LEARNING TO TEACH MATHEMATICS
AND
THE PLACE OF ACTIVE LEARNING

by

HÜLYA GÜR

The University of Leicester
School of Education

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Submitted in accordance with the requirements for the degree of
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Dedicated to my daughter, Begum and my husband, Yilmaz
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THE PLACE OF ACTIVE LEARNING

HÜL YA GÜR

ABSTRACT

This study is concerned with the comparison of ‘learning to teach’ studies in teacher training programmes in Turkey and England with special reference to using active learning approaches and stage theories. It aims to realise the following two main objectives in terms of training programmes:

1. To indicate to what extent the adaptation of an active learning approach in teacher training programmes makes an impact on learning to teach.
2. To describe and compare the similarities and differences in trainees’ learning to teach in both training programmes and to make connections with the broader educational policies in Turkish and English Teacher Training Programmes and in Schools.

It begins with a literature review of learning to teach and active learning and then examines different aspects of the presentation of the stage theory in terms of the stages trainees go through during their teaching practices in order to reach the ‘reflective teaching stage’. This present study concludes with the presentation of findings and evaluation of the contribution of this research.

The research design combined a qualitative approach in a quantitative framework. Two contrasting training courses were followed through their one-year programmes. Data collection was from classroom observations, examining documents (including official documents and trainees’ written documents), semi-structured interview with four trainees and a mathematics subject tutor and questionnaires. English and Turkish versions of the questionnaire were developed, tested and piloted. The English questionnaire was administered (n=12) at the end of the first teaching practice and at the end of the last teaching practice. The Turkish questionnaire was administered (n=57) at the end of the first semester. The aim of conducting the questionnaires was to find out trainees’ beliefs and views about teaching and to chart changes in these.

In-depth study of how four trainees learn to teach in an English programme is central to the qualitative work in relation to Stage Theory and the place of Active Learning, both in classrooms and university training programmes. Given the centrality of the workplace for training, the study highlights the need to take account of each trainee’s learning, in English and Turkish programmes, and to pay more attention to pedagogical content knowledge. If what is learned is influenced by how and where learning occurs, as demonstrated in the present study, then the Active Learning account of the Stage Theory may be an appropriate theoretical model for delimiting the scope of school based training, investigating the practical problems in learning to teach in the English teacher training programme, and adapting the findings to the Turkish Teacher training programme.
PREFACE
This dissertation is an account of my original work undertaken since September 1996 as an Educational Doctorate student at the University of Leicester, Department of Education. It includes nothing which is the outcome of work done in collaboration. No part of this dissertation has been or is being submitted for any other degree, diploma or other qualification at this or any other university and specific acknowledgment is made in the text where I have availed myself of the work of others. The practical co-operation of participating schools and university Departments of Education is gratefully acknowledged. I am also grateful to the British Council and the World Bank and, in Turkey, the YOK for financial support in the form of a NEDP Research Scholarship awarded in the 1996 Competition.

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CONVENTIONS AND ABBREVIATIONS

Abbreviations

the following abbreviations are used throughout the present study following the convention
whereby the full term followed by the abbreviation in brackets is given on the first time of
use with only the abbreviation given thereafter:

DfE  Department of Education
DfEE Department of Education and Employment
NC  National Curriculum
HMI  Her Majesty’s Inspectorate
ITT  Initial Teacher Training
PGCE Post-Graduate Certificate of Education
BEd  Bachelor of Education
NQT  Newly Qualified Teacher
QTS  Qualified Teacher Status
CEP  The Career Entry Profile
ICT  Information and Communications Technology
YOK  Yuksek Ogrenim Kurumu (Higher Education Council)
Q  Questionnaire
Int. Interview
Freq. Frequencies
Tutor University Lecturer who teaches trainees during the PGCE course
Co-tutor Mentor who looks after trainees during teaching practice
NEDP National Educational Development Project
PDP  Professional Development
AT  Attainment Target
ZPD  Zone of Proximal Development
NNP National Numeracy Project
OHP  Over Head Projector
CHAPTER 1
INTRODUCTION

1.1. AN OVERVIEW OF TEACHER EDUCATION IN ENGLAND AND TURKEY

Teacher education has a high profile all over the world. However, this has raised many questions as to its contribution. These have ranged from questioning the effectiveness of teacher education to denying it has a crucial role at all. In other words what is the importance of teacher education in societies and how do we train our teachers? The world is changing rapidly. Economic, political and social developments affect teacher education and training. For a substantial period of its lifetime, the World Bank has consistently argued the importance of education for economic and related forms of development, certainly as far as developing countries are concerned, such as Turkey.

According to the World Bank report, in Turkish teacher education like other developing countries (Tulasiewcz, 1996), trainees do not know how to handle classes of over 45 because they do not have experience of that size of classroom and there is a big gap between theory and practice. In England and Wales, teacher education has a leading role as an example for developing countries. The English Education System is controlled by the Teacher Training Agency (TTA) and inspected by the Office for Standards in Education (OFSTED). The English PGCE (Post Graduate Certificate in Education) course is one year of 36 weeks. 60% of the time is spent in teaching practice. On the other hand, the Turkish PGCE course is 28 weeks including 40% of the time in teaching practice. In England, the PGCE course has only a minimum input of theory, especially the non-pedagogical variety (Tulasiewcz, 1996). However, in Turkish teacher training (including BEd. and one-year PGCE (Postgraduate Certificate Education), psychology and sociology are still taught as part of the course. In contrast to Turkey, in England, teaching subjects are mostly classroom-oriented and school based. Subject methods and curriculum studies are taught at the university. Classroom management is mostly developed during the teaching practice. Teacher training priorities are reflected in the competencies expected of teachers in terms of subject knowledge, class management, assessment and teaching strategies (Teacher Training Agency, 1996). Such competencies are taught in pedagogy, subject methods and curriculum studies courses, during which cases are discussed and solutions offered for critical examination.

The key problems to be considered in both England and Turkey are related to the quality of intake, the duration of training, the supply and demand for teachers, the curriculum of teacher training and the facilities in teacher education.
1.2. THE DEVELOPMENT OF THE RESEARCH QUESTIONS AND THE EVOLUTION OF A RESEARCH METHODOLOGY

1.2.1. The initial research intention:

The purpose of study was to examine mathematics teaching in England and Turkish and to identify possible solutions to problems which had been singled out for reform in the latter country (see Appendix 13 for details). As part of this reform programme, which was supported and financed by the World bank, the Turkish government sent some ‘pioneering’ students to study English educational system and to make some recommendations that might help to improve the Turkish system. One key area of the reform programme was mathematics education.

The initial intention for the research was to compare groups of student teachers of mathematics during their training. Typically, in Turkey, there might be up to 60 students in one institution who would be learning to teach mathematics. The researcher had assumed similar situations would exist in Leicester and therefore was looking to undertake a quantitative study in which students in each country would be given a questionnaire. However, on arrival it transpired that in the English system a PGCE group rarely exceeded 20 students. In Leicester, there were only 12 mathematics students on the PGCE because of the national shortage of mathematics' graduates. With such small numbers it was clear that any questionnaire, although clearly applicable for the Turkish cohort would have limited value in the case of the Leicester PGCE group. The approach to the research also changes as a result of the taught courses attended during the first year at Leicester. In Turkey, the research tradition is heavily biased towards quantitative study whereas in the UK over recent years a trend towards greater use of qualitative case study has emerged. The research methods course reflected this and suggested, ways in which through interviews and observations, deeper insights into the training processes and their effects on the students teachers’ performance during the school practice could be explored.

1.2.2. Revision of the initial proposal:

Another reason for the change in research strategy was the experience gained in the first term when visiting local primary schools to study the teaching of mathematics. In Turkey, a mathematics lessons typically consists of exposition, demonstrations, homework and drills. Teachers mostly require pupils to copy whatever is written up on the board. In England the primary schools approach differed considerably. In one lesson for example, the teacher used a whole range of activities such as group work, investigation, practical work, as well as class discussion. Teachers talked about such lessons in terms of ‘activities’ and these active learning methods were clearly widely used. Furthermore, the PGCE course tutor also strongly advocated their use at secondary level. The research problem therefore changed in the sense that the initial purpose of a straightforward comparison, to incorporate aspects of English practice directly into the Turkish reform programme, was less feasible. For example, the average number of pupils of
around 40 in the Turkish classroom was clearly a limiting factor. The research questions shifted and became more concerned with the attitudes of the trainees to such methods compared to more traditional teaching and whether such attitudes were changed during the course of the one-year PGCE. This was because whatever is finally decided about reforming Turkish mathematics education it would require a similar process of attitude change amongst teachers. In-depth interviews seemed to be an appropriate method for investigating the ways that the English PGCE students developed over the course of their training. Part of these interviews required students to explore ways in which their thinking about teaching mathematics developed during the PGCE and to identify the major influences on these changes.

1.2.3. Situating the research within a theoretical framework.

During the review of the literature the concept of a developmental model in teaching emerged. Part of this Stage Theory of learning how to teach concerned the shift from novice to beginning teacher status as the students moved through the training programme. Within the literature the researcher came across different understandings of what was involved in the pedagogy of learning to teach which differed from the her own initial concept. Learning to teach appeared to involve the integration of subject knowledge, skills and general pedagogic knowledge, some of which was acquired prior to the course and some as part of each trainee’s experience during the PGCE year. By the end of such training, students should have acquired a reasonable understanding of relevant pedagogy that is how to teach mathematics effectively to learners. However, after careful reading of the literature on learning to teach, the researcher found that many aspects of this process remained unclear and that some studies took conflicting approaches.

Emerging from this early work was a hypothesis that since ‘activity methods’ promote effective learning for pupils in the mathematics classroom, a similar approach should assist student-teachers to understand how to teach mathematics effectively. In brief, if the trainees are to use the active learning effectively in their teaching they must also meet it in their own learning of how to teach. These encounters with ‘activity methods’ must clearly be linked to the changes in their thinking and attitudes as they pass through the early stages in their development as effective teachers. Part of this process requires that they become reflective practitioners and critical evaluators of their own practice since by being able to function in this way teachers are in a better position to contemplate possibility of changing the way they teach. This line of reasoning therefore suggests that to move through various stages of development requires the use of an active learning approach. When, however, the extensive literature on ‘active learning’ was surveyed most of it related to pupils in schools. Strikingly, when teacher training was mentioned little attention was given to this possible link with a stage theory of learning to teach. The advantages of active learning for teacher trainees were said to include greater personal satisfaction, more interaction with other teacher trainees, promotion of shared activity and team work (co-operative learning) experience, greater opportunities to work with a range of different
learner groups, and opportunities the mathematics trainees to contribute and respond. It was claimed that it allows the group members to express their own ideas and viewpoints.

A key feature of active learning approach at Leicester was the use of 'episodes' in the teacher-training programme at the school of Education. Trainees were informed that active learning gave them an opportunity to participate in their own education for the real world of the classrooms. During sessions the tutor presented sample episodes (the researcher's term). For example, the tutor would introduced a topic, such as solving equations. The students were invited to brainstorm the ideas for teaching this topic. They divided into groups, discussed, investigated, presented their ideas, wrote down their conclusions and displayed their findings in various ways. Different topics gave different perspectives on aspects of pedagogy such as use of questioning or the use of feedback etc. Clearly, the extent to which students can engage successfully in the above process is dependent on the number of factors, a crucial one of which should be the stage of their development as teachers. Developing a theoretical model of the way in which these key elements in learning to teach were linked and the influence of other various intervening factors gradually emerged as a central theme of the research. The case studies involving students who had contrasting experiences in their own previous learning of mathematics therefore assumed much greater significance in the research.

1.2.4. Organisation of the study

The main body of the present study is organised in seven chapters including an introduction and a conclusion. After the introduction, the second chapter provides a broad background to discussions about trainees' learning to teach. To do so, this chapter is divided into three sections. Each section provides a review of literature. These sub-sections are as follows: learning to teach; stage theory; and active learning. The sub-sections develop new concepts in teacher training programmes which are called 'Active Learning' and 'Stage Theory'. These are then applied to the present implementation of training programmes in England. Trainees' learning to teach mathematics will be investigated based on these literature reviews. The third chapter explains the methodology which is used in the present study. The fourth chapter explains Questionnaire findings in the Turkish teacher training programme. Prior to this, in order to provide the background for this examination, the issue of teacher training programmes within the Turkish context will be addressed. To support this analysis a brief background of review of the Turkish teacher training programmes is provided. The fifth chapter examines the English Questionnaire findings with reference to the background of English teacher training programmes. The sixth chapter explains and discusses the case studies. Some of the extant literature on this issue will be reviewed. The seventh chapter discusses the overall findings and limitations of the study. After discussing the development of the training programme in the English context, its relevance to Turkish training programmes will be explored in terms of using the active learning approach. Finally the main conclusions are summarised.
CHAPTER 2

LITERATURE REVIEW

2.1. LEARNING TO TEACH

TEACHER TRAINING AND EDUCATION

Introduction:

Teacher education is taught in universities and colleges as a B.Ed., or a one year PGCE, in Turkey and England. These two routes to teacher education are based on very different assumptions about what is involved in learning to teach. Entrants entering the programme through these different routes go through programmes that place a different amount of emphasis on preparation in subject matter, pedagogy and the role of personal experience in learning to teach.

Teaching is both a science and an art (Curzon, 1990, Capel et al. 1995). There is no single and correct way of teaching. Every teacher trainee is an individual and brings something of their own unique personality to the teacher training programme. Teacher beliefs on the teaching and learning of mathematics influence teaching approaches (Thompson, 1984, 1992; Clark & Peterson, 1986; Bromme & Bromphy, 1986; Brookhart & Freeman, 1992). An effective reflective teacher is one who can integrate theory and practice. Any trainee or teacher who teaches has a ‘theory’ of how to teach effectively and of how pupils learn. Teaching and learning mathematics covers an understanding of it (Hiebert & Carpenter, 1992). The theory may be implicit in what the teacher or trainee does however, the teacher or trainee may not be able to tell you what their theory is (Capel et al., 1996). A PGCE course allows a start to be made on developing a personal understanding of the teaching process. In this respect, teaching is a very personal activity and while certain teaching styles and strategies might suit one teacher, they may not be appropriate for another (Capel et al., 1996, p8). A review of initial and in-service training opportunities for secondary mathematics and science concluded that most courses showed little variety in the use of teaching strategies, most of them being centered on verbal communication and teacher exposition, from teacher to teacher, or trainee to trainee (Avalos, 1998).

In teacher education, there is no general agreement about how to train the competent teacher. However, there is information currently available on what is involved in learning to teach on any kind of teacher education programme and how such outcomes relate to pedagogical knowledge and skills (Feiman-Nemser, 1990). The wide differences in teacher education programmes, both in content and context, provide opportunities to examine some
of the basic questions about learning to teach and the role that various factors, including teacher education programmes, play in developing the expert practitioner.

This research examines some of the key assumptions underlying traditional training and alternative approaches such as using the active learning approach in teacher training or teacher education. The research investigates the difference between knowing mathematics and teaching mathematics; the difference between learning to teach on teaching practice and learning to teach on the PGCE programme; and the influence of prior background, socialization, work and life experiences, personal beliefs, preconceptions and attitudes to becoming a teacher. Kagan (1992) asserts that prior beliefs associated with an individual biography such as teaching experience at school, and pupil and other colleague relationships influence trainees’ beliefs. In sum, society and culture influence trainee beliefs about learning to teach.

This analysis of the issues underlying alternative approaches to teacher preparation can be a useful source of information for policy makers, university teacher educators, and others involved in efforts to raise standards in teaching. Constructing a teacher education programme requires judgments about what teachers need to know and how they can best acquire that knowledge.

**Subject Knowledge and Pedagogy**

* If a trainee knows mathematics very well, then a trainee can teach it!

Trainees and also experienced teachers need to know their subject very well. Ball (1988a, 1988b) asserts that efforts to establish a relationship between teachers’ content knowledge and their teaching have been largely unsuccessful. Trainees with extensive course work in the subject they will teach, still have difficulty explaining basic concepts and few could provide explanations for basic principles and meanings (Ball, 1988a). These findings raise some questions about the relationship between knowing one's subject, and teaching effectively. Someone who knows mathematics may be able to solve problems and do well in mathematics courses, yet not be able to explain concepts to others (Stoddart & Floden, 1996). In this respect, good subject knowledge of mathematics may not be sufficient to teach this subject effectively. Knowing and teaching are very different. On the other hand, knowledge is not passively received either through the senses or by way of communication. Knowledge is actively built up by the cognizing subject (Welsh & Jenlink, 1998). From this standpoint, knowledge as an entity ceases to be separate from the knower as experiencer and becomes the 'conceptual means to make sense of experience, rather than a representation of something that is supposed to lie beyond it' (Von Glaserfeld, 1990, p.27).
However, effective teaching requires the expert to expand, unpack, and simplify his or her own knowledge to the level of the class, and novices find this difficult. According to Shulman (1987) teaching is an act of pedagogical reasoning:

As we have come to view teaching, it begins with an act of reason, continues with a process of reasoning, culminates in performances of imparting, eliciting, involving, or enticing, and is then thought about some more until the process can begin again. In the discussion of teaching that follows, we will emphasize teaching as comprehension and reasoning, as transformation and reflection (p.13).

Pedagogical reasoning involves a cycle of activities: discussion, comprehension, reasoning, transformation, instruction and reflection (Shulman, 1995). According to Shulman (1987) transformation involves: interpretation, representation, adaptation and tailoring. He argues that comprehension is a finishing point for the understanding of the concept to be taught, but comprehension is not the extreme point. Trainees or teachers may transform their knowledge to the learners’ level of understanding. Shulman’s model of pedagogical reasoning and action is a good example of a contemporary view of reflective teaching, about the content to be taught and how it is to be taught.

According to Simon (1995) pedagogy as a science of teaching is impossible to achieve. The term pedagogy has been related to the process of teaching and to that of learning on the part of the pupil.

