which teachers of mathematics and science have been prone. If the nature of models was more clearly understood by teachers the puzzling and false notions that capacitors never discharge completely, alcohol stays in the bloodstream forever and baths never empty could then be explained and dispelled more convincingly than they used to be in traditional mathematics and science classrooms. Beware of asymptotes!

Algorithm
Numerous algorithms have been developed to describe the modelling process. Some of these have been used, with varying degrees of success, in undergraduate modelling courses. Formal presentation of such algorithms to GCSE classes would almost certainly be unwise, defeating many of the objectives we seek, and encouraging an unacceptable emphasis on facts and elements of rote learning. Nevertheless the following modification of a well known algorithm, constructed with the aims and objectives of GCSE in mind, might be of advantage to the teacher of mathematics in school (Fig. 6).

It must be remembered that this algorithm is itself a model and must not be confused with the real world or presented as a unique methodology for constructing models. Nevertheless, with careful adaptation and presentation, it could provide a framework to provide "psychological familiarity." This familiarity would alleviate the confusion and panic which pupils, undergraduates and teachers often experience when asked to model, investigate, solve or prove. How many of us have felt vulnerable in inset situations when a voluble colleague produces solutions at the drop of a hat? How often have we subsequently discovered that our friend is either impulsive or has previously met the problem? If only we could remember not to panic and be reflective. If only we could stick to the modelling process under such pressure. Do impulsive teachers have the same effect on reflective students?

Although Fig. 6 refers specifically to mathematical modelling it could quite easily be used to provide some guidance to teachers, and subsequently to students, who were involved with the modelling algorithm as a guide. It involves an investigation of the geometry of car wheels when the car is turning on full lock. This exercise might be made into a modelling exercise by allowing the pupils to examine a car, a go-kart or a tractor. The use of TECHNICAL LEGO, MECCANO, etc. would enable this process to be extended, especially at the evaluation stage, when small scale versions could be constructed based on the mathematical models. These could

Mathematics provides a GCSE exercise which could be undertaken by pupils using a modified version of the modelling algorithm as a guide. It involves an investigation of the geometry of car wheels when the car is turning on full lock. This exercise might be made into a modelling exercise by allowing the pupils to examine a car, a go-kart or a tractor. The use of TECHNICAL LEGO, MECCANO, etc. would enable this process to be extended, especially at the evaluation stage, when small scale versions could be constructed based on the mathematical models. These could
be tested and the mathematical models could be modified accordingly. This exercise provides simple opportunities for variables to be selected and simplifications to be made (e.g., parallel from the mental image of the first cycle, while models related to the Ackerman Principle, etc., might be developed by high ability students to solve the practical work with "conceptual models" and discussions with fellow pupils, teachers, parents and mechanics would allow new problems to be identified and more variables to be introduced (e.g., steering mechanisms, tracking and differentials). In a recent in situ course, in which this exercise was tested, participants and tutors were pleasantly surprised at the wealth of experience available in their own ranks and the ease with which new ideas and directions were discovered. Pupils should be encouraged to use the expertise of teachers and other pupils. They should be guided to read and research (e.g., the Ladybird book "The Motor Car," although it contains little mathematics, is a rich source of ideas from which to develop the particular modelling exercise described above). The mathematical models involved in developing this model is simple geometry (involving circles, parallelograms and trapezia) but all the stages of the modelling process would be illustrated. Since the process is cyclic pupils could follow the process to an extent which matched their abilities. Some guidelines for future models would be inevitable but since this is related to communication skills and mirrors the activity of professional modellers this should not be a problem in any way. The activity of this kind might suggest how the problems of assessing group work and cooperation can be approached. Individual modellers are judged by the way in which they communicate with others and use ideas creatively. Pupils who model should be assessed in similar ways. The cycle of predicting, describing and predicting the behaviour of the mathematical model, if it models the real world, is to be hoped that important aims will not be abandoned in this process. Any revision should be used to re-examine the role of the model and modelling. There is evidence that the first attempts to devise schemes for GCSE Mathematics have been made in this way, with the exceptions and remarks which they have prepared. This mistake should not be compounded in future change. Using new strategies such as mathematical modelling new opportunities must be explored. Teachers, examiners and curriculum developers should use the ideas of the "Model View" of mathematics to develop new assessment strategies to enable pupils to meet those important aims which at present do not appear to be fulfilled.