The new pedagogy requires carefully defined goals, structure and adult guidance. Without this a high proportion of children, whose concepts are formed as a result of their everyday experiences, and, as a result are often distorted and incorrectly reflect reality, will never even reach the stage where the development of higher cognitive forms of activity becomes a possibility. (Simon, 1995, p20).

Shulman (1986), thirteen years ago, critically analysed what he regarded as a sharp distinction between knowledge and pedagogy that tended to result in the identification of teaching competence with pedagogy alone. Pedagogy has been identified variously as the neglected strand of education (Simon, 1995) and the last corner of the secret garden (Millett, 1996). Effective teaching, raising standards, the learning environment, and methods of teaching and learning are all important issues in teacher training today and pedagogy still plays an important role. Beginning teachers’ pedagogical problems in lessons may be solved if they work together with experienced teachers and tutors (Stones, 1994). A PGCE course requires a trainee to take responsibility for his or her own professional development.

Shulman (1986) classifies several elements of the knowledge: knowledge of subject matter; knowledge of other subject matter; pedagogical content knowledge; knowledge of the curriculum; knowledge of learners; knowledge of educational aims; and general pedagogical knowledge. His definition of pedagogical content
knowledge, 'which goes beyond knowledge of subject matter per se to the dimension of subject matter for teaching' is wide ranging:

I include, for the most regularly taught topics in one subject area, the most useful forms of representation of those ideas, the most powerful analogies, illustrations, examples, explanations and demonstrations -in a word, the ways of representing and formulating the subject that makes it comprehensible to others. Since, there are no single most powerful forms of representation, the teacher must have at hand a veritable armamentarium of alternative forms of representations, some of which derive from research whereas others originate in the wisdom of practice. Pedagogical content knowledge also includes an understanding of what makes the learning of specific topics easy or difficult: the conceptions and preconceptions that students of different ages and backgrounds bring with them to the learning of those most frequently taught topics and lessons (Shulman,1995,p9)

The classification of Leinhardt&Smith (1985) and Leinhardt&Greeno (1986) is different from that of Shulman. Although neither Shulman (1995) nor Ernest (1989a, 1989b) offer any epistemological reasons for the categories they use, they offer a common framework. Within this, it is possible to explore the available research evidence concerned with initial teacher training and to consider what research evidence is already available which will identify likely difficulties in terms of pupils’ learning.

Bennett&Carre (1995) strongly emphasise that trainees have a limited understanding of subject content and pedagogical content knowledge. If subject knowledge were to be incorporated into a one year PGCE, which aspects of curriculum and pedagogy would be dropped or postponed? A one year PGCE course is arguably too short to provide sufficient training. Such problems are not only regional or national but universal. Kennedy (1991) maintained that teachers develop their knowledge, both pedagogical and content, over a long time gradually evolving understandings about learners, subjects and classrooms. In addition to this, Ormrod&Cole (1996) emphasize teaching content knowledge and pedagogical content knowledge. After initial training, newly qualified teachers need to further develop both their conceptual understanding and pedagogical knowledge and skills.

Grossman et al (1989) provide a theoretical framework within which the interrelationships between three components of subject knowledge in a given discipline are identified.

1. Content knowledge includes: factual information; central concepts; organizing principles and ideas. This refers to the amount and organization of knowledge per se in the mind of the teacher (Shulman,1995) or trainees.

2. Substantive knowledge includes: explanatory models or paradigms; conceptual tools used to guide inquiry and make sense of data. Substantive knowledge of mathematics includes an awareness of the different branches of mathematics and how these are related, the
central ideas in different mathematical topics, and so on (Carre&Ernest,1995). The focus here is on understanding of the global (macro-level) nature of mathematics and not unrelated school topics, such as ‘arithmetics and trigonometry’, ‘algebra, geometry, tangents and things’ or the operations of, ‘addition, subtraction, multiplication’. The second part of the substantive knowledge of mathematics is micro-level concepts of mathematics. It may be inferred that much of the learning teacher trainees bring to the course is surface knowledge which lacks conceptual depth and an awareness of interconnections (Carre&Ernest,1995).

Both Shulman (1986) and Ernest (1989a) discuss the significance of this aspect of knowledge although they classify their thinking under slightly different headings. Pedagogical knowledge of mathematics is the knowledge of mathematics for teaching (Wilson et al,1987; Brown&Borko,1992). This includes knowledge of approaches to topics within mathematics, different ways of representing the mathematics, and knowledge of children’s strategies and errors (Ernest,1989a). Transformation of teachers’ own subject matter knowledge to knowledge for teaching also requires a knowledge of the materials and media (Shulman,1986) through which the instruction can be carried out. There are a number of issues related to pedagogical content knowledge which deserve attention here.

3. Syntactic knowledge includes: relevant forms of methodology; ways of introducing new knowledge-justification and evaluation. This addresses vital aspects of mathematics: the nature and means by which new mathematical knowledge (Nunes,1997) is generated and the nature of truth and falsity in mathematics. In other words, the process used by mathematicians to solve problems, test generalizations and establish the validity of an answer (Carre&Ernest,1995). On the other hand, practical knowledge, including practical classroom problems (McLaughlin,1994) is an important source in developing a pedagogy of mathematical knowledge (McQualter,1986). Strategies are clearly identified to solve the mathematical problem.

Presumably it is the maths teacher trainee who bring this unique facet of syntactical knowledge to the course with them. It is clear that many teacher trainees do not have a clear understanding of the syntactical nature of mathematics, the process of mathematical thinking. Given the weight attached to mathematical processes in the national curriculum this is an important result (Carre&Ernest,1995, p42).

Any kind of knowledge for teaching must encompass a multifaceted view of practice which extends beyond teaching as directed ‘activity structures’ such as checking homework, getting problems worked out on the board and doing exercises in the classroom
Askew et al. (1997) define a framework for beliefs, knowledge and practice. According to them, this model covers beliefs, knowledge and practice; aspect of beliefs and pedagogic content knowledge and gathering information on beliefs and pedagogic content knowledge (p.18). On the other hand Grossman et al (1989) made a distinction between beliefs and attitudes. Brown&McIntyre, (1993) assert that ‘teaching is a craft as much if not more than a science-based technology and that teachers learn the craft aspects of their profession through observing others and later, from their own practical experience’ (Brown&McIntyre,1993,p12).

Content knowledge is different from subject to subject. According to new secondary PGCE requirements, all mathematics teacher trainees have different level of content knowledge. During 1990s, a number of questions about the complex nature of teacher’s knowledge of subject content have been addressed (Wilson et al,1987; Grossman et al,1989). Aubrey (1993) provides a useful contribution to the debate about what teachers should know. Critical of the emphasis placed on procedures, management, evaluation, and testing by the teacher effectiveness movement, which gathered momentum in the 1980s, Shulman (1986) argues for matters central to an understanding of content to be addressed (Prentice,1997,p413). Shulman identified pedagogy and content as interrelated elements.

Pedagogical content knowledge refers to how to teach a particular topic or subject and how learners learn it with reference to subject specific difficulties, particularities, misconceptions and the way in which curriculum materials are organised. Pedagogical content knowledge (Brown&Borko,1992) also requires: an understanding of what it means to teach a given topic and an understanding of principles and techniques to teach a given topic. It is also informed by both knowledge of subject matter and general pedagogical knowledge. General pedagogical knowledge contains the broad principles and strategies of classroom management and organization that appear to transcend subject matter. It also includes some knowledge of learners and their characteristics: knowledge of theories and principles of teaching and learning; knowledge of learners and knowledge of principles and techniques of classroom behaviour and management. The literature about pedagogical content knowledge raises several questions for this section: Meredith (1995) found that pedagogical content knowledge implied one type of pedagogy rooted in certain representations of prior knowledge (Hiebert&Carpenter,1992) and teacher-directed, didactic models of teaching. Marks (1990) claimed that pedagogical content knowledge involved no more than ‘general pedagogical principles’ (p.7) applied to a particular subject matter. According to Davies et al. (1990), subject knowledge depends on an understanding of defined subject aims and concerns.
Summary:

The importance of subject knowledge in the context of teacher education is supported by a growing body of research findings and the perceptions of experienced university tutors. Unfortunately, from wider political debates, in which this issue is frequently highlighted, a grasp of the complexity of teaching is not always apparent. It could be argued, to echo Wideen (1996), that the Government's reforms of initial teacher education in the early 1990s in the UK have resulted in a preoccupation with the restructuring of systems rather than a re-conceptualizing of content and mode of provision (cited in Prentice, 1997, p422). The role of active learning is another ingredient to which Wideen (1996) refers. It is assumed that through structured discussions about practical experiences on the PGCE course, points of view change or are modified. As a result of this, a trainee's ability to effectively represent and explain content to pupils develops as they learn to teach it.

Trainees cannot teach what they do not know, and how they teach what they know is influenced by the way in which they came to know it. Whichever route to teaching is followed, it must also be remembered that personal content knowledge, beliefs, and prior experiences all influence trainees. According to Shulman (1986), the professional understanding of teachers, on which effective teaching and professional development is founded, relies on a complex combination of knowledge of subject matter and knowledge of pedagogy.

The trainee on a one year PGCE course has a certain level of subject knowledge and the initial teacher education course usually concentrates on subject application in the classroom. The trainees often find they have to re-learn aspects of their subject which they may not have thought about for years as well as material which is new to them. Teaching requires trainees to transform their knowledge into suitable tasks, which lead to learning. Alexander et al (1992) claim that the knowledge and skills needed for each role must be identified with precision, in the same way as is now being attempted for secondary teaching (p.50). However, to teach effectively, more than a good subject knowledge is needed (Capel et al, 1996).

Practical teaching experiences:

Do trainees learn to teach by doing it?

According to this assumption, a trainee does not need prior pedagogical knowledge to teach a subject. Teaching is a practical skill that is best learned by teaching. Kidder (1989) demonstrates that teachers also learn from experience:
Like anyone else, teachers learn through experience, but they learn without much
guidance. One problem, of course, is that experience, especially the kind that is both
repetitious and disappointing, can easily harden into narrow pedagogical theories
(Kidder, 1989, p. 51).

Hargreaves & Evans assert that 'Like students, teachers learn by doing, reading and
reflecting, collaborating with other teachers, looking closely at their work, and sharing what
they see' (Hargreaves & Evans, 1997, p. 82).

Lyons (1979) maintained that 'since teaching is a pragmatic art best learned by
experience, school districts should establish apprenticeship programmes for people who can
satisfy the literacy requirements and show competence in subject matter' (p. 109). This
assumption suggests that teacher education courses are unnecessary, and anyone with a
bachelor degree and grounding in the subject matter to be taught and support, can develop
teaching expertise through on-the-job training (Stoddart & Floden, 1996, p. 94). On the other
hand, Gatz (1983) and Hall (1983) lend support to the idea of teaching as an art, using a
synthesis of ideas about teaching styles, attitudes and beliefs to make a coherent lesson.
Ohanians (1992) stated that teaching as an art is reflection in action.

If we look at the consequences of learning to teach by doing, it is easy to expose a
few problems. The research of Feiman-Nemser (1983) and Zeicher (1983) about what
teachers learn from first-hand classroom experience has shown that it can be miseducative.
Trainees and newly qualified teachers learn from school experience but without proper
guidance. This restricts their ability to explore a variety of instructional practices (Hoffman
practical teaching experience causes the development of different kinds of awareness for
trainees. Moreover, they meet the culture of a particular national school. The role of the
university is to introduce different school cultures (age, multiculturalism, etc.) to trainees on
PGCE course.

On the other hand, PGCE courses develop trainees' pedagogical knowledge,
pedagogical content knowledge and subject knowledge. PGCE courses also give an
opportunity for trainees to spend 60% of their time gaining school experience (DfEE, 1998a). Trainees face reality in their school experience. As Weinstein (1988) asserts,
the ordeal experienced by many first year teachers stems from unrealistic expectations about
the difficulty of teaching in general and about their ability to deal in particular, with the
demands of the classroom. They especially have difficulty with class control.
Prior experience:

* Do trainees' prior work experiences influence their learning to teach?

Most secondary trainees' route to teaching is school-university-PGCE. They have limited work and life experiences. They carry their secondary education influences into their teaching (Lortie, 1975). Zimpher & Ashburn's (1992) research shows that most trainees in the USA come from rural areas or small towns and from the same area as the training institution. In the last decade, the number of mature entrants has increased. Age and prior work experiences are important variables to explore. Stoddart et al.'s (1992) case studies show that novice teachers' prior experiences and the subjects they were taught were the dominant influences on their developing professional practice.

Learning to teach is a very complex phenomena and process. Learning to teach involves the integration of knowledge, skills and pedagogy through all trainees' experience. In sum, pedagogy is at the heart of the matter and of learning. In the light of the provisional discussion, this research will focus on trainees' backgrounds, beliefs, and attitudes, and the consequences for their learning to teach.

* Prior belief studies:

Pajares (1992) and Richardson (1996) emphasise the importance of trainees' beliefs before entering the programme. Pajares found that their beliefs changed during adulthood. Richardson posits that these prior beliefs about teaching come from individual experience, schooling and instruction and formal knowledge. Other effects on beliefs are years of pedagogical modeling from teachers (Loflin Smith, 1993), and subject matter instruction at university (Moon, Mayer-Smith & Wideen, 1993). Weinstein (1990) asserts that prior beliefs are robust and act as filters throughout all subsequent training. Bolin (1990) states that trainees who come into teacher education with craft knowledge are confident; and they believe they know how to teach; they need a few strategies to get them started. The same view is argued in Stoddart & Stofflett (1992) that pre-service teachers do not develop new perspectives but become more skillful. On the other hand Munby & Russell (1994) found that beginner teachers' beliefs were changed during teacher training. These studies point to the effects of a trainee's prior beliefs and some changes in these beliefs.

Calderhead & Robson (1991) found a variety of images of teaching among beginner teachers. Richardson (1996) states that whereas beliefs are powerful, their strength and character vary across entering candidates, who do not always represent an undifferentiated group.
The prior belief studies were undertaken mainly by teacher educators. The main aim of teacher educators is to help trainees to learn to teach in ways that are basically different from how the researcher themselves was taught (Borko & Mayfield, 1995; Gunstone, Slatter, Baird & Northfield, 1993) and that are different from real teaching in the classroom (Bramald, Hardman, & Leat, 1995). Artiles et al. (1996) highlighted the changing beliefs of beginner teachers. On the other hand, Feiman-Nemser & Buchmann (1989) and Calderhead & Robson (1991) recommend that the alternative to changing beliefs is to build on the beliefs that already exist. It seems that how to accommodate trainees’ beliefs is still a dilemma in learning to teach.

Powel and Riner (1992) found that older students with prior work experience drew more heavily on principles of teaching and learning gained from course-work, than did their younger counterparts, who drew more on their most recent school experience.

Weinstein (1990) looked at the effects of a 14-hours course with 21-hours of field experience that occurred over a seven-week period. Weinstein (1990) found that pre-service teachers’ beliefs about good teaching would change during the semester, but there was no change either in their beliefs’ about teaching or in what she termed their ‘unrealistic optimism’. She suggests a change to the teacher training programme. The new programme might include reflection, inquiry and the use of case materials.

Aguirre, Gurney, Haggerty, and Linder (1990) examined the effects of methodology courses in science. Lawrence (1992) examined the development of pedagogical understanding and epistemological frameworks in an introductory psychology course, and Bramald et al (1995) examined how an education course altered the thinking of beginning teachers.

Wubbels, Korthagen, and Dolk (1990) and Wubbels and Kothagen (1990) looked at two attempts to promote conceptual change, aimed at altering the beliefs of pre-service teachers about instruction and assessing conceptual change using different instruments. These studies showed disappointing results in terms of producing a conceptual change in pre-service teachers’ views.

Fosnot (1996) examined the development of student teachers’ thinking in a programme developed by the Center for Constructivist Teaching that used a five-stage ‘constructivist approach’. Stoddart et. al. (1992) examined conceptual change in science and mathematics among elementary pre-service student teachers exposed to contrasting approaches. Apart from Stoddart’s study, other study data supported the claims that significant development, involving a change in beliefs, had occurred among the beginning teachers.
Dunkin et al (1994) emphasise subject matter and teaching skills. Levin and Amon (1992) examined the impact of a programme based on an emphasis on pedagogical thinking. All three studies show positive results in terms of significant cognitive development and/or a change of belief. Featherstone (1995) examined student teacher experience of the theoretical knowledge on the course. Allard & Cooper's (1997) work raised not only gender issues, but also the possibility of conflict of ideas between teacher educators and beginning teachers.

According to Britzman (1986) the university provides the theory, the school provides the setting and the student teacher provides the effort to bring them together.

Teacher educators see student's practical teaching as a time for the beginning teacher to examine non-traditional ways of teaching (Griffin, 1989), to apply pedagogical content knowledge learned on campus (Onslow, Beynon, and Geddis, 1992), to reflect on their experience (Borko and Mayfield, 1995), take risks and to focus on the ‘why’ of teaching rather than the ‘how’. These studies show that pre-service teachers engaged in ‘routine’ rather than ‘reflective action’ in their practical teaching.

Bullough (1992) and Britzman (1991) emphasize that student teachers’ experience conflicts with schooling. Smith (1996) examined student teachers who had gained a commitment to collaboration as a result of working in professional development schools; Smith also found that the student teachers were able to clarify their work and understand clearly their responsibility toward pupil learning.

In teacher education, teacher educators and pre-service teachers are faced with a dilemma, that of bridging the culture gap between school and university. The reality of learning to teach depends on whose voices are being heard. The problem lies in part with conflicting expectations (Wideen et al., 1998). Expectations play an important role in teacher education. Teacher educators', co-tutors’, and trainees' expectations are different. Teacher educators try to provide an idealistic view about learning to teach, co-tutors try to give a realistic view, and trainees try to combine theoretical and practical knowledge in real school settings.

Most of the research points to a need to examine trainees’ prior beliefs and to negotiate an effective teaching role based on classroom experience, a delicate reading of knowledge and new expectations of teaching gained on campus (Kagan, 1992).

Summary and discussion of results

These learning to teach studies point to contrasting conclusions. One of them is that the teacher trainees in teacher education programmes and pupils in the schools are very
different. Trainees' beliefs also affect their teaching. Trainees find it a struggle to control the class. Beginning teachers aim to survive rather than learn from experience (Lacey, 1977). On the other hand, some beginning teachers do have their views of teaching altered by teacher education programmes.

In conclusion, many of the learning to teach studies are not directly linked or judged in comparison with others. However, each provides different angles on learning to teach: trainees' beliefs; attitudes; how they learn to teach; and the impacts on training programmes. Kagan's (1992) and Wideen et al's (1998) recommendations that what beginning teachers require is initial knowledge regarding classroom management is not a view held by other researchers. Wideen et al argue that trainees need theory in teacher education programme. As mentioned earlier, trainee's initial knowledge in a teacher education programme is based on a training programme in which the university provides the theory, methods and skills; the school provides the settings in which that knowledge is practised; and the beginning teachers provide the individual effort to apply such knowledge; this knowledge has formed the base for the university’s input. Reflective practice and action research (Feathersome, Munby, Russell, 1997; Wubbels & Korthagen, 1991) and methods in constructivist theory (Fosnot, 1996; Gunstone et al. 1993; Richardson et al. 1997) are given as alternatives to the initial knowledge model.

Wideen et al (1998) suggest future areas of study (Richardson, 1996; Wideen et al, 1998): teacher educators, the supervising teacher and pupils and their parents, as these are often forgotten issues in learning to teach. This present study will consider teacher educators’ effects on trainees and their learning to teach.

The present study is aimed at improving our understanding of the process of learning to teach, especially learning to teach mathematics, particularly algebra and data handling using the certain active learning approaches. This was done principally by attempting to answer such research questions as:

• What kind of background they have: what secondary and undergraduate education experiences does the mathematics teacher trainee bring to the teacher training course and how does this influence their learning to teach mathematics?

• Have teacher trainees enough subject knowledge and understanding of learning to teach mathematics, and how does it affect their teaching practice?

• What are the other influences on learning to teach mathematics?; What are the reactions to using active learning approaches in learning to teach mathematics?
What are the similarities and differences in England and Turkish secondary mathematics teacher training, how different is it for Turkish trainees learning to teach mathematics?

The main goal is to describe and understand the teacher trainees’ knowledge, beliefs, thinking, background, and actions related to the teaching of mathematics during their training. I have drawn heavily upon Shulman’s theoretical model of domains of teachers’ professional knowledge (Shulman & Grossman, 1988) to develop the belief and knowledge components of this framework. In the next section of this chapter, conceptualization is modified and investigated according to Figure 2.1: the trainee’s own beliefs stemming from: background, secondary education, university education, teacher training course, mathematical subject sessions, and professional development sessions, teaching practice. Peer relationships also affect trainees’ beliefs. In addition to this, pedagogical content knowledge, subject matter knowledge, general pedagogical knowledge, knowledge of curriculum, knowledge of learners, knowledge of educational aims were also influences on trainees’ learning to teach mathematics.

* INTRA PERSONAL AND INTERPERSONAL FACTORS

Effects on the teacher trainee’s learning to teach in Leicester PGCE course:

Borko et al. (1990) and Brown et al. (1991) examined trainees’ backgrounds and found that these influenced learning to teach. In this study trainees’ own background includes trainees’ secondary education, trainees’ university education, their teacher training course (including mathematical subject course sessions and other sessions). Professional Development Sessions address classroom management very early on the course. Teaching practice is also an important factor and involves two schools per trainee: Mode A and Mode B attachments. Peer relationships also seem to be an important factor for trainees learning to teach. Figure 2.2 shows how all these factors have an effect on trainees’ own learning to teach mathematics. Figure 2.1 emphasizes the most important factors affecting student teachers’ learning to teach.
Teacher trainee's beliefs:

Pajares (1992) states that beliefs about the teaching are well established by the time students go to college. On the other hand Guskey (1986) asserts that initial teacher education programmes are usually unsuccessful in bringing about belief changes, unless teachers actually use a new approach that they subsequently find successful. Furthermore, Thompson...
Teacher trainee's detailed beliefs model

(1992) states teacher's beliefs influence their actions and that reflection (Ohanians, 1992) is a key factor in enabling them to reorganize their actions and their beliefs. Schon (1983) stresses the importance of reflection for teachers learning to teach mathematics. According to Schon (1983), the process of reflection-in-action is central to the 'art' by which practitioners sometimes deal well with situations of uncertain, instability, uniqueness, and value conflict. However, Galton (1995) observes that the reflective process is less successful with pre-service teachers and those at the beginning of their teaching careers.

Trainees' belief are likely to span their beliefs about education in general; about mathematics; mathematics teaching and learning; how best to teach the subjects; teaching with understanding; and knowledge of teaching approaches.
We prefer to think that knowledge of teaching is actively constructed by practitioners themselves, in-extricably linked to their experiences and inquiries in actual situations of practice. We think such experiences and inquiries are sustained through communities that enable ongoing action and discourse (MacKinnon & Granua, 1994, p167).

Moreover, their beliefs will influence their reactions and thinking in different situations.

Lortie (1975) asserts that beginning teachers bring with them their own sets of concerns and agendas, which are formed largely during an apprenticeship of observation whilst pupils at school, and with specific images of teaching in mind (Calderhead, 1988). Sometimes there are ideal images of the kind of teacher they would like to be and sometimes one particular teacher who acts as a model of teaching in trainees mind. It seems that trainees arrive on teacher training programmes with certain conceptions of teaching, which may be vague and difficult to articulate, but which appear resistant to substantial change. They are persuaded that it is important for them to challenge their beliefs, which dictate to what extent new ideas will be interpreted to fit in with a teacher's existing set of beliefs (Ahmed, 1987).

It is argued at the beginning of the section, that this set of beliefs will embrace beliefs about mathematics, and also mathematics teaching and learning. Beliefs about mathematics are shaped to a large extent by a trainee's own mathematical experiences. In a 36 week training course, there is a problem, the difficulty in working from where each trainee is, in terms of their beliefs about mathematics and the need to test out a range of teaching approaches which are themselves outcomes of a particular set of beliefs. On the other hand, a trainee, who has their own belief, may fail to learn from a teacher's range of approaches if that teacher's view of mathematics does not agree with their own views of schooling.

**Attitudes to mathematics:**

Trainees arrive on a training course with a particular set of attitudes to mathematics, mathematics teaching and learning. Attitudes, as opposed to beliefs, reflect the difference between two trainees, one of whom, for instance, may feel themselves to be a confident mathematicians whilst the other does not, however, they might both share the same beliefs and have more or less the same knowledge base. While it might be postulated that graduates of mathematics and mathematics related topics graduates will have positive and confident attitudes, it would appear that this may not be the case. They see themselves as mathematicians not as mathematics teachers. The main reason for this apparent view relates to the teacher's belief about mathematics. Teacher trainees see themselves as learners of
teaching and it is likely that their views about how they are going to learn are very little different from those they acquired when learning mathematics as pupils.

PGCE courses and teaching experience in school influence the trainee. Figure 2.1 (page 18) captures the range of factors affecting student teachers. This section considers both intra personal elements including prior experience, attitudes, beliefs, some role models, and inter personal including tutor, co-tutor, pupils in schools, other training colleges and teaching practice effects.

**Pedagogical content knowledge of mathematics:**

This is a complex combination of content knowledge, curriculum knowledge, knowledge of learners, and their characteristics, and general pedagogical knowledge.

The present study concentrates on two mathematical domains: algebra and data handling. *Set of beliefs and knowledge* about algebra (AT3: Attainment target 3) and data handling (AT5: attainment target 5) and understanding of teaching these topics include 3 aspects.

1. **Beliefs about what is to be taught in algebra and data handling include:**
   - the nature of mathematics in general
   - algebra and data handling in particular

2. **Beliefs about pupils and how trainees learn to become a mathematics teacher and how they learn to teach mathematics include:**
   - whether or not some pupils are naturally more mathematically able in algebra and data handling.
   - the type of experiences that best bring about learning for trainees and pupils
   - the role of pupils in lessons
   - the role of tutors in university and in schools

3. **Beliefs about how best to teach pupils algebra and data handling include:**
   - perceptions of the trainee's role in the classroom
   - the influence of the 'accepted' wisdom of 'good' teaching practice.

**Contextual influences**

This covers teaching practice and ethos in PGCE courses and teaching practice; the content of National Curriculum as a whole; parental and pupils' expectations.

Like Jackson (1968), this study considered the trainees' thinking during pre-active, interactive, and post-active teaching and all components of teaching. As regards trainees'
thinking, teaching practice is crucially important to learn about the school culture. Culture in secondary schools affects trainees learning to teach.

In the light of this literature review, the researcher also started to examine learning to teach mathematics in relation to an active learning approach. If trainees use an active learning approach how easy is it to learn in order to teach? What stages do they pass through and what are the effects of their beliefs, attitudes, the university course, teaching practice, friends, pupils, tutors, co-tutors, and other teachers? These are also central research questions for this study.

Changes in beliefs and practice:

Shulman (1987) asserts that there are several types of understanding and knowledge that impact on practice for trainees and experienced teachers:

- content knowledge; general pedagogical knowledge; curriculum knowledge;
- pedagogical content knowledge;
- knowledge of learners and their characteristics;
- knowledge of educational contexts;
- knowledge of educational ends, purposes and values and their philosophical and historical grounds.

However, there are major difficulties in implementing lasting changes in education. Fullan (1991) points to four main factors in a comprehensive review of empirical studies of educational change: active initiation and participation; pressure and support; changes in behaviour and beliefs; and the overriding problem of ownership.

Smyth (1989) asserts that in-school development is less likely ‘to founder on the rocks of transference (to a different context), ownership (by a particular group) or adoption (by unwillingly participants)” (p.219). The question of ownership also links with Fullan’s last factor. He referred to ‘ownership in the sense of clarity, skill and commitment in a progressive process’ (Fullan, 1991, p. 92). Many researchers in addressing the importance of ownership emphasise Fullan’s first findings about the need for active participation, stressing the effectiveness of bringing about professional development by working in classrooms with teachers who are involved in setting their own agendas (Joyce&Showers, 1980; Biggs, 1983; Elliott, 1989; Day, 1989; Cobb, Yackel & Wood, 1988; Jaworski, 1991; Nolder, 1992).

The findings of literature support the notion of ‘reflective practitioner’ which was introduced by Schon. Schon (1983) asserts the importance of reflective activity, either collaboratively through collegial interaction or in the context of external agencies working with teachers in classrooms.
Ernest (1989) emphasized the importance of reflective activity in changing teachers' beliefs, thus linking with Fullan's third factor concerning changes in beliefs in relation to changes in practice. Other mathematics researchers such as Cooney (1985) and Thompson (1984) stress the relevance of teachers' beliefs: 'teaching reforms can not take place unless teachers’ deeply held beliefs about mathematics and its teaching and learning change' (Ernest, 1989, p. 249). However, Fullan notes that research suggests that the process of changing beliefs and practices is not linear, rather 'In many cases, changes in behaviour precede rather than follow changes in belief (p.91), thus echoing the views of Cobb et al. (1988) that 'beliefs and practices are dialectically related' (p.24).

Askew et al (1997, p.117-118) identify the following factors in promoting change:

- emphasising reflective activity through interaction and discussion;
- encouraging ownership and active participation;
- linking with school improvement policies;
- establishing teacher support groups;
- focusing on classroom practice, possibly with external support;
- relating changes in practice with changes in beliefs.

Reflection through action

In the context of university practice, tutors use different kinds of tools in the teacher training programme:

1. discussion groups, seminars, feedback sessions, individual and group interviews, and tutorials with trainees;
2. role playing, journal writing and assignment writing, preparing school files and evaluation sheets, video-recording trainees' own lessons and giving feedback and discussions, keeping diaries.

The combination of these tools attempts to help trainees pass through the learning to teach stages and to reflect on their learning for teaching.

Not surprisingly, many teacher trainees enroll on a teacher training programmes expecting to be 'told' how to teach. There is no doubt that there are teaching skills and strategies that aid one's effectiveness as a teacher. However, teaching is more complex than simply applying the right strategies or developing the skills necessary for content delivery. Teaching is fundamentally linked to learning. Teaching for understanding involves exploring relationships between teaching and learning within the context of such things as: 'the content, and the teacher's understanding of content; the nature of the students and their
experiences; and the temporal and physical characteristics of the setting' (Loughran, 1996, p. 15).

Reflection on the active learning approach in practice suggests a process of thinking after an activity but trainees’ reflection on active learning can occur before, during, and after the teaching practice, and each episode which is recognized as a problem situation may vary, as will the critical thinking and the subsequent learning. Modelling of reflection on active learning must also portray these differences if the process is to be understood, and valued by the teacher trainees.

The research shows that increased confidence and competence in knowledge of trainees is closely bound up with the ability to apply that knowledge: the relationship between ‘knowing’ and ‘applying’ is cyclical rather than linear (Nickerson, 1988). ‘Knowledge, from the constructivist point of view, is always contextual and never separated from the subject . . . to know also implies understanding in such a way that the knowledge can be shared with others and a community thus formed. A fundamental role is played by the negotiation of meaning in this interaction, which is of a social nature’ (Moreno-Armella, & Waldegg, 1993, pp. 653-661). Smith (1996) argued that socialization can not be delegated to textbooks. During the socialization process, the learner is being expected to negotiate a shared meaning with the tutor, the teacher, peers, colleges, and text books largely by coming to grips with conventions and conventional language. In this process, richer learning environment has an important role.

In the context of National Curriculum mathematics, this would suggest that learning activities which focus on narrow skills are less likely to be successful than those that require pupils to integrate ideas, especially between understanding and skills in number and algebra, and ‘using and applying’ strategies for problem solving, and communication and reasoning in both algebra and data handling. The extent to which this is evident in the classes of newly qualified teachers and experienced teachers warrants further examination.

The philosophy that underpins the Leicester tutor’s teaching in PGCE sessions is that teacher trainees should be actively involved in their own learning so that their thinking, ideas, and beliefs are challenged in ways which provoke them to reconsider, and better articulate, their understanding of subject matter knowledge and pedagogy. To encourage this active participation, the following should be kept in mind and worked towards:

1. The tutor/teacher trainee and teacher trainee/pupil relationship are built up over time primarily by demonstrating that withholding judgment is important in developing mutual trust and respect for each other. The tutor’s role is to introduce new teaching and learning methods, to actively involve and value each
trainee’s contribution in his/her own teaching and learning. Meaningful learning is the key factor.

2. Learning is complex and varies from one concept to another and one person to another. Prior knowledge is very important in teaching.

3. Teaching requires different learning strategies such as: discussion, group work, individualized work, role play, and so on, and planning and implementing are essential for teaching.

Teacher trainees need to learn and reflect on the acceptable behaviours involved in this learning and teaching process using an active learning approach. During this process, the tutor is conscious of constantly reinforcing these behaviours in positive ways. Tutors need to encourage teacher trainees. Also, being able to respond to changes in the teaching and learning environment is vital. This teaching and learning pedagogy is fundamental for both PGCE sessions and real class settings.

4. ‘Reflection on practice encourages research on practice by shaping questions which explore the outcomes of particular strategies in particular situations. Reflection facilitates risk-taking in teaching’ (Loughran, 1996, p27). Tutors encourage teacher trainees to reflect on both teaching and learning so that they might reconsider their actions when they are in similar situations when they are teaching.

5. The tutor thinks aloud and uses journal writing in PGCE teacher training sessions. Thinking aloud gives teacher trainees immediate access to the thoughts, ideas and concerns which shape his teaching. The tutor takes account of three distinct periods (pre, post, and during teaching practice). The tutor also uses a journal in PGCE sessions. This covers the tutor’s organization and plan of sessions; small notes and questions about the tutor’s understanding of sessions; time sequencing of the planning; small notes of reminders for the trainees; preparing brainstorming and discussion situations; asking them about their own experiences. Therefore, teacher trainees are able to make their own decisions about the extent to which they might actively develop reflection themselves, and how they might incorporate it into their own developing practice in passing from one stage to another.
CHAPTER 2.2

2.2. STAGE THEORY

A decade ago, Berliner (1986) used schemata theory to explain the behaviours of novice and expert teachers. On the other hand, Berliner, 1986; Borko & Livingston, 1989; Sabers, Cussing & Berliner's (1997) comparative studies suggested that cognition underlies novice and expert teacher's performance. Berliner's model focuses on the cognition that underlies a teacher's behaviour in class. Berliner classified five stages for teachers: novice; advanced beginner; competent teacher; proficient teacher; and expert teacher. The present study of stage theory is different from Berliner's model, and focuses on teacher trainees learning to teach. The new model accounts for the shift in concerns from self to pupils in terms of the resolution of a novice's image of self as a teacher. The stage model takes into account the trainee's behaviour to each pupil, and the teaching and learning processes. The new model suggests that the teacher trainee's initial inward focus is necessary and needs to be reconstructed.

The teacher trainee can be supported through different stages of learning to teach. However, it is important to emphasize that, in arguing for a developmental approach, if the teacher trainee is to develop fully, then there will be times when the trainee has to find out his/her own and pupils' needs. However, this research would support the idea that in essence, trainee's teaching in teaching practice is no different from any other form of teaching in schools as a teacher. It is necessary to use trainees' start from where the trainees are and take typical patterns of development into account (Pollard & Triggs, 1997). Furlong et al (1994) and Pollard and Triggs, (1997) defined stages for mentoring. In this research, the researcher developed and adopted these stages (Table 2.1, page28) for teacher trainees learning to teach. Different learning outcomes can be identified for teacher trainees.

The development of each individual teacher trainee will be much more complex than a simple stage model implies; each trainee will develop at his/her own rate and will need to revisit issues because they have forgotten them or wish to relearn them in a different context or at a deeper level. For this reason these stages of learning to teach, need to be considered flexibly and with sensitivity. There are not clear divisions between the stages and each stage should be viewed as cumulative rather than discrete.