References

17. Feynman, R. P., Leighton, R. B., and Sands, M. D., "The
Peter Armstrong is a lecturer in the Department of Engineering Mathematics, Loughborough University of Technology, where he is course tutor of the MSc in Mathematical Education. His teaching is mainly connected with postgrad and the initial training of mathematics teachers and his research is concerned with in-service provision for the "hidden shortage" of mathematics teachers and the implementation of GCSE coursework.

Avin Bajpai started as an Assistant Lecturer in Loughborough College of Advanced Technology (the predecessor institution of Loughborough University of Technology) on September 1st, 1958, after having worked in industry in London for about 4 years. Currently he is the Head of the Department of Engineering Mathematics at the University and is the Founder Director of CAMET. He is also the Founder Editor (since 1970) of the International Journal of Mathematical Education in Science and Technology, which is in its nineteenth year of publication.
Appendix 6

Example Cover Sheet 1

LOUGHBOROUGH UNIVERSITY OF TECHNOLOGY

CAMET
(Centre for Advancement of Mathematical Education in Technology)

Rurshire/Loughborough 'Pilot' Experiment
In-Service Education and Training for Teachers of Mathematics

Week 1: Thursday 5 February 1987
Venue: The Rurshire Mathematics Centre, Midchester
Time: 2.00 p.m. to 6.30 p.m.

Programme:

2.00 p.m. Welcome Owen Eastwood

2.15 p.m. Introduction to the Course Peter Armstrong

2.30 p.m. Participants and resource persons to introduce themselves

3.00 p.m. Individual Activity: Questionnaire *Quotations about Mathematics*

3.20 p.m. Small Group Discussions: Questionnaire *Quotations about Mathematics*

4.00 p.m. Tea

4.30 p.m. Small Group Discussions/Interviews
Resource persons will consult with participants and discuss perceived needs and appropriate aims and objectives of the course

5.15 p.m. Classroom Practice: *Mathematics Counts Paragraph 243*
Video Presentation
Discussion

6.00 p.m. Plenary Session

6.30 p.m. Close
Example Cover Sheet 2

Consultation

Week 1: 4.30 to 5.15 p.m.

Small Group Discussions/Interviews

The resource persons will consult with you to discuss your expectations of this INSET Programme and to identify what you believe to be your needs in this respect. It is hoped to include process aspects as well as content in the evolving scheme. It is intended that the programme will be problem orientated rather than solution based.

Examples of components which might be suggested for inclusion in the programme follow. Your comments on these would help to design the scheme but these examples should not be regarded as exclusive, please feel free to make alternative suggestions.

GCSE syllabuses will be available to assist this consultation process if required, particularly in the consideration of possible mathematical content. These syllabuses, of course, also have implications for teaching, learning and assessment processes. There is, perhaps, an urgent need for skills and techniques, related to such processes, to be included in the mathematical curriculum of the lower and middle secondary school, if not earlier.

Process Aspects

Teaching strategies and skills (paragraph 243: *Mathematics Counts*)
Learning styles and skills (including theories of learning etc.)
Matching (including special needs, expectation, conditions of learning)
Assessment skills and techniques
Using resources (teacher and learner)
Communication skills of the learner in Mathematics
Confidence of the learner to use Mathematics
Motivation of learners
Curriculum Issues

Content Aspects

Examinations and syllabuses
Specific Topics (e.g. sets, functions, graphs, transformations, geometry, trigonometry, matrices, numbers, probability, statistics)
"Modern/New" Mathematics
Applicable Mathematics
Relevant Mathematics (Horizontal and Vertical: Adult Life, Employment, Further and Higher Education)
Primary School Mathematics
Lower Secondary Mathematics
Higher Secondary Mathematics
Sixth Form Mathematics
Higher Mathematics
Mathematics across the Curriculum
Mathematics and other Subjects
Computing/Calculators
Mathematical Models and Modelling
Numerical Methods
History of Mathematics
Structure / Philosophy of Mathematics

Other Issues
The role of the Teacher of Mathematics
Mathematical Journals/ Publications/Textbooks
Software
Mathematical Associations
Mathematical Education Projects
Teacher Training Opportunities
Approaches to Teaching Functions and Graphs

Aim

To become aware of the variety of approaches to the Teaching and Learning of Functions and Graphs.