The stage theory was first mentioned by Fuller & Brown (1975). The notion of stage theory provided the basis for studies by Smith & Sanche (1992), who focused on student teaching, and Pigge & Marso (1997), who monitored beginning teachers over a seven-year period. However, both studies used a version of the Teacher's Concerns Checklists,
originally developed by Fullar&Brown. The research obtained slightly different results. The result of both studies shows that trainees have survival concerns which decrease over time. Smith&Sanche’s (1992) study examined student teachers’ concerns during the shorter period of teaching. Smith&Sanche (1992) and Pigge&Marso (1997) found that beginner teachers show different aspects of stages they go through as they are learning to teach. They found that a student teacher’s concerns about teaching had changed little between initial, intermediate, and final points in the internship. However, Fuller&Brown’s predictions about teaching were obviously similar but Pigge&Marso (1997) examined trainees’ increased concern about teaching in the longer term. Differences in concerns varied across the ability levels of pre-service teachers. The clear design of these two studies and the limited number of variables being considered gives them an inherent appeal. But, as other researches have shown, learning how to teach is a complex and messy business. This view leads us to ask whether the authors of these two studies, in simplifying the system being studied, may have overlooked some significant factors. In these two studies little information is provided regarding the context in which these concerns were being examined and the programme in which the students were involved. The addition of such information would have provided a richer backdrop for the findings that were reported.

Trainees need to gradually employ more and more strategies and techniques from the repertoire that the researcher will set out in the active learning section.

A common finding of the learning to teach research is that teacher trainees typically go through a number of different stages of development.

The following list of stages (Table 2.1) in teacher trainees’ development provides a framework for discussion about teacher trainees’ learning to teach studies.

1. Beginning teaching stage;
2. Supervised teaching stage;
3. From teaching to learning stage;
4. Reflective teaching stage.

In the light of the research evidence, the next section explains the aspects of all these stages of this framework.

I. BEGINNING TEACHING STAGE:

In learning to teach, trainees have to learn how to deal with classroom management problems and how to solve and identify some of the complexities of teaching.

Trainees have difficulties in classroom management and control, and timing. Firstly, trainees often find it difficult to explain how they achieve discipline and order. For an expert
<table>
<thead>
<tr>
<th>STAGE</th>
<th>TRAINEE</th>
<th>TRAINEES’ SELECTION OF TEACHING METHODS AND AIDS</th>
<th>UNIVERSITY TUTOR’S IDEALISTIC VIEW</th>
<th>CO-TUTOR’S REALISTIC VIEW</th>
<th>STRATEGIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beginning teaching</td>
<td>struggling to ‘see’ - i.e. disentangle complexities of classroom; dominated by class control issues &amp; developing a new persona; a highly stressful time</td>
<td>mostly exposition with whole class teaching, a few worksheets, some questions, checking pupils textbooks</td>
<td>as a role model for trainees, guide and prepare trainees for real school life.</td>
<td>as model - demonstrate, interpret, guide trainee’s ‘seeing’, draw attention to significant features, explain what you are doing and why</td>
<td>focus on rules, routines and rituals (e.g. starts and ends, questioning or handling minor disruption) - observe and discuss; then copy/try out in collaborative teaching episodes; start to ‘act and feel like a teacher’</td>
</tr>
<tr>
<td>Supervised teaching</td>
<td>teaching competence; developing and trying out own ‘performance’, and aiming to achieve greater control Can get stuck here</td>
<td>expositions, worksheets, little group work</td>
<td>as trainer - introduce different teaching methods, and aids</td>
<td>as trainer - systematic and structured attention to different elements of teaching</td>
<td>systematic observation and feedback on trainee’s ‘performance’ by the co-tutor; tight focus and specific targets and strategies.</td>
</tr>
<tr>
<td>From teaching to learning</td>
<td>concentrating on pupils’ learning rather than own teaching- developing more effective teaching</td>
<td>according to lessons’ aim, individual learning, and pair and group activities, question-answer session, limited exposition</td>
<td>as a critical friend for their teaching methods, aids, assignments, files, and so on. Gives regular feedback to trainees and encourage to them use all opportunities in teaching</td>
<td>as critical friend - a difficult role, still offering support and encouragement, but pushing the trainee on</td>
<td>Close observation of pupils at work-discussion; re-examination of lesson planning- content rather than trainee performance, e.g. ‘What are pupils to learn, why, and how?’</td>
</tr>
<tr>
<td>Reflective teaching</td>
<td>developing reflective practice- standing back from own performance to enable critical evaluation</td>
<td>mostly active learning approach according to lesson aim: exposition followed by group activities, ...IT, OHPs, some software and calculators, worksheets, project and homework</td>
<td>explores complexities of teaching and prepares them for qualified teacher status, and try to minimize their weakness areas of</td>
<td>as co-enquirer - more open and equal relationship, together exploring complexities of teaching</td>
<td>partnership and joint planning, teaching and review; trainee must take more responsibility, work on broadening repertoire, and be pushed to understand and analyse more deeply</td>
</tr>
</tbody>
</table>
this is not a problem, it is a part of the natural teaching process. Secondly, trainees have difficulty identifying the class teachers’ management and control strategies, because they arrive for teaching practice nearly in the middle of the term. In teaching practice, the trainees observe the class teacher and start to act like a teacher. Vygotsky’s notion of the Zone of Proximal Development (ZPD) captures the nature of this learning. According to ZPD, learning involves linking unaided and aided levels of attainment. In this respect, for the beginning teaching stage, a trainee can participate in what is known as scaffolding. ZPD puts a link between a learner’s attained level of skills and that required for the task. According to scaffolding, the teacher provides just the amount of help required for the task to be successfully completed by the learner. The teacher trainees develop effective skills by observing experienced teachers, tutor and co-tutor. All these would contribute to trainees’ learning to teach.

At the beginning stage, a teacher trainee sets out rules, rituals, and routines and establishes authority by observing and teaching collaboratively alongside his/her own tutor and co-tutors. Tutor and co-tutors are models for the teacher trainees and contribute by ‘interpreting events, guiding their observation, drawing their attention to what they are doing and why, and to the significance of what is happening in the classroom’ (Pollard & Triggs, 1997, p. 55).

In this first stage, a trainee’s subject knowledge gives him/her confidence to teach mathematics. At this stage class management and control are very big problems for trainees. A novice teacher’s main concerns have been summarized in four stages (Fuller and Brown, 1975): pre-teaching concerns; task concerns; pupil concerns; self concerns. A trainee has similar concerns at the beginning teaching stage.

**Observable outcomes at the beginning teaching stage:**

- Their key responsibilities are to take a register and check pupils’ exercise books.
- They feel uncomfortable in the class and struggle to cope in a new situation in school.
- They are happy to use whole class teaching, mostly exposition and a few worksheets. Trainees spend a large proportion of the teaching time teaching the class as a whole.
- Trainees’ exposition tends to place emphasis on describing and explaining new information to the pupils through direct trainee-pupil interaction, and is mostly based on teaching the class as a whole.
- They do little checking of pupil understanding.
They see the role of the university tutor as that of a role model who is a guide and prepares them for real school life. Similarly, the role of co-tutor (or tutor) is also that of a role model.

- Tutors explain, demonstrate and guide trainees in what are they doing and why in the class.
- Their practice does not match their planning.
- The trainees use questioning, but only use closed questions such as yes/no; right/wrong type questioning.
- They give praise for right answers.
- The trainees are inclined to adopt ready made plans without modification.
- The trainees are anxious to use investigational work, structured individual work, small group work and so on. But they think that if they use these methods, they will lose the control and management in the class.

II. SUPERVISED TEACHING STAGE:

A teacher trainee now has experience of teaching such as knowing about management and class control, and how to set out rules. In the second stage, teacher trainees mostly consider their own performance as teachers. They are more systematic and structured, and they strive to achieve more control over the teaching and learning process. Pollard & Triggs (1997) suggest that this development can be supported best if the mentor or co-tutor, and when appropriate the visiting higher education tutor, explicitly develop a formal 'training' role, focusing directly on the 'competencies' of teaching.

In teaching practice, trainees will continue to need to observe and investigate classroom practices. Pollard & Triggs (1997) suggest that tutor and co-tutor need to observe trainees's lessons and give them feedback on specific teaching competencies.

Observable outcomes at the supervised teaching stage:

- The trainees try to make a clear structure for the pupils.
- The trainees spend a large proportion of time teaching the class as a whole.
- The trainees try to check pupil understanding.
- The trainees try to follow their own lesson planning but still have difficulty with timing, and class control and management.
- The trainees are able to define the situation, and follow some rules but not actively determine what is going on.
• The trainees start to use *wh*-type questions (Stratus et al, 1998). Trainees give pupils indirect instruction which involves tasks where pupils are given a significant degree of initiative and responsibility in deciding how the tasks are organised.

• The trainees have insufficient confidence in class management and control. An appreciation of pupils' learning demands a willingness to experiment with different strategies of classroom organisation (Pollard & Triggs, 1997).

• The trainees try occasionally to use investigational work, structured individual work or small group work, but the results may be disappointing.

III. FROM TEACHING TO LEARNING STAGE:

Furlong et al (1994) called this stage 'de-centering'. Pupils' learning and becoming an effective teacher are key factors at this stage. Trainees still need to know how pupils learn; pupils' needs, and interests; how pupils understand the topic, and pupils' readiness level. 'Trainees’ understanding of how pupils learn, and what their role as a teacher should be, may initially be naïve and simplistic' (Pollard & Triggs, 1997, p.57).

**Observable outcomes at the 'From teaching to learning stage':**

• The trainees have confidence with class management and control, and 'act' as a teacher.

• The trainees are able to turn their attention away from their own performance, and look more deeply at the content of their lessons in terms of what their pupils are actually learning.

• The trainees are keen to keep pupils quiet and occupied, but then fail to look critically at what learning is taking place.

• The trainees take account of individual pupil’s needs and interests.

• The trainees believe that teaching is simply about the transmission of knowledge and the accumulation of factual information; pupils are blank slates; school learning is 'discrete' and separate from learning going on elsewhere in pupils’ lives; giving correct answers denotes understanding at this stage;

• They still need to understand all the complexities of teaching.

• Pupils take an active role in their learning and, when appropriate, participate in investigation and inquiry.

• The trainees need to look critically at the teaching process, and evaluate, assess, and re-examine their teaching and effectiveness; the trainees evaluate themselves in particular aspects.
• Tutor and co-tutor are critical friends for teacher trainees, and they give to trainees oral and written support, feedback, encouragement, and personal affirmation.

• The trainees use whole class teaching which consists of a mixture of informing, describing, explaining and questioning in their teaching. In addition, trainees create a greater sense of coherence for the teaching to pupils as a whole, to foster greater transfer of learning.

• The trainees try to use different kinds of teaching materials and aids to teaching.

• The trainees try to follow mostly their own lesson planning.

• The trainees use open questions which include wh-type questions.

• The trainees give pupils semi-direct instruction which involves the activities and tasks being structured and organized, and after finishing the task the trainees encourage pupils to represent their findings.

• The trainees try to use investigational work, structured individual work, small group work, but the trainee is not fully motivated towards such methods.

IV. REFLECTIVE TEACHING STAGE:

A trainee's development should include in this stage: a wide repertoire of teaching strategies; the learner (trainee and pupil) takes an active part in their own learning; understanding of the complexities of teaching and learning including the social, moral and political dimensions; trainees discuss their teaching and planning with the co-tutor at a more fundamental level than before; the co-tutor is no longer an authority who knows the right answers.

At this stage, trainees behave like expert teachers: The expert teacher's knowledge, planning (Leinhardt 1989; Berliner 1986), analysis of pupils' work, and teaching style are different from the novice teachers. According to Leinhardt's (1989) findings, expert lessons based on rich and are detailed agendas, and are more pupil-centered with a big repertoire including complete explanations for questions. Leinhardt&Greeno (1986) found that expert teachers possess a large repertoire of flexible routines which are capable of being arranged in different orders, and require little monitoring or explanation in their execution (p.94). Consequently the complex knowledge of the expert teacher is believed to be composed of 'a set of schemata for teaching activities' (p.75).

According to Borko&Livingstone (1989), unlike the novice, expert teachers are 'improvisational performers'. In other words, experts are very proficient at using a wide repertoire of teaching strategies (Galton&Bylth,1989). On the other hand, Borko and Livingstone (1989) maintained that experts’ lesson evaluations were more pupil-focused,
emphasizing understanding and noteworthy events, in contrast to novices’ concerns about classroom management and self presentation. Teacher trainees and beginning teachers have a lack of practical experience, limited teaching skills, use limited teaching methods, and do not know pupils and their needs. The reason for this is that schemata for the development of subject matter and pedagogical knowledge during the teaching practice are underdeveloped. Feiman-Nemser&Buchmann, (1986), (1987); Wilson et al. (1987); Livingstone&Borko, (1990) found that the development of these schemata together with pedagogical reasoning skills were major components of learning to teach. Berliner, (1986); Leinhardt (1989); Livingstone&Borko, (1990) and Winitzky (1992) claim that the transition from novice to skilled practitioner is broadly confirmed. Although employing a range of methodologies all of these studies see teaching as ‘an active process in which teachers’ knowledge provides the source of identifying and interpreting professional situations and responding to them’ (Calderhead,1987,p.15). However, Borko, Galton, Berliner did not think all teachers get to this stage.

On the other hand, Adler (1991) has conveniently set out what she sees as being three distinct meanings which can be ascribed to the term ‘reflective practice’. McIntyre (1990) has elegantly and convincingly argued: that enquiry into one’s own practice, on the other hand, is so difficult that it is to be aspired to rather than employed as a learning strategy by the novice; and, is, in any case, more appropriate to the experienced professional whose skills are largely routinized. The first and basic way to talk about reflective practice might also be described as ‘reflective teaching’, where teachers are encouraged to reflect on the effectiveness of their own classroom skills. This is basically an act of classroom self-evaluation. Actually, Schon describes two forms of reflection: Reflection-on-action and reflection-in-action. Reflection-on-action is the basis of much of the literature pertaining to reflective teaching and teacher education, and is similar to Dewey’s notion of reflection. Reflection-in-action is understood through ‘phrases like ‘thinking on your feet, keeping your wits about you, and learning by doing’. These suggest not only that we can think about doing but that we can think about doing something while doing it. Some of the most interesting examples of this process occur in the midst of a performance’ (Schon,1983, p.54). Reflection-in-action comprises the re-framing of unanticipated problem situations such that we come to see the experience differently. (The attention by Schon to reflection-on-action and reflection-in-action was the start of a new wave of research and learning about reflection). The second approach is that usually associated with Schon (1983) and is characterized by the term ‘reflection-in-action’. Central to Schon’s view of the development of professional artistry is the idea of tacit professional knowledge which is refined through
action and reflection but which is not necessarily made explicit verbally. This seems to correspond to McIntyre’s (1990) view that in teacher education programmes, we need to tap into teachers’ ‘craft knowledge’ and make it accessible to the novice. According to Adler, this view of reflective practice is limited in that it does not allow for the practitioner to bring into question the social and political contexts of educational practice. She suggests a third view of reflective practice which seems to be based on the work of Zeichner. Zeichner’s view extends the concerns of the practitioner beyond classroom techniques and situational understanding and is characterized by the term ‘reflection as critical inquiry’. This approach to reflection takes in the ethical and moral dimension and it is this aspect of reflective practice which the researcher believes is already under threat and could be extinguished completely in the context of school-based ITT (initial teacher training). Zeichner’s research, using discourse analysis in teacher education programmes, is very interesting and has important implications for teacher training programmes such as the Leicester Secondary Mathematics Teacher Training. On the other hand, Zeichner et al have shed some light on the nature of the discourse which takes place between tutor and trainee in the context of teacher training, and the analysis of this within the process of supervision (Zeichner et al, 1986).

Indeed, there is no reason to see ‘reflective teaching’, ‘reflection in action’ and ‘critical inquiry’ as being in any sense at odds with each other. One might argue that basic classroom effectiveness is best served by an approach to professional development which seeks to promote critical inquiry. It is argued that critical discourse involves assessment of the ‘values embedded in the form and content of the curriculum materials and instructional practices’ (Zeichner et al, 1988, p.53). However, it is clear that values are embedded in the practices adopted in the classroom. It is important to be aware of the fact that the individual teacher trainee acts according to personal value positions and that these taken for granted actions transcend the particular teaching strategies or curriculum materials chosen for use within a particular lesson.

In sum, in this stage of practical preparation in teaching, teacher trainees need to be encouraged to switch from a focus on their own teaching performance to a focus on the pupil’s learning and how they can make it more effective. But to achieve this switch means more than the trainee simply extending his or her repertoire of routines. They must develop a deeper understanding of the learning process, think critically and make justifications.

Current policy on teacher education requires teachers to focus on how trainees improve pupils’ learning (Delors, 1996) and asks them to turn their attention to the role of reflection in classroom practice (Lange & Burroughs-Lange, 1994; Thiessen, 1992). Whole
class teaching is associated with higher order questioning, explanation and statements. These are correlated with a higher level of pupil performance. Despite the potential weaknesses (ability range, losing control, narrowing challenge), whole class teaching is an essential teaching skill from the start. Dewey (1933) refers to ‘reflection in action’, a very challenging notion when developed and applied to teaching. The researcher has reviewed its implications and identified six characteristics:

1. Reflective teaching implies an active concern with aims and consequences as well as means and practical competence.
2. It is applied in a cyclical or spiralling process, in which trainees monitor, evaluate, and revise their own progress periodically.
3. It requires competence in methods of classroom inquiry to support teaching competency.
4. It requires positive attitudes to teaching such as open-mindedness, responsibility, and wholeheartedness.
5. It requires judgments of own teaching.
6. It requires more collaboration with colleagues.

Using a mixed approach enables a dialogue between trainee and pupils to develop, which is more meaningful for pupils and promotes better attention and interest. Trainees also create a greater sense of coherence for teaching pupils as a whole and foster greater transfer of learning.

**Observable outcomes at the reflective teaching stage:**

- The trainees set out the rules.
- Class management, control and timing are no longer problems.
- The trainees show signs of effective planning which involves effective teaching of pupils; everything in the plan is adapted in the class according to the lesson plan.
- The trainees’ lessons are based on rich and detailed agendas.
- The trainees use mostly pupil-centered approaches to teach; trainees’ lessons are more pupil centered than teacher-centered.
- The trainees use a very rich repertoire of flexible routines which are capable of being arranged in different orders, and require little monitoring or explanation in their execution.
- The trainees use a variety of teaching strategies very proficiently.
- The trainees evaluate themselves very critically.
• The trainees’ lesson evaluations are mostly pupil-focused on pupils’ understanding, pupils’ needs and their interests.

• The trainees think whole class teaching is still an essential teaching skill. Despite the weaknesses of whole class teaching, trainees use of whole class teaching is associated with higher order questioning, explanation and statements according to the aims of the lessons. These correlate with a higher level of pupil performance. Although using whole class teaching, trainees take account of the ability range of the class, pupils’ needs and interests.

• The trainees are keen to use a variety of teaching materials effectively for teaching.

• The trainees are ready to answer pupil’s questions fully.

• Trainees are keen to use open questions which involve wh-type questions, as this gives opportunity to encourage higher order thinking.

• The trainees give direct instruction to pupils which involves activities and tasks which are highly structured and organized, and after finishing the task trainees want them to represent their findings.

• The trainees are keen to use investigational work, structured individual work, and small group work.

• The trainees are mostly responsible for their own professional development.

• The trainees consider the social, moral and political dimensions.

OVERVIEW

This list is not meant to imply that all teacher trainees must move through these levels. Nor is it meant to suggest that a final list of such levels could ever be compiled. Instead the list is meant to illustrate the way that teacher trainees might talk about teacher development in ways that are not necessarily all that meaningful to non-professionals, but that nevertheless can be used as part of a justification for schemes in teacher trainees’ own evaluation.

Trainees have idealistic views about teaching and pupils before beginning teaching practice but when they enter the classroom their idealistic views give way to realistic views. They understand the difference between theory and practice. In the first teaching practice, the trainee finds teaching is a complexity. The trainee observes the co-tutor to see how the co-tutor deals with problems in the class. For the trainee, the first teaching practice is about survival.
Teacher trainees and beginning teachers have a lack of practical experience, limited teaching skills, use limited teaching methods, and do not know pupils and their needs. The schemata for the development of subject matter and pedagogical knowledge during the teaching practice are underdeveloped.

Using an active learning approach through the stage theory helps a trainee develop learning to teach skills. These are summarized as follows:

I. The ability to make a difference: Trainee
   - shares goals, and expectations, and targets with the pupils and parents;
   - employs and explains own expectation and goals for pupils;
   - gives pupils responsibility for their own learning;
   - communicates clearly and easily;
   - organizes content of the work;
   - manages control of classroom;
   - uses timing and ordering effectively.

II. Knowledge and understanding of their subject: Trainee
   - understands own subject in depth, and develops teaching strategies;
   - understands how to use own subject knowledge to support pupil’s learning of the subject;
   - makes links between different subject areas and also prior lessons;
   - employs and accommodates teaching materials effectively;
   - employs a range of teaching methods appropriate to a whole class, individual, pair, or groups.

III. Interpersonal skills: Trainee
   - creates a positive atmosphere in the classroom which encourages pupils’ learning;
   - establishes a good relationship with pupils and gives them active support;
   - uses and matches teaching methods and learning activities according to the aims of the lessons and pupils’ individual needs and their cognitive stages;
   - takes account of the level of pupils’ understanding;
   - teaches different range of ability and year groups of pupils.

IV. Developmental skills: Trainee
   - is enthusiastic about new ideas and is open-minded;
   - makes links between the idealistic and realistic situation;
   - always recognizes and minimizes worry and tension;
   - evaluates critically themselves and pupils and gives pupils feedback.
From this beginning examination of the needs of trainees' learning to teach at different stages of development, we are then able to propose a fuller and more complete view of the role of tutor and co-tutor. In the beginning of the teaching practice, when teacher trainees are still at the beginning teaching stage, they and the tutors need to act collaboratively, working shoulder to shoulder. Teacher trainees receive regular feedback. Once trainees move beyond the first teaching stage to the reflective teaching stage, they start to take more responsibility for their teaching, and gain confidence. Feedback is needed. Finally, once teacher trainees have achieved basic competence, the role of the tutor needs to develop further. While other aspects of the role may continue, the tutor, in the reflective teaching stage of development, needs to establish the aim of promoting critical reflection on teaching and learning by the trainee.
Chapter 2.3

2.3. ACTIVE LEARNING

The importance of pedagogical content knowledge and knowledge of curriculum for teaching practice has been argued by Shulman (1986). Trainees already have well developed ideas which they bring with them to the course; trainees have strong beliefs about mathematics, and mathematics learning and teaching; what they see in mathematics classrooms mostly reinforces their original views and further contributes to the feeling of idealism when they experience traditional university training courses.

The university course tutor faces a tension in deciding what his or her role should be. Knowledge for teaching includes both practical and theoretical knowledge.

The traditional approach of demonstrating, explaining, and questioning was the most dominant style for teaching up to the 1980s (HMI, 1980). There is, however, some divergence, not only between schools, but also to some extent between different mathematics teachers in the same school. The problem of an adequate supply of teachers of mathematics has been addressed, as a major concern, in the HMI's (1990) report on standards in schools. In addition, schools have to reconcile the demands of a wide range of national developments such as GCSE, TVEI, Records of Achievement, and the National Curriculum.

How pupils learn is a central focus for investigation by psychologists, and the nature of concept formation has been investigated by Vygotsky, amongst others.

As we know from investigations of the process of concept formation, a concept is more than the sum of the certain associative bonds formed by memory, more than a mere mental habit; it is a complex and genuine act of thought that cannot be taught by drilling, but can be accomplished only when the child's mental development itself has reached the requisite level. Practical experience also shows that direct teaching of concepts is impossible and fruitless. A teacher who tries to do this usually accomplishes nothing but empty verbalization, a parrot like repetition of words by the child, stimulating a knowledge of the corresponding concepts but actually covering up a vacuum (Vygotsky, 1986, pp. 149-150).

Thus, according to Vygotsky's view, the teacher cannot do the learning for the pupil and in order for understanding to occur the pupil has to be active in the learning process (Leikin & Zaslavsky, 1997). The same position is also true for the teacher trainee. The teacher trainee has to be active in his/her own process of learning to teach. The use of active learning strategies has emerged as a critical variable in the active learning process (Wragg et al. 1993). In fact, the term active learning is then 'meaningful learning, in which something of interest and value to the learner has been accomplished and understood' (Capel et al, 1996, p229). Active learning is also used with different meanings such as 'deep learning',
instead of meaningful learning and in contrast to ‘shallow learning’ which is learning without understanding (Capel et al,1996,p229). Smith (1996) asserts that ‘mathematics can be effectively learned only by involving pupils in experimenting, questioning, reflecting, discovery, involving and discussing’ (Smith,1996,p154). According to Kyriacou (1997) ‘active learning is the end of the continuum of teaching styles, as opposed to a very traditional, didactic, teacher-centered, exposition-based approach to teaching’ (Kyriacou,1997,p146). There are two main sources of opposition to and concern about the active learning approach: a lack of confidence about content and/or role, and strongly held views about what constitutes a mathematical education.

An essential part of the study was a clarification of what an active learning approach might mean in terms of teaching practice and issues for teacher trainees. This leads to a recognition of issues in the development of teaching, and also a critique of the research process arising from the involvement of the researcher over a long period of time.

In relation to active learning, a number of phrases are used such as learning by doing, learning by experience, learning through action, learning through task, student-centred learning, peer collaboration and co-operative learning (Brandes & Ginnis,1986; Dennison & Kirk,1990). They have identified two basic characteristics in active learning: an emphasis on learning by doing and an emphasis on pupil decision-making. Good & Brophy (1989) argued that active learning involves providing pupils with an opportunity in which they raise their own questions and use teachers and other resources to pursue self-defined goals. Barnes (1989) has suggested seven key principles of active learning: purposive, reflective, negotiated, critical, complex, situation-driven, and engaged. According to Barnes, the first four principles were called aspects of participation, and the last three were called aspects of realism.

Purposive: the task is seen by the learner as relevant to his/her concerns;
Reflective: the learner reflects on the meaning of what is being learnt;
Negotiated: the learner and the teacher negotiate the goals and methods of learning;
Critical: the learner appreciates different ways of interpreting learning;
Complex: the learning task reflects real life complexity;
Situation-driven: the learning task arise out of the needs of the situation;
Engaged: the learning activities reflect real life tasks.

Other active learning principles described by Kyriacou (1992), are as follows:
1. where learners are given a marked degree of ownership and control over the learning activities used;

2. where the learning experience is open-ended rather than tightly pre-determined;

3. where the learners are able to actively participate and shape the learning experience.

'The major problem facing the marked increase in the use of active learning activities in secondary schools is the tendency by some teachers to believe that active learning activities always promote active mental experiences' (Kyriacou and Marshall, 1989, p4). Kyriacou (1992) asserts that active learning has been applied to a diverse range of activities. These include practical work, computer assisted learning, role play, work experience, individual work schemes, small group discussion, collaborative problem solving, and extended project work. However, it is important to note one caveat to this definition. Some writers, in discussing active learning, place emphasis on the nature of the learners' mental experience rather than on the nature of the learning activities set up by the teacher (Kyriacou & Marshall, 1989). Nevertheless, Kyriacou's definition focuses primarily on the learning activities rather than on the learners' mental experience, and this is the meaning of active learning overwhelmingly adopted by advocates and practitioners. Indeed, the latter is absolutely fundamental to its impact on learners' learning. In summary, active learning, as Kyriacou has defined it above, includes a number of constituent elements: ownership, control, involvement, negotiation, choice, discovery, responsibility, meaningfulness, relevance, personal application (Brandes & Ginnes, 1986, Dennison & Kirk, 1990).

I hear, I forget
I see, I remember
I do, I understand (old proverb)

On the other hand, Burgess (1986) defined active learning in terms of how learners learn through the practical activity of doing and through applying their knowledge and skills to their own experiences. 'Active Learning' is here denoting learning activities in which students are given considerable autonomy and control of the direction of the learning activities. These activities are investigative work, problem solving, small group work, collaborative learning, and experimental learning. On the other hand, 'passive learning' in which the students are passive receivers of information, includes listening to the teacher's exposition, being asked a series of closed questions and practice and application of information already presented. Passive activities are listening to an explanation, reading the learning material, and other on-task passive activities (Leikin & Zaslavsky, 1997). There is
evidence that presently many secondary school mathematics students employ passive learning behaviours (Anthony 1996) which are more aligned to ‘school work’ contexts than to intentional (voluntary) learning contexts. Capel et al. (1995) and Kyriacou (1992) suggest that active learning involves activities such as small group work, role-play, project work, problem solving investigations, and computer assisted learning tasks; all formats where a high degree of control over the learning process is given to learners. The key factor in the active learning model is a sense of ownership, control and personal involvement (Kyriacou, 1995). Active activities include solving a problem independently, copying written material or taking notes, giving an explanation, posing a question or requesting help. In regard to active learning, however, the trainee and the teacher need to be aware that this term has not been used with any consistency. As well as referring to teaching methods or learning activities, it is also sometimes used to refer to the mental experience of learning by discovery.

Active learning strategies may be applied to teacher trainees, teachers and also pupils. The main aim is that the learner is more active in his/her own learning. This gives the learner opportunity for greater understanding, more effectiveness, and for the transfer of learning from one subject to another. Motivation and the attitude of learners to learning play a crucial role in using an active learning approach. In addition, as the learner is also mentally involved, the learning is appropriate for the learner’s cognitive development. This requires three major conditions for the learner:

1. attentiveness: ensuring that the learners are attending to the learning experience;
2. receptiveness: making sure that the learners are motivated and willing to learn and respond to the experience;
3. appropriateness: setting up an experience that is appropriate for the desired learning outcomes.

For a teacher trainee, the model enables them to spend more time with groups or individuals, which can allow better quality assessment to take place. The advantages of active learning for teacher trainees include greater personal satisfaction, more interaction with other teacher trainees, promotion of shared activity and team work (co-operative learning), greater opportunities to work with a range of different learner groups, and opportunities for PGCE secondary mathematics trainees to contribute and respond. It allows the group members to express their own ideas and viewpoints. The practice of ‘co-operative learning’, i.e. having students work together in small groups, is often advocated in university
teaching and for elementary level mathematics teaching (Johnson et al. 1991). It is known to be beneficial to students in a number of ways. Active learning supports co-operative learning not competitive learning. ‘The model of cognitive development based upon Vygotsky’s ideas appears more appropriate, that is, a model based on co-operative learning’ (Galton, 1995, p.114). In active learning, the task is identified clearly, and is motivating for the learner. Whilst active learning is being pursued, teaching which assists higher order intellectual skills is occurring. In using an active learning process in PGCE university sessions and classrooms in teaching practice, teacher trainees have an opportunity to find out more about learners’ individual and observable needs. Kyriacou et al. (1992) surveyed the choice of learning activities based on their observations of mathematics lessons in schools. The choices involved:

1. the use of concrete materials and direct experience;
2. the use of investigative or problem oriented techniques;
3. the use of small group work;
4. learner ownership of the learning process or task;
5. personal focus and relevance of the learning process or task.

Some studies raise more profound questions about: What is mathematics, what constitutes mathematical activity, and what constitutes mathematical learning. There are some studies which see active learning connoting particular types of teaching methods, such as small group work and computer assisted learning (Good et al., 1990). Kyriacou (1992) asserts that many researchers’ view of active learning is located within a constructivist model of mathematical learning. Active Learning, operationalised by cognitive, meta-cognitive, affective and resource management learning strategies, is necessary for students to effectively cope with the high level of demands placed on the learner in a constructivist learning environment (Anthony, 1996). Active learning is a core constructivist principle. In a truly constructivist teaching and learning process, the trainees and the teachers and also pupils are all active learners. The trainees and the teachers are learning about the pupils’ mathematical understanding and, in the process both teacher and trainees are learners, reconstructing their own mathematical understanding. According to constructivist researchers self-reflectivity refers to the fact that constructivists apply the principles of constructivism to themselves in their activities. Similarly, the researchers exemplified active learning and self-reflectivity as she described her learning of the conceptions of the exponential functions carried by her students. ‘Through the process of the interview, my own conception of exponential functions was transformed, elucidated, and enriched’
Knowledge of the mathematics of the students is not passively received, but is actively built up by teachers (Confrey, 1981). Although the literature expounds many types of constructivism (Ernest, 1994) all embrace the basic principle that 'learning is not a passive receiving of ready-made knowledge but a process of construction in which the students themselves have to be the primary actors' (Von Glasersfeld, 1995, p. 120). Kyriacou (1992) has classified some studies. For example, Van Oers (1990) 'meaningful mathematical actions', learners taking an 'active role in discovering and applying mathematical concepts', Leder & Gunstone (1990) of 'active participants in the learning process', Cobb (1990) of 'mathematical experience establishing meaningful connections'. A number of studies have explored teachers using active learning (Good et al., 1990; Palincsar et al., 1989; Schoenfeld, 1989). These make claims about learner involvement, learner interest, the encouraging of learners to communicate mathematical ideas, confidence building, and meaningful learning.

*Learning how to learn* is a characteristic of active learning. The learning approach must be skills-attitude-based with all learners participating in and motivated by the task. The university subject tutor expects that what is learned from previous education will be of use in the workplace and encourages trainees to use everyday life examples. In the PGCE course, skills are developed which the trainees use throughout their lives and in practice.

**Active Learning Elements in School and Classrooms:**

Active learning may be considered in relation to National Curriculum topics and appropriate teaching methods to serve specific aims. Learners should be active in their own learning activities mentally, practically and physically. The key point is that learners are responsible and control their own learning. The teacher is a guide for the learner and acts as a facilitator rather than a provider. Active learning may involve the following elements in the university tutor's and/or trainee's own teaching:

1. Start with brain storming;
2. Exposition and practice (teacher demonstration and exposition);
3. Questions and answers session;
4. Problem solving;
5. Bringing up learners to the board to show how much they understand;
6. Individual working (using discovery learning);
7. Group working: co-operation with other learners, individual learner demonstration, and expression of learners' own ideas; group problem solving (including team working); small group discussion; formal presentation to peers and also to the whole group;
8. Project work such as surveys in field work or tightly structured homework;

9. Resource-based learning activities: DARTs (directed activities related to texts, textbooks); computer-assisted learning (including CD-roms), IT (information technology), which covers a range of micro computers, generic or integrated software packages, such as word processors, spread sheets, databases, and communication programmes, and interfacing equipment; input devices, such as keyboard; output devices, such as monitors, printers and plotters; storage devices such as CD-ROM, and micro-electronics control devices such as a floor turtle. DARTs activities are designed to help learners understand instructions given by teachers. The DARTs activities are interactive with the learner (Gilham, 1986, p. 164ff; Davies & Green, 1984);

10. Finally, represent findings orally and in writing. Learners might use the boards, OHP or make a poster, video or worksheet to represent their findings.

In all this, however, a teacher makes possible learners' learning but cannot do the learning for them. Learners need to engage in their own learning activities (practically and mentally). The teacher's and tutor's role is to motivate the learners, explaining the purpose of the task and providing the elements required for active learning. Active learning is also purposeful interaction with subjects, ideas, concepts and phenomena. This interaction take place with other learners. Active learning also promotes monitoring of the learner during the learning process and supports high level thinking and learning. Ahmed (1987) asserts that mathematics should be the kind of learning which requires a minimum of factual knowledge and a great deal of experience in dealing with situations using particular kinds of thinking skills. In active learning, the most important role is the teacher's role and the tutor's role. They need to prepare and organize the active learning environment to serve the learners' needs. Clear instruction should be provided and purposes explained to the learners.