Objectives

(i) To consider the mathematical background to the concept Function and how it relates to Graphs.
(ii) To look at a variety of approaches to teaching Functions and Graphs which have been suggested by different authors, schemes and projects.
(iii) To discuss different approaches that teachers might take to teaching Functions and Graphs.

Implementation

Part 1: Exposition and Large Group Discussion.

Part 2: Small Group Activity

Form four groups A,B,C,D. Each group should spend 45 minutes on each of the four activities in the following order;

Group A: (1,2,3,4)
Group B: (2,3,4,1)
Group C: (3,4,1,2)
Group D: (4,1,2,3)

As you work at each activity consider and discuss the approach to Functions and Graphs which the authors and developers of the material have adopted.

Compare the approaches illustrated by the different materials.

You will not have time to work through every part or section of the material or to make a study in depth of its content. However by sampling you should be able to identify the approach adopted and to consider how effective and useful it might be in a classroom etc.
Appendix 7

PRACTICAL WORK IN MATHEMATICS

CONTENTS

Introduction
Practical Work in Mathematics
Using the Package
Teacher's Notes

I  Pyramids and Spheres
II  Gears
III  Rollers, Wheels, Bearings and Belts
IV  Conics
V  Packaging
VI  The Children's Playground
VII  Linkages and Simple Machines
VIII  Circles
IX  Curves
X  A Survey

Student Worksheets

1  A Cube from Pyramids
2  The Cone
3  Volume of a Hemisphere
4  What Shape? A Modelling Exercise
5  Gear Wheels
6  Spirals: The Logarithmic Spiral
7  Spirals: Archimedes' Spiral
8  Spirals: The Fibonacci Spiral
9  Spirals: The Helix
10 Conics: Drawing Pins and String
11 Conics: Set-square
12 Conics: Paper-folding
13 Conics: Curve Stitching
14 Conics: Stretching a circle
15 Conics: Concentric Circles
16 Gear Teeth
17 Shapes that Roll
18 Systems of Belts
19 The Rocking Horse
20 The Curve of Quickest Descent
21 Boxes
22 Packing Circular Objects
23 The "Best Shape"
24 Linkages
25 James Watt Steam Engine
26 Tchebycheff's Machine
27 The Trammel Ladder
28 The Piston
29 The "Turning Circle" of a Car
30 Curves
31 The "Up and Over" Garage Door
32 Running Track
33 Converting a Try
34 Roundabouts
35 Lawn Sprinkler

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Appendix 8

RURISHIRE/LOUGHBOROUGH 'PILOT' EXPERIMENT
In-Service Education and Training for Teachers of Mathematics

P.K. Armstrong (Lecturer in Mathematical Education,
Loughborough University of Technology),
A.C. Bajpal (Professor of Mathematical Education,
Loughborough University of Technology) and
O. Eastwood (Mathematics Inspector, Rurishire LEA)

The DES Consultative Document Action on Teacher Supply in Mathematics Physics and Technology (July 1986) referred to a "Hidden Shortage" resulting from a poor match between teachers' initial qualifications and experience and the subject they are asked to teach. For some time Rurishire Mathematics Inspectorate has been concerned that a substantial percentage of mathematics tuition has been provided by non-specialist teachers of the subject and that this has tended to be given to less able children. There appears to be a lack of suitable in-service provision for the teachers concerned; possibly because they often have significant experience in other aspects of the curriculum. They include deputy heads and senior staff, who are required to "fill in" mathematics slots in the timetable, as well as the more "obvious", but less senior, non-specialists. In addition some of this tuition is given by supply teachers for whom in-service training is traditionally limited. Mature entrants to the teaching profession, although normally possessing some qualification and training in mathematics also require suitable in-service provision if they are not to contribute to the hidden shortage.

Following consultation between Schools, the Mathematics Inspectorate of Rurishire and the Department of Engineering Mathematics, Loughborough University of Technology, a 'Pilot' INSET Experiment, directed at this hidden shortage, was launched in February 1987.