In a teacher training programme, active learning gives an opportunity for trainees to actively participate in their own education for the real world of the classrooms, school, teaching and learning. For teacher trainees, some sample episodes - the researcher's term - may be prepared by the tutor. For example, the tutor introduces the topic, they use brainstorming, and they divide into groups, they discuss, investigate, write down and represent their findings orally and in writing. Each episode gives a different perspective to the topic. Each episode introduces different problems which trainees may come across. Each episode provides some points to think about. Problems may not have one single answer; there may be many possible answers and solutions. These answers and solutions will depend on the analysis used to understand the problem. At the end of each episode, teacher trainees
discuss the situations and make some comments on them. The argumentative process is the essence of the episode in active learning. This experience can be both frustrating and stimulating. Episodes that are real examples or stories of practising teacher trainees are used in the university sessions. Each tries to capture an event or experience that was particularly significant or memorable in a teaching and learning environment. Since the episodes are true stories, for privacy reasons the names of all individuals, and learners and of all actual places are disguised. Active learning via episodes provides a basis for developing teaching and learning skills and for continuing to use them during one’s teaching career.

Challenges for Tutors:

In this present study, the researcher uncovered a number of significant issues which present challenges for tutors in reconciling the demands of the National Curriculum and trainees’ and pupils’ needs. Difficulties are often encountered by tutors in identifying strategies for promoting planning, assessment, equal opportunities, cross-curricular links, and so on. Some steps -methods of teaching and learning adopted by the tutor- were considered relevant to preparing the episodes for each subject and topic. These were as follows:

1. Act as a role-model for trainees;
2. Select episodes and subjects according to the National Curriculum and professional development topics;
3. Gain trainees attention;
4. Brainstorming;
5. Decide what trainees know about the topic;
6. Find out their right level of thinking;
7. Motivate and interest trainees to take part in their own learning (mentally and practically);
8. Give them responsibility in terms of ownership and control;
9. Define clearly the aim of the lesson, course or topics;
10. Make links with previous lessons and other National Curriculum topics and subjects;
11. Prepare reading, and give them references to related literature;
12. Analyze the episode, and divide the episode into sub sections;
13. Re-shape the seating arrangement of the class (the Leicester university tutor called this furniture business) and decide which teaching strategy is useful for this task;
14. Give directed, structured tasks to investigate the topics;
15. Develop topics, develop enrichment materials;
16. Decide appropriate teaching method according to aim, ability, and needs;
17. Decide appropriate teaching resources and materials;
18. Organize people according to aim of the lesson and for effective learning;
19. Encourage trainees to initiate discussion in groups;
20. Represent the findings and results orally or in writing in the university sessions or subsequent sessions.

Tutors should be aware that effective teaching in the training programme for trainees must include the following strategies:

- observing and analysing learning;
- planning, organising and managing a richly resourced learning environment;
- listening, responding and asking open-ended questions;
- facilitating, supporting and intervening;
- challenging and posing problems to solve;
- enthusing and building on trainees' intrinsic motivation;
- collaborating in activities initiated by trainees;
- reflecting and evaluating.

Research evidence consistently shows the importance of the learner being directly and actively involved in first hand experimental learning. It also shows how this leads to development of learner conceptual understanding (Vygotsky, 1986).

Because of the complexities of teaching and learning about teaching, various approaches to initial teacher training have evolved over the years. Initial teacher education programmes designed to ‘make’ reflective practitioners have been vigorously pursued in pre-service and in-service education (Loughran, 1996).

Reflection is an important human activity in which people recapture their experience, think about it, mull it over and evaluate it. It is this working with experience that is important in learning. The capacity to reflect is developed to different stages in different people and it may be this ability which characterizes those who learn effectively from experience (Boud, Keogh and Walker, 1985, p. 19).

In this connection, how might reflection be conceptualized and how might a teacher trainee become a reflective practitioner?

Reflection is a process that may be applied in puzzling situations to help the learners make better sense of the information at hand, and to enable the tutor or teacher to guide and direct learning in appropriate ways (Loughran, 1996). On the other hand, Goodchild (1992)
goes on to consider the importance of reflection and interpretation which he sees as a mechanism for making sense of the learning activity and for locating it in a wider framework of meaning and purpose. In this respect, the tutor’s role in university, and the trainee’s role and teacher’s role in the classroom are to ensure that there is time for such reflection, and to provide a mechanism to ensure that reflection occurs

... to help student teachers become more reflective about education, the atmosphere within seminars must be open and relaxed. It is difficult under the best of conditions for individuals to question their beliefs and to explore the implications of their actions. Challenging students to reflect upon their experiences and ideas must be done with sensitivity and respect for the individuals. If healthy dynamics are not established, challenging students to think may result in defensiveness, not insight (Goodchild,1992,pp.44-48).

The role of tutor in the seminar in PGCE sessions is very important if such purposes are to be fully realized. The tutor is a role model for trainees in a teacher training programme. Schon (1987) explored three conceptions of modelling (follow me, joint experimentation, and hall of mirrors) in the practicum. McKinnon (1996) started to uncover the influence of modelling on teacher trainees’ learning about, and development of, reflection. It is not surprising that, as in the case of seminars, journal writings, supervisory meetings, the influence of the tutor or co-tutor role model are crucial if teacher trainees are to develop their skills of reflection. Tutors in teacher education programmes introduce cooperative learning, group work, problem solving or many of a number of other interactive learning approaches according to the purpose of learning (Loughran,1996).

...student evaluations of the program point to the importance to them (trainees) of consistency between espoused pedagogical principles and actual behaviour by staff. This importance is shown by both positive comment on examples of consistency between espoused principle and actual practice, and negative comment, often detailed and perceptive, about examples of inconsistency (Gunstone et al,1993,p.54).

The characteristics previously analysed and combined with tutors in teacher education programmes who genuinely model reflective practice in their pedagogy, could place teacher trainees in a position whereby through the development of their skills in reflection, they could take more control of, and accept more responsibility for their learning about teaching (Loughran,1996). In this perspective, teacher trainees might develop a greater understanding of what it means to be a reflective practitioner through an active learning approach, and apply it to their own practice.
Active Learning' in teaching practice:

The move toward active learning has included demands that teacher trainees, tutors, and teachers should arrange for freedom, activity and discovery in pupils’ learning and understanding. Active learning is supported officially but not given the name active learning in OFSTED reports, and government Circulars.

From a review of British survey evidence, it is concluded that an active learning approach in mathematics, contrasted with other teaching methods such as whole class teaching, helps pupils to learn mathematics. The national standard in mathematics is a current concern in England (Askew et al, 1997). This arises from comparatively poor performance in this area, in relation to other countries and to international performance in mathematics (Askew et al, 1997; Robitaille & Garden, 1988; Lapointe, Mead & Askew, 1992; Bierhoff & Prais, 1995). Ofsted (1994) reported that:

At KS2 (Key Stage), mathematics is judged to be the weakest subject in the curriculum... Pupils’ understanding of mathematics is judged to be particularly weak in half of all schools... Immediate benefit would be seen if teachers’ confidence in their own mathematical competence could be improved (pp. 21-22).

Ofsted (1995) repeats similar points:

The foundation laid in KS1, however, was not consolidated. Too few KS2 pupils were able, for example, to recall their tables, compute with sufficient speed and accuracy, apply their knowledge in investigative work (pp. 16-17).

Whole Class Interactive Teaching in Active Learning:

Kyriacou (1992) identified seven widely used learning activities in secondary mathematics classrooms, based on data from 52 heads of mathematics departments. The choices were classified:

1. Traditional teaching: teacher explains/demonstrates a mathematical process or technique together with oral questioning of pupils to check understanding, followed by pupils undertaking written problems applying the process or technique.

2. Active learning activities:
   - Group discussion and collaboration during in which pupils are required to work in pairs or small groups on the task set;
   - Problem-solving or investigational task from which pupils derive mathematical knowledge and understanding;
   - Use of structured individualized programmes of work such as work cards or booklets;
• Practical simulations using pupils and/or materials to describe or represent mathematical knowledge or processes;
• A mathematical project based on an extended piece of work;
• Computer-based activities in mathematics.

As far as active learning in mathematics classroom is concerned, inspection evidence and the experiment of the National Numeracy Project emphasises successful teaching of mathematics using ‘whole class interactive teaching’ (DfEE, 1998) (see Appendix 1). There is support for this in the research literature, which also identifies the quality of the teaching as the key factor. Teaching the whole class does not mean that the teacher simply ‘lectures’ the class.

Summary:

Learning to teach and especially the first days and weeks of the trainee’s teaching are often accompanied by a mixture of enthusiasm, anxiety and apprehension. Not knowing how to respond to the differing demands and expectations of co-tutors, tutors, colleagues, classes of pupils can result in many new teachers having feelings of doubt and stress. This present study will confirm the conflicting expectations faced by beginning teachers. Although some studies have indicated the desire of new teachers to ‘do the right thing’, there is a parallel and deeper conflict and subsequent adjustment which newly qualified teachers may have to make as their own educational expectations and beliefs come up against the reality of the values and practices in schools. Culture shock in schools is undoubtedly felt by many beginning teachers and this impedes both thinking about and adopting alternative teaching methods and strategies such as an active learning approach. Despite the heart-searching and difficulties surrounding the use of a active learning approach, the tutor and the OFSTED inspector have suggested that reflecting on learning in the PGCE course is usually facilitated by the availability of skills profiles evidence developed through the stages of a teaching practice. This present study inevitably began in the context of a need to improve the appraisal of the skills of beginning mathematics teachers, within the framework of a PGCE secondary mathematics teacher education course. In the process, more has been achieved by engaging these beginning teachers in thinking about how to improve and understand their practice.

Trainees need to be cognitively, meta-cognitively and effectively active in their own teaching and learning process through identification, classification, formulation and restructuring of goals; use of planning and preparation; development and execution of plans; engagement in self monitoring; appropriate use of resources; development of classroom management strategies; reflection and evaluation. A focused active learning approach
helped in the adoption and transfer of their skills to practice in real classroom situations. In teaching teacher trainees to teach mathematics, the tutor acted as a role model for trainees and adopted an active learning approach to his own teaching. These conclusions will be elaborated upon and detailed in subsequent chapters.

It is clear that the use of stage theory applied to active learning in school-based teacher training has real potential. However, this present study has highlighted a number of implications for school based teacher training.

First, there are caveats concerning changes required in the concept of teacher trainee’ work. The teacher trainee needs to take more responsibility in teaching practice schools. The notion of school as a ‘learning community’ in which learning occurs at various levels will need to become widely accepted. The teacher trainees need to interact, challenge, and support each other. They also need to interact with tutor, co-tutor and other teachers in school. Second, there are implications for re-examining the nature of partnership between initial teacher training institutions and schools. Both institutions’ staff need to find time to work together. Third, there are implications for re-examining the nature of partnership between initial teacher training programmes for tutors such as Circular 4/98 (DfEE. 1998). In this sense, the research on teacher trainee’s learning to teach, illustrating the powerful images that teacher trainees bring with them to training programmes, is perhaps generalizable to all professional and subject development. Development programmes should seek to establish conceptions of active learning approaches in such a way that the unique combinations of challenge and support necessary to foster growth are realized in an active learning context.

The active learning model of teaching, with its emphasis on the continuing development of performance, intellectual processes and schemata, has pointed to some clearly defined complementary roles in teacher training and to the need for the training to be directed towards the compilation of a professional portfolio. The tutor’s role in using an active learning model is crucially important.

The literature review on ‘Learning to Teach’, ‘Stage Theory’ and ‘Active Learning Approach’ provide the theoretical underpinning for the present research. The next chapter describes and justifies the methodology adopted in the researcher’s particular circumstances.
CHAPTER 3

METHODODOLOGY

Grounded theory was used in this study, following the examination of literature on initial teacher education, culture (Britzman, 1986), cognition and pedagogy, as well as the researcher's own experience as a mathematics teacher and mathematics research assistant. Qualitative and quantitative methods were used to gather data. Quantitative methods were only used to gather data in the pilot study questionnaire and main questionnaires (both Turkish and English versions of the questionnaire). The general intention was to combine both quantitative and qualitative approaches to maximise illumination of the research issues whilst minimising the inherent limitations of particular data types. The table shows the relationship of qualitative and quantitative components in the overall design of this study (in the style of Miles & Huberman, 1994).

| Quantitative => Quantitative => Qualitative => Quantitative => Qualitative |
|-----------------------------|-----------------------------|-----------------------------|-----------------------------|
| questionnaire (pilot)  | questionnaire I  | interviews  | questionnaire II  | assignment II  |
| assignment I  | (England, Turkey)  | & files  | reports  | (OFSTED inspection)  |
| files  |  | observation  | observation  |

Table 3.1: links between qualitative and quantitative data in overall design.

The aim of using multiple methods of collection was to ensure that the weakness of any one method was minimised by the complementary strengths of contrasting methods. It also provided a triangulation to enhance claims for validity and reliability. Triangulation is a useful technique where research is engaged in case study, a particular example of 'complex phenomena' (Cohen & Manion, 1994, p. 241). Data triangulation (Figure 3.1) and method triangulation was used in this study (Denzin, 1978). It also prevents 'method boundedness' in which exclusive use of one method generates data which is merely a reflection of that method (Cohen & Manion, 1994, p. 270). The use of multiple methods provided a response to the research questions from different angles. The importance of triangulation, '...the use of two or more methods of data collection ...' (Cohen & Manion, 1994), is well documented in ethnographic work and data collection procedures could be planned to take account of this through data collected at different times, with trainees and tutors, and from written evidence, such as documents. What triangulation allows the researcher to do is to explore more fully the richness and complexity of the situation, attempting at the same time to use the
PS: School tutor was not used as a data source because opportunity to access the school tutor could not be obtained. In further research on this subject, school tutor views should be considered.

- GTTR: Graduate Teacher Training Registry

information gathered to help understand how particular events and pieces of information fit together and why these events and pieces of information are presented in this way.

One method of triangulation is respondent validation, where respondents are offered the researcher’s accounts and interpretations of what has taken place (see Figure 3.1). Whilst this method can provide constructive validation as well as the possibility of
additional data, it also has some limitations. In this research, trainees might well dispute interpretations put on data.

In summary, it has been argued that an appropriate research method for answering the researcher's questions is ethnography. Every research method has some advantages and disadvantages. The research methodology has been identified and associated concerns of validity have been explored. It has also been possible to identify strategies which would be used to develop the four (case study) ethnographies and the subsequent development of grounded theory.

RESEARCH DESIGN

The main study required a predominantly qualitative and small scale approach to explore the framework provided in the pilot study. The main study was structured to follow two different teacher training programmes in Turkey and England. An in-depth study was needed to explore the research questions. For this reason, the case study was conducted with four secondary mathematics teacher trainees on the Leicester University Secondary PGCE Mathematics course.

The researcher had difficulties which arose because of the very small size of the sample in Leicester -one group- compared to the much larger groups in Turkey, and also because of the practical difficulties of collecting the data.

The research design was structured according to the research questions. (Table 3.2)
<table>
<thead>
<tr>
<th><strong>PILOT STUDY</strong></th>
<th><strong>MAIN STUDY</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Date</strong></td>
<td><strong>1997/1998</strong></td>
</tr>
<tr>
<td><strong>Population</strong></td>
<td><strong>Secondary Mathematics Trainees on two contrasting training programmes (Leicester PGCE and Balikesir BEd.) in England and Turkey.</strong></td>
</tr>
<tr>
<td>Secondary Mathematics Teacher Trainee PGCE course in England BEd course in Turkey</td>
<td>Whole sample of both training programmes</td>
</tr>
<tr>
<td><strong>Sample</strong></td>
<td><strong>Method</strong></td>
</tr>
<tr>
<td>Leicester Secondary Mathematics Teacher Trainee Cohort Balikesir Secondary Mathematics Teacher Training</td>
<td>Survey Contextual Survey in Turkey Contextual Survey in England In-depth Study (4 out of 12) in England</td>
</tr>
<tr>
<td><strong>Instruments</strong></td>
<td><strong>Observation</strong> (in class and PGCE maths sessions) Video recording Documents <strong>For each trainee:</strong> Interviews: <strong>For university tutor:</strong> Observation tutor’s sessions Interview Questionnaire for trainee</td>
</tr>
<tr>
<td>Pilot Questionnaire English (PQE) Pilot Questionnaire Turkish (PQT) Questionnaire (Turkish version) Observation Admission details Photographs Lesson plans and evaluation sheet (for trainee and inspector) Questionnaire I&amp;II Course documents Trainees’ files GTTR data Uni.Ass I&amp;II* Career development files Inspector’s report</td>
<td>N (PQE): n=12 (PQT): n=38 N=57 (Turkey) N=12 (England) (8 female, 4 male) n=4 for case study sample (3 female, 1 male)</td>
</tr>
</tbody>
</table>

*University Assignment I and II*
CASE STUDIES:

Hammersley & Atkinson (1983), Burgess (1984a,b, 1986), Schatzman & Strauss (1973) influenced this research design.

This research was an exploratory case study which was aimed at defining the researcher's research questions (Yin, 1993, p.5). However, Yin (1989) asserts that the case study method can be quantitative or qualitative, but in this research, both methods were used together. Selecting the cases to be studied is one of the most difficult steps in case study research (Yin, 1993, p.8).

This research forms part of the mainstream of qualitative research in the sociology of education with a focus on natural settings: a secondary PGCE mathematics course located at one university and a group of secondary schools. It concerns perspectives and understanding of people, an emphasis on social process and an inductive attempt to generate analysis. When the researcher began to adopt an ethnographic approach, the researcher was particularly influenced by the field-guides of Schatzman & Strauss (1973), Burgess (1984a,b), and the arguments for the research presented by Hammersley and Atkinson (1983) & Pollard (1985, 1996). With this background, the researcher adopted a classic case-study approach, with its associated strategies of observing, participating, developing personal rapport, collecting school files, GTTR forms, Career Development Files, university assignments I and II, conducting interviews, questionnaire I and II, and attending trainees' tutorials as a means of trying to understand their perspectives, attitudes, and responses. Of course, the results of such an approach are highly susceptible to specific factors such as the nature of the sample itself, the range and validity of the data which are collected and the analytical procedures which are employed to build an interpretation. However, a case study is more than just an extended example or an anecdote interestingly narrated, it is systematically gathered evidence and is concerned essentially with interaction of factors and events (Nisbet, and Watt, 1978).

Case study method is used to define topics broadly, cover contextual conditions (and not just the phenomenon of study), and rely on multiple sources of evidence (Yin, 1993, p.xi), but methodological advances are still desired (Yin, 1993, p.xii).

Documents considered as primary sources include manuscripts, charters, laws, memories, biography, official publications, wills, newspapers and magazines, log books and research reports. (p.50)...documents in education often consist of unpublished materials and events (Cohen & Manion, 1994, p.50-51.).
SAMPLING:

‘Sampling is crucial for later analysis’ (Miles & Huberman, 1994, p. 27). An opportunistic sample was used in the case studies. Trainees’ age, gender, mathematics background, work experience and opportunities for teaching of algebra and data handling in teaching practice were considered in choosing the case study sample.

In both countries, the samples were selected to serve the researcher’s aim (Cohen & Manion, 1994, p. 89).

The reasons for choosing the secondary mathematics teacher trainees were as follows:

1. They had already left the school and they could look at their school life more objectively from a certain distance, in comparison with pupils.
2. They had fresher memories of their school life in comparison with teachers who usually had been teaching for years.
3. They were in a special position in that they were studying theories in a university as students and would soon be practising in schools as teachers. This could offer the researcher an opportunity to explore the development of their views on particular approaches in comparison with both teachers and pupils.
4. The teacher trainees were readily available in the university. This was very convenient for distributing questionnaires and conducting interviews.

This research focused on teaching algebra and data handling which were both National Curriculum topics, part of the teaching teacher training programme and evident in schools. The reasons for choosing algebra and data handling were as follows:

- These topics appear in both teacher training programmes.
- Teaching algebra and data handling are two contrasting subjects: algebra is still taught using traditional methods which are the same as a century ago. On the other hand, data handling is a new topic introduced in the last two decades and taught using a variety of methods.
- Teacher trainees experience both topics in the teacher training course and apply their learning in school.
- University assignment II includes these topics with a focus on teaching experience, background readings and their reflections on the school.
- Literature shows that pupils find algebra difficult and they do not perceive the relevance of algebra for careers.
Table 3.3 shows the theoretical sample frame constructed from dimensions expected to have some significance as follows: institution; age and work experience; mathematical background; gender; subjects taught.

Table 3.3: Theoretical Sample Frame for case study

<table>
<thead>
<tr>
<th></th>
<th>MALE</th>
<th>FEMALE</th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td>Linda Hackett</td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>(age: 43)</td>
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MAIN CHARACTERISTICS OF THE TWO PROGRAMMES:

Institutions and the sample

The aim in contrasting two secondary mathematics teacher training programmes was to find out similarities and differences between two different cohorts and how trainees learn to teach in different institutions in both countries.

Contextual Variables:

• Age, work and experience:

Age is considered as a significant factor in learning to teach and learning to teach mathematics. Booth (1993) asserted that trainees who had previous work experience might have contrasting needs and approaches to learning to teach from those of the recent graduate. The majority of Balikesir teacher trainees came directly from secondary school to the teacher training programme which takes four years and hardly any work experience. But the Leicester PGCE trainees showed a variety of age ranges and work experience compared with those of the Balikesir teacher trainees.

In literature, a small number of studies have examined the effect of age and gender on approaches to learning to teach. Richardson (1996) compared the approaches taken by mature and non-mature teacher trainees. He found statistically significant correlations between age and scores. This study aimed to examine the effects of trainees’ age on learning to teach using the active learning approach in both institutions.

• Mathematics background:

Trainees’ mathematical background affects their beliefs (McDiarmid, 1990), attitudes and confidence. In this research, trainees’ background of mathematics was also considered as a significant factor in learning to teach mathematics. (Grossman et al, 1989;
Selection of trainees:

In England:

The Graduate Teacher Training Registry (GTTR) forms were collected as a research instrument for this study in England. The GTTR is a central agency which acts on behalf of universities, colleges of higher education and certain groups of schools in England and Wales to process applications for entry to their pre-service Postgraduate Certificate in Education (PGCE) courses. These courses are sometimes known as Graduate Certificates in Education (Guide for Applicants: 1998 Course Entry (1997)). The schemes provide a framework within which the applications process takes place. The GTTR computer records all the details of the progress of an application. A confidential reference is obtained and an application form is sent to the GTTR. The GTTR records details of the application on the computer file and a reduced size copy of the form is sent to the first institution listed on the form, provided that it still has vacancies for the named course. The institution considers the application and decides whether to call for interview. The outcome of the interview is communicated through the GTTR. Referral to a second or subsequent choice means the application has been unsuccessful at the preferred choices. Requirements in Secondary Mathematics PGCE are given in Appendix 2.

In Turkey:

Higher education is provided by the government after secondary school. A small tuition fee is levied. Scholarships are provided for the academically successful but economically disadvantaged students. Entrance to higher education institutions is governed by the centralised two step University Entrance Examination. Successful candidates have a seat in the teacher education programme.

FIELDWORK AND RESEARCH INSTRUMENTS:

In the main study, questionnaire I&II and tutor's questionnaire, observation (trainee's session in school and PGCE course; tutor's session), interview (with case study participants and tutor), school files, GTTR forms, Career Development Profile, University
Assignment I&II and an inspection report were all used as research instruments (see Table 3.4).

**Table 3.4: Chronology of Fieldwork 1997/1998**

<table>
<thead>
<tr>
<th>DATE</th>
<th>DATA COLLECTION</th>
<th>SOURCE</th>
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<tr>
<td>June 1997</td>
<td>Pilot questionnaire</td>
<td>Leicester in England</td>
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| December 1997 | Pilot questionnaire  
Questionnaire I  
Collect school file for first term  
Admission details  
Observation trainee and sec. math*  
Secondary maths course details | Balikesir in Turkey, n=38  
Leicester in England, n=12  
documents (Leicester trainees)  
GTTR forms (Leicester trainees)  
documents (Leicester trainees)  
documents (Leicester trainees)  |
| January 1998 | Interview with Linda Hackett and Claire O’Neill  
Observation trainee and sec. Math* | documents (Leicester trainee) |
| April 1998  | Interview with Scott Holligan  
Observation trainee and sec. math*  
Questionnaire for Turkish version  
Observation **  
Inspector’s evaluation sheet | documents (Leicester trainees)  
n=57 (Balikesir trainees)  
documents (Balikesir trainees)  
document (Balikesir trainees)  |
| May 1998    | Interview with Catherine Penn  
Observation trainee and sec. Math* | document (Leicester trainee) |
| June 1998   | Questionnaire II (24 June)  
University Assignments I&II  
School file II  
Observation trainee and sec. math***  
Interview with tutor (Dr. Mike Price, 29 June)  
Career development file  
Inspection report | n=12 (Leicester trainee)  
document (Leicester trainee)  
document (Leicester trainee)  
(document (Leicester course tutor))  
document (Leicester trainee)  
document (Leicester trainee)  |

*Observation in secondary mathematics sessions in PGCE and teaching practice.

** Secondary Mathematics Sessions were observed. Secondary school teachers who have 30 years, 13 years and 3 years' experience were also observed in secondary schools in Balikesir in Turkey.

*** Observation of both secondary mathematics sessions including master class sessions and teaching practice

The researcher used triangulation to combine methods. Threats to validity can also be addressed through triangulation Hammersley & Atkinson (1983).
### Table 3.5: Data collection methods in previous researches

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</table>

* indicates present study; ✓ shows methods which were used in the present study by the researcher.

In Turkey, questionnaire, naturalistic observation and photographs were used as research instruments. Trainees' lesson plans and evaluation sheets of inspectors and tutors were collected. The reason for just using these methods is that there was not enough time to
collect the same kind and range of data in Turkey. GTTR forms, career development profiles, and university assignments do not exist in teacher training institutions in Turkey. Research on the social context of mathematics education is extremely limited in quantity and according to Bishop & Nickson (1983): 'Many of our conclusions are based upon surveys, analyses and extrapolations from results of research not carried out with specific reference to mathematics' (p.67). Bennett (1984, 1993, 1995) also expressed concern at the lack of research when he said that '... in all arguments about teaching methods, innovation is being urged without research' (p.9). Not only is there a need for innovative research but also a need for replications of studies already carried out, because Entwistle (1981) pointed out that 'given the weakness in social science data, and the problems in drawing inferences from them, it is important not to rely on the results of a single study or even a single research approach (p30.)'. Reviews of the last ten years' of literature show that researchers used a variety of approaches to collect data (Table 3.5). The researcher's data collections methods are given in the last column of the Table 3.5.

**QUESTIONNAIRE:**

As many researchers have indicated, each method has its strengths and weaknesses. Comparative studies mostly used questionnaires (Wubbels & Korthagen, 1990; Calderhead & Shorrock, 1997). The questionnaire was chosen as the research instrument for gathering information in terms of its strength, as indicated as below:

1. It allows one to obtain information from 57 Balikesir Mathematics Teacher trainees in Turkey and 12 Leicester Mathematics trainees in England in one session.
2. It can get a lot of information in a quick and cheap way.
3. It allows information comparisons between institutions and individuals.
4. The results allow generalisations to be applied to the larger population, if the survey sample is representative of its population: sample of Balikesir to all Turkish Mathematics Teacher Training Programmes and Leicester Mathematics Teacher Training to all English Mathematics Teacher Training Programme.

Potential weaknesses to try to minimise are:

- **Face value:** the responses to each question or statement can be scaled clearly, but it is difficult to interpret responses and the dispositions towards each question or statement which will have to remain unknown.
- **Limitation of the alternative framework:** it does not provide the opportunity for the respondents to offer their own views beyond the written questions or...
statements. For this reason, two open-ended questions were included and the researcher wanted respondents to write any relevant comment.

- Non-response rate: in this study, this problem was overcome because of the opportunistic sample. The response rate was 100% in both countries.

Clear instructions guide respondents and invite participation, whereas complicated instructions and complex proceedings intimidate respondents (Cohen & Manion, 1994, p. 96). A short covering letter was used to indicate the aim of the survey to convey to respondents its importance, to assure them of confidentiality and to encourage their replies (Cohen & Manion, 1994, p. 97-98). The end of the questionnaire thanked respondents for their participation and a direct reference was made to confidentiality of respondents' answers (Cohen & Manion, 1994, p. 97) (Appendix 3).

The questionnaire which was conducted in Turkey had some advantages: it was easy to administer, quick to fill in, easy to follow up and analyse. However, preparatory translation for the Turkish sample was actually time consuming. Some questions needed to be explored in depth. The advantage of the questionnaire was being able to get more reliable answers from respondents. As it was anonymous, it encouraged greater honesty and it was more economical than the interview in terms of time and money.

A disadvantage of the questionnaire was that respondents might produce answers for the statements on the questionnaire too easily and without reflection. To eliminate this disadvantage, methods and data triangulation were used to get the right answer from respondents. The questionnaire's appearance, simplicity of design and clarity of wording were all considered for both questionnaires (English and Turkish versions) (Cohen & Manion, 1994). The questionnaire also had disadvantages such as the respondent being unable to question any misunderstandings and some questions had different meanings for different people (Cohen & Manion, 1994, p. 283) from different countries.

The questionnaire provided background information on:

- the trainees' secondary mathematics backgrounds;
- the trainees' university mathematics backgrounds;
- the trainees' experience of mathematics sessions in the PGCE course in England and in the BEd in Turkey;
- the trainees' experience of other PGCE professional development sessions;
- the trainees' teaching styles;
- the trainees' organization and planning for mathematics teaching;
- the trainees' knowledge and beliefs about algebra and data handling;
• the trainees' teaching and learning algebra and data handling experiences;
• the trainees' backgrounds of teaching practice in secondary and primary schools;
• materials and resources which were used by trainees and their teachers to teach
algebra and data handling.

The questionnaire is divided into four sections (Appendix 3). The first section
included background information on the trainees: me and mathematics; me and mathematics
teaching; me and my students; and me and my PGCE course. Trainees read through the
statements in the questionnaire and indicated the extent to which they agreed or disagreed;
or rated in importance (five point scale) each statement, by ticking in the appropriate box.
Trainees ticked just one box only, or if really undecided, they used the neutral box and there
were no right or wrong answers. A few items in the questionnaire required trainees to rank
in order the frequency with which they used each grouping and strategy. The questionnaire
had one open-ended question.

The questionnaire was piloted and administered twice in the Leicester sample: after
the first teaching practice and after the last teaching practice. Questionnaire I was conducted
on the last day of the first term and Questionnaire II was conducted on the last day of the
last term of their course. Every trainee participated.

After collection, each questionnaire needed coding. Coding of the items was built
into the construction of the questionnaire itself. Pre-coding was appropriate for closed-ended
questions -for example male 1, female 0 (Cohen&Manion, 1994,p.102). The questionnaire
also had ranking items. A ranking response is one in which a respondent is required to rank
in order a series of words, phrases or statements according to a particular criterion
(Cohen&Manion, 1994,p.280). Ranked data can be analysed by adding up the rank of each
response across the respondents, thus resulting in an overall rank order of alternations.

The Translation of the Instrument (questionnaire) into Turkish:

The questionnaire was translated into Turkish by 3 doctoral students (see Appendix
4); one was a linguistics student, one was an educational doctorate student and the third one
was an economics doctorate student at Leicester University; and a fourth student was post-
doctorate who had studied in America. All were proficient in both Turkish and English.

All translations were collected and discussed to decide upon the most appropriate
draft. The people involved were: two Turkish Mathematics lecturers, one of them teaching
at the Aegean University in Izmir, Turkey, the other teaching at the Balikesir University in
Balikesir, Turkey; and four Turkish Secondary mathematics teachers, who are currently
teaching maths in Balikesir, Turkey. Two of these secondary mathematics teachers are
currently teaching maths in the Anatolian High School and the other two currently teaching mathematics in mainstream schools in Balikesir. All these people helped to construct a suitable Turkish version of the English questionnaire and final corrections were made to the agreed version.

The purpose of doing these translations was to ensure that the wording of the items in Turkish was equivalent to the original meaning of the items in English. The translated Turkish versions of the questionnaire were to be given to mathematics teacher trainees who were in the last year of their education in Balikesir University in Turkey on 26 December 1997.

**Adaptation of the Instrument/s for the Turkish Sample.**

Since the questionnaire was developed with respect to English culture, it needed to be adapted to Turkish culture. As far as measuring the psychological construct was concerned, it was expected that some items would be valid across different cultures while others might be valid only for specific ones. Each item was examined concerning its adequacy for Turkish culture. However, the small amount of literature which was available then, did not give a clear verdict on the cross-cultural applicability of the instruments available. In summary, there is a fundamental distinction between "meaning" and in translation which manifests itself across Western and Eastern cultural divides, and different cultures may interpret things in different ways. As a result of this examination, it was agreed that no major change was needed to the questionnaire, for it to be meaningful when translated into Turkish. However, some items of the questionnaire were not suitable for Turkish culture and therefore needed some alteration or change. Translation of algebra and data handling was another problem. Maths handbooks and textbooks were examined to find out what algebra and data handling are called in the Turkish Language. This problem was discussed with other mathematician colleagues who work at universities in Turkey. As a result of this examination and discussion, algebra was translated as arithmetic, numbers, sequences and equations (simultaneous, quadratic, etc.). Data handling was translated as probability, statistics and data collection. At the end of the translation procedures, questionnaires were sent to Turkey for piloting. After piloting, a few items were changed because of misunderstandings. For example, whole class teaching means mainly teacher exposition, but teacher trainees thought it might mean interactive teaching with the pupil actively participating in their learning. In December 1997, the questionnaire survey was conducted and the questionnaire's return rate was 100% in Turkey.
Reliability and validity of questionnaire and observation were established on the following grounds:

1. The reliability of the questionnaires was investigated using Cronbach reliability coefficient (Cronbach was found 0.82 for QI; 0.86 for QII and 0.79 for TurkishQ). Guilford (1952) argued that a test is internally consistent when the value of the reliability coefficient is around 0.7.

2. Both the choice of instruments of observation and questionnaire arose from studies of other teacher trainees, enhancing face validity and from a careful survey of relevant literature (Table3.5). This provides concurrent and construct validity because the constructs are demonstrably related to existing empirical and theoretical knowledge.

3. Steps were taken to establish the validity of the qualitative data by
   - cross referencing and comparing observations to other sources and cases
   - identifying deviant cases.

4. Research findings were reproducible in several ways:
   - some findings from the pilot study where replicated in the principal study from a different population with the same general characteristics.
   - agreement was found over multiple rounds rather than a single round, of data gathering.
   - emergent hypotheses were tested
   - findings were made across multiple cases, in a range of settings and over time.

These parallel findings across data sources provide evidence of high external reliability.

In conclusion, all data gathering methods produce generally converging conclusions that have internal coherence and are linked to external theoretical and empirical ideas. The use of a theoretical sample makes the results broadly applicable but further work is needed to examine the extent to which any of the results would generalize to other teacher trainees in different teacher training programmes in Turkey. On this basis, the results which are reported are claimed to be both reliable and valid in this study.