Twenty one teachers of mathematics, in Rurishire secondary schools, were identified as being in this category and invited to join a course of in-service education and training provided by Loughborough University and sponsored by Rurishire LEA. It was agreed that a team from the University Departments of Engineering Mathematics and Education would meet the teachers in the Mathematics Centre, Midchester, on 19 occasions over a period from February to July, 1987. Each session would be conducted on a Thursday afternoon from 2.00 pm until 6.30 pm. In early Autumn a short residential course would take place at Loughborough. An on-going programme of support and evaluation would follow.

From the outset consultative and feedback processes were built in, as essential features of the experiment, in order to ascertain the perceived needs of the participants and to design and modify the programme accordingly.

The main aim of the programme was to enable teachers to provide effective mathematics
tuition up to, and including, the fourth year of the secondary school, since the majority of teachers attending the course were involved to this level. Nevertheless, partly because a minority were sometimes asked to teach later years, this aim was designed to be relaxed as necessary. This was welcomed by the teachers, who were interested to discover what mathematics was involved higher up the school and beyond in order to place their own teaching in context. In addition, perhaps because a Department of Engineering Mathematics was involved, but none-the-less pleasing, the teachers were anxious to investigate the relevance and applicability of school mathematics in the world at large.

Initial consultation soon identified the need to include both process and content in the course. Recent curriculum changes, such as GCSE, and the introduction of new technology into schools were common concerns. There was a need to increase the level of awareness of the teachers in these matters. The traditional system seems to by-pass many of these teachers, as far as information and training is concerned, despite a number of well intentioned initiatives.

It was apparent that existing INSET schemes were not catering for the teachers involved and that a specially designed programme was required for a group who soon proved to be highly motivated, receptive and adaptable. An encouraging indication of these qualities in the participants (and, perhaps, the effectiveness of the design model chosen) is that the 'drop-out' rate more than halfway through the programme is zero and promises to remain near or at that level. Reactions from schools, ascertained by the Mathematics Inspectorate, have been very favourable. The teachers have now become almost obsessive resource borrowers from the Mathematics Centre and more than one HOD has been pressurised to purchase new material and learning aids. Participants report back regularly that they have used the strategies and resources to which they have been introduced in the course and provide useful criticism of these. The weekly sessions have been conducted as seminars, workshops, investigations, practicals, problem solving, modelling sessions, discussions and lectures in a deliberate reflection of Paragraph 243 of the Cockcroft Report. Throughout, mathematics has been presented as a relevant subject and applications have figured prominently. The needs and aspirations of mature learners have always been emphasised, even on those occasions when the teachers have played the roles of their own students; which they have performed willingly, usefully and expertly. New materials, 'tailor-made' for the programme, have been prepared and issued each week to the teachers. It is intended that this material should not only be used in the schools where the participants are employed but that it should be distributed widely to other schools and resource centres.

The first but tentative evaluation, therefore, is encouraging but much has yet to be done since the programme is intended to be an 'experiment' to furnish results which will be used in future INSET developments for similar groups. It is hoped that other authorities and groups might take advantage of these research findings and of the expertise and new materials being developed. Cooperation between authorities and the assistance of Central Government, through the offices of DES, is required if this experiment is to continue and if suitable INSET programmes for this identified group of teachers are to be developed and provided on a wider geographical basis. Loughborough University and the Mathematics Inspector of Rutshire would be pleased to consult with interested parties to these ends and to give further information of the work of the INSET Experiment.

It must be remembered that non-specialist teachers of mathematics, currently in post, will be providing tuition in that subject for many years to come. This will be the case despite any increase in entrants to teaching produced by the recent and welcome initiatives to improve
supply. Investigation has shown that there are many long service teachers who have not been given the opportunity to join suitable INSET programmes for many years. Although qualified in mathematics they are often out of touch and readily admit it. Together with the non-specialist teachers of mathematics they constitute a large pool of serving teachers for whom the established system of in-service education is inadequate. It is a matter of extreme urgency that steps are taken to meet the needs of this important group of serving teachers, which forms the 'hidden shortage'. Government, Local Authorities and Industry should decide, as a major priority, to provide the support which is necessary to design and run suitable INSET schemes for these teachers.