• INTERVIEWS:

Teacher trainee interviews were used in England to follow up the questionnaire data, involving two trainees at the end of their first term, and two in their second term. The aim was to get in-depth data about their attitudes and beliefs about learning to teach mathematics in secondary schools. Questionnaire and written documents were supported by interview and observation. All interviews were semi-structured, based on protocols that
were developed, piloted and recorded on audio-tape. All interviews were transcribed and revised with the supervisor. However, 'the structure was one in which the content and procedures were organized in advance' (Cohen & Manion, 1994, p. 273); semi-structured interviews served the same purpose. In the usual in-depth interview, one could urge informants to reminisce on their experiences (Merton & Kendal, 1946 in Cohen & Manion, 1994, p. 274).

In the semi-structured interview, the researcher wants to explore, to clarify some items using probes such as: 'Could you explain...?', '... like what or such as?' The best way to understand the trainees is in their own words (Taylor and Bogdan, 1984). This method was more efficient than open-ended questioning and more flexible than structured questioning. Interviews which were used in case studies may be termed autobiographical interviews. The aim was to understand a trainee's beliefs, attitudes and views of mathematics and mathematics teaching. The interviews were designed hierarchically (Tomlinson, 1989): their route to teaching; their secondary school years (teaching and learning at this time; good or bad experiences and implication today); algebra and data handling lessons while in secondary schools (teaching methods, materials, ...); their teaching and learning while they were in undergraduate education; reason for choosing PGCE and responses to sessions on the course; their anxieties and weaknesses; teaching aspirations; and exploring some questionnaire items (see Appendix 5).

At the end of each interview, the researcher asked the interviewee to tick a form naming items which were helpful or unhelpful in their teaching. The aim here was to allow the interviewee to choose between two alternatives. The most frequently used was the dichotomous item which offers two alternatives: helpful to their teaching and unhelpful to their teaching (Kerlner, 1970 in Cohen & Manion, 1994, p. 276). It gives greater reliability (Kerlner, 1970) by making the respondents answer in a manner fitting the response category; and is more easily coded.

One difficulty in conducting interviews was finding an appropriate time with the trainee. Transcribing interviews was also very time-consuming, 'but crucial if the data is to be useful for later reference and analysis in conjunction with other data on the same topic' (Saran, 1995, p. 226).

**UNIVERSITY TUTOR INTERVIEW:**

The university tutor interview provided a different perspective from other data sources. The tutor, Dr. Mike Price, was interviewed to get the university view about trainees learning to teach mathematics; trainees' mathematical knowledge; their education in the ways of teaching and learning; planning and organisation of the course; PGCE course
sessions; and general issues. Semi-structured interview was used to get data both for teacher trainees and tutor. The tutor provided an ‘idealistic’ view of the training course, to check inferences and evidence. The semi-structured university tutor interview produced data at different levels of generality, including:

- details about the teacher training course and policy;
- details about acceptance of each trainee on the course;
- idealistic views of initial teacher training;
- further details about trainees and their development during the course;
- details about teaching and learning methods used by the tutor at the university;
- details about pedagogical and mathematical content knowledge;
- details about each trainee’s awareness and weaknesses.

In each case a standard presentation was adopted stressing that the questions gave an indication of the things the researcher was particularly interested in, but inviting the inclusion of other ideas which the tutor felt relevant.

Trainees’ interviews took place in January, April and May. The tutor-interview was conducted in June.

- OBSERVATIONS:

  Learning to teach is a large and complex affair. Furlong & Maynard (1995) asserted that learning to teach is a very ‘public’ affair: students’ successes and failures are visible to a great many different people—teachers, tutors and pupils.

  Trainees were influenced in learning to teach through a variety of sources but some of them were more important than others. The most important influences were teaching experiences in the Mode A and Mode B schools, the university course and trainees’ backgrounds. Teaching experience took a number of forms, depending upon its stage in the training course and the expectations of college and school. Teaching experience could take many forms, including:

  - observing and working with teachers at work
  - observing pupils in the lesson;
  - classroom practice;
  - taking responsibility for teaching a specific subject at certain times in a week;
  - taking responsibility for teaching national curriculum topics in mathematics and cross curricular studies.
In this research, naturalistic observations were used as a research instrument, providing evidence of interaction between views, actions, experiences and real situations. Events (during PGCE sessions and in teaching practice), trainees’ discussions with tutor or pupils, and their questioning, were also observed in real settings. Observation data was gathered from PGCE mathematics sessions in the university and trainees’ teaching practice classrooms via field notes. Field notes, as recommended for use in the research by Lofland (1971) and actually undertaken by King (1979) and Walcott (1973), were gathered (in Cohen&Manion (1994),p.112). Critical events were noted. All documents which were used for teaching in a class were collected at the end of each observation. Data collection and analysis were interactive. Data collection via field notes included:

- class management and control strategies;
- teaching styles and methods- including active learning approach, intervention strategies, questioning styles, responses, explanations, checking pupils’ understanding;
- learning opportunities :materials for teaching, resources for teaching, variety of activities, range of tasks, expected outcomes;
- interaction with pupils.

In the case study, the researcher was observing the characteristics of the PGCE Secondary Mathematics Course. The purpose of such observation was to probe deeply and to analyse intensively the multi-various phenomena that constitute the whole course, with a view to establishing generalisations (Cohen& Manion,1994,pp.106-107).

Naturalistic observation was used as a research tool to gather information in both countries. The aim of the classroom observation was to provide real, shared events as a focus for discussion about trainees’ learning and teaching, interpretations of learning to teach, perceived influences on learning; and methods and strategies used in teaching mathematics. The researcher obtained copies of documentation for each observed session. During the observation, the researcher took notes of incidents. What led up to this? What were you thinking of? Where did the idea came from? Why did you decide or say or do a particular thing? Another aim was to find out trainees’ interpretations of learning and knowledge and their use in practice.

**Observation in England:**

For every session of the algebra and data handling, a time was agreed with each trainee and tutor, the researcher observed and took notes and collected lesson documents for the mathematics teaching. It was stressed throughout that no change to existing practice was
required, as the researcher’s intention was simply to record and describe what normally took place in the algebra and data handling sessions. Data collected were of two kinds:

i. Trainee-trainee and trainee-tutor interactions were noted through the teaching period in PGCE sessions; trainee-pupil interactions were noted in the trainees’ teaching practice classroom.

ii. As field notes accumulated in the project, a more standardised format was generated. This included a plan of the seating arrangement of the secondary mathematics teaching room and teaching practice classrooms, showing the main activities and area, with a section describing lesson and task segments observed, trainees grouping, lesson and topics content involved, mathematical ‘displays’ observed and any additional comments.

The researcher wrote to the schools in which the trainee was teaching to get permission for making observations. The schools accepted the observation of their classes and pupils, and the researcher started to observe in secondary schools. The observation took place in algebra and data handling sessions of the trainees and tutors (Appendix 6.2).

Trainees’ algebra and data handling sessions were observed during PGCE mathematics sessions and teaching practice. The timing of classroom observations was settled by trainees’ timetables in teaching practice.

<table>
<thead>
<tr>
<th>Table 3.6: Observation in England</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Observing algebra and data handling sessions</strong></td>
</tr>
<tr>
<td>E</td>
</tr>
<tr>
<td>N</td>
</tr>
<tr>
<td>G</td>
</tr>
<tr>
<td>A</td>
</tr>
<tr>
<td>N</td>
</tr>
<tr>
<td>D</td>
</tr>
</tbody>
</table>

- **Observation in Turkey:**

The researcher also used naturalistic observation in Turkey (see Appendix 6.1). Three mathematics teachers and three mathematics trainees were observed in different schools in Balikesir, Turkey (see appendix 7). Three teaching practice schools were chosen for observation. All observation took place in April 1998. Observation time was very limited in April because Turkey has 10 days religious holiday (4-12 April) and two days public
holiday, (23-24 April) during April, but the researcher had no chance to go and collect data from there again.

Table 3.7: Observation in Turkey

<table>
<thead>
<tr>
<th>Observing Teachers and Trainees in Secondary Mathematics Lessons</th>
<th>Collecting Documents</th>
</tr>
</thead>
<tbody>
<tr>
<td>T -30 year experience of teaching</td>
<td>-Teacher’s lesson plans</td>
</tr>
<tr>
<td>U -mathematics teacher trainee</td>
<td>-Trainee’s lesson plans</td>
</tr>
<tr>
<td>R -13 year experience of teaching</td>
<td>-Evaluation sheets for trainee</td>
</tr>
<tr>
<td>K -mathematics teacher trainee</td>
<td>-Evaluation sheets for trainee</td>
</tr>
<tr>
<td>E -3 year experience of teaching</td>
<td>-Evaluation sheets for teacher</td>
</tr>
</tbody>
</table>

Documentary evidence

Leicester trainees are required to keep School files and write two University Assignments. For University Assignment I, trainees should seek the advice of their co-tutor regarding the choice of relevant aspects upon which to focus throughout their block attachment. In the report, trainees produce self-evaluations and individual action plans. University Assignment II includes a critical essay on the teaching of a specific mathematical topic within Key Stage 3 and 4. This assignment shows a trainee’s development in Standards Area A- Subject knowledge and understanding -with particular reference to the following aspects applied to one mathematical topic (University of Leicester, 1998a,b, pp. 17-21) (see Appendix 8). During the PGCE, teacher trainees keep a School File. The school file provides a major source of evidence for teacher trainees’ competence in organizing their materials, planning (long, medium and short term), developing and using resources, record keeping and evaluation of their lessons. Planning and preparation for teaching are essential (see also Appendix 9). Planning is the process of thinking, consultation and developing ideas that lead to the production of plans which act as a guide for lessons. Although this does not guarantee perfect lessons, it can greatly help trainees to avoid disasters and to feel more confident about their own ability, particularly when they are under pressure in the classroom. Planning can be of three kinds: long-term, medium-term and short-term (see Appendix 9).

In planning, resources play an important role. Each lesson plan should not only indicate the resources required but, in the early stages of teaching experience, give specific information about their whereabouts and accessibility. It is advisable not leave anything to chance. Lesson plans may include some open-ended tasks for more able students. Previous lesson plans should have links to the lesson which follows.
All records of written evaluations are kept in the School File. Co-tutors scrutinise the School Files and start to complete Evidence Record Forms before the University Moderation Visit in the Autumn Term. Files continue to be monitored and further relevant evidence of progress is recorded on the forms. School Files also include background reading, preparation, notes on development of personal competencies, action plans, cooperation on the work with other trainees, trailing and classroom evaluation and work/materials produced for the schools, discussion with the co-tutor and possible links with other staff, pupils and schools.

The trainee has to be competent in many areas, including organisation of teaching and learning activities, time management, class management, evaluation of own and pupil's progress and learning. However, without effective lesson preparation and planning, high quality teaching-learning will be hard work and pupils will never make the progress of which they are capable.

Lesson plans of Leicester Trainees:
The aim of planning lessons is to provide a framework for:

- organising time, sub-subjects, class situation, resources;
- organising teaching methods and materials ready for the lesson;
- following patterns of learning with which the class are familiar;
- spending time introducing the lesson carefully, checking that the trainee has clarified his/her expectations and providing work appropriate to the pupil's ability and understanding;
- collecting documents about pupils' progress and their written work;
- allowing for flexibility to go in different directions if a trainee's plan isn't working;
- analysing the learning process and reflections upon ways to improve trainee's teaching.
- taking responsibility as a class teacher.

Lesson plans of Turkish Trainees:
Teacher trainees prepare lesson plans which include sections such as: beginning of the lesson; core of the lesson; end of the lesson; teaching material; teaching method.

The trainees’ lesson plans are very detailed and even include the opening sentences and closing sentences of their lesson. One or two of the trainees’ plans are checked by the tutor and co-tutor.
Lesson evaluations:

In England, unlike Turkey, these are written reflections about the lesson and personal progress in teaching (see Appendix 10). Trainees write about weaknesses and awareness about teaching the lesson and their own role as a teacher. They evaluate pupil learning and teaching organisation. They provide pointers for future teaching. Just as pupils learn, trainees are also learning about their own teaching. Teaching requires judgment, speed of thought, rapid responses and an understanding of the way in which pupils think and act. Some trainees tend to make rather woolly remarks in their lesson reviews such as, ‘This is a good lesson...’ but reviews should be more specific and pin-point aspects of the lesson which were noteworthy and where improvements might be possible or desirable in future lessons.

Master copies:

In England, these include examples of worksheets, activity sheets, schedules and supporting aids such as OHP (Over Head Projector) and transparencies. The OHP is very useful when the trainee has information for a whole class. OHPs allow trainees to compile lists or tables, show illustrations and project silhouettes. They are attractive to pupils and gain pupils’ attention, amongst other things. Using an OHP does not reduce preparation time, because of the need to write out notes and prepare transparencies for the machine. In Turkey, OHPs do not commonly exist in schools.

ACHIEVING COMPETENCE

In England over the last two decades, governments have taken an increasingly close interest in the quality of initial teacher training. Circular 9/92 (secondary), Circular 14/93 (primary), and Circular 4/98 (DfEE) were issued by the Department for Education between 1992 and 1998 (see Appendix 11).

The Teacher Training Agency (TTA) made proposals about a national curriculum for use in training teachers (TTA,1997), and Circular 4/98 (DfEE,1998a) were issued by the DfEE in which they stressed the importance of:

- subject knowledge and understanding;
- planning, teaching and class management;
- monitoring, assessment, recording, reporting and accountability;
- other professional requirements.

The TTA proposals emphasise the importance for Newly Qualified Teachers (NQTs) to have high expectations of their pupils and foster their enthusiasm and motivation. Furthermore, NQTs must be familiar with the Special Educational Needs Code of Practice
(DfE/Welsh Office, 1994), and have a sound knowledge of Information Technology (Circular 4/98). Secondary teachers will need to have acquired a thorough understanding of their specialist subjects and the associated concepts and skills, to degree level standard.

• THE CAREER ENTRY PROFILE (CEP)

The career entry profile was first introduced in 1997-1998 in England. The standards set out in the Career Entry Profile (CEP) replace the more general ‘competences’ set out in DfE Circulars 9/92 and 4/93 and DfEE Teaching Training Circular Letter 1/96. The standards apply to all trainees seeking Qualified Teacher Status (QTS) and who are to be assessed for QTS from May 1998. Successful completion by a trainee of a course or programme of ITT, including employment based provision, must require them to achieve all the QTS standards and courses must involve the assessment of all trainees against all the standards specified for the award of Qualified Teacher Status. Qualified teacher status is awarded after satisfactory completion of a course of Initial Teacher Training (ITT). The standards are set out under the following headings, as in the DfEE Circulars:

- knowledge and understanding;
- planning, teaching, and class management;
- monitoring, assessment, recording, reporting and accountability;
- other professional requirements.

Trainees' Career Entry Profiles forms were also collected as another source of data for this present study.

Gaining Access:

The researcher's supervisor gave an opportunity to conduct the research in the Leicester PGCE in England. The researcher worked as a research assistant in Balikesir University in Turkey before coming to England. This greatly helped in the conduct of research in Turkey.

All secondary trainees were firstly monitored to find out who might teach algebra and data handling in their teaching practice. A letter was written to them to get permission to use their files as research evidence. A letter was also written to school mathematics teachers (co-tutors) to get permission to observe their lessons and trainee lessons. The researcher also outlined her general research interests to the mathematics teacher trainees before conducting the questionnaires.

The questionnaires and trainees autobiographical interviews were administered in the usual secondary mathematics teaching room in Leicester. The tutor-interview took place in the tutor's office in the School of Education. All interviews were tape-recorded with the
trainees' and tutor's permission. After the interview, the researcher asked trainees to fill in a form about some unhelpful and helpful aspects of learning to teach.

Bureaucracy takes time and in Turkey it means a lot of paperwork, especially getting permission from the local Educational Ministry, City Council, and schools. Firstly, you have to write to the Authority to get permission for conducting a questionnaire study and making observations. Secondly, you have to wait for a reply to your letter for permission (normal procedure takes at least 15 days). If you get the permission from the Authority, you might have to contact the headteacher and you might also have to explain your purpose and find the teacher who is prepared to participate in your research. Most of them are very reluctant to take part. They do not want you involved in their lesson. It seems that subject teachers are uncomfortable about being observed. They think they are being inspected.

Ethics:

Ethics has been defined as:

a matter of principled sensitivity to the rights of others. Being ethical limits the choices we can make in the pursuit of truth. Ethics say that while truth is good, respect for human dignity is better, even if, in the extreme case, the respect of human nature leaves one ignorant of human nature (Cavan,1977, in Cohen&Manion (1994),p.359).

All participants agreed to participate and confidentiality and anonymity were considered in this research. The participants were free to answer the questions, but if they did not want to answer the questions, they did not.

Data collection and analysis

The researcher picked up a wide range of documents such as: files, evaluation reports, and all raw field notes and document summaries, which were coded (Miles&Huberman,1994,p.54) without being transformed into write-ups. The researcher coded the documents in the left margin, and it proved useful to put pre-analytical remarks of all sorts in the right margin (Miles&Huberman,1994).

All interviews were transcribed and then coded. University assignments, school files, and observation extracts were also coded. Each trainees' GTTR data, assignment extracts, school file extracts, observation extracts, interview extracts and questionnaire extracts (open-ended responses) were collected as a whole and a report was written for each individual trainee. Thus, information gained was used to refine questions and guide prior analysis, as advocated by Spradley (1979). Summaries, particularly in the form of
conceptually clustered cross-case matrices (as illustrated in Miles&Huberman, 1994, pp. 128-130), were used to discern connections across the data.

Time sequence was used for analysing school files and assignments (Miles & Huberman, 1994, p110) and cross case analysis used to enhance generalisability (Miles & Huberman, 1994; Denzin, 1983; Guba & Lincoln, 1981) and to deepen understanding and explanation.

In data analysis, content analysis was considered. Responses to open-ended questions, files, assignments and observations were analyzed through content analysis.

In addition to this, Questionnaires I and II, and the Turkish Questionnaire were analysed according to content analysis. All trainees' answers to the questionnaire items were classified according to negative and positive pole categories. If the code is 1 and 2, this item goes to the negative pole. If the code is 4 and 5, it goes to the positive pole. If the code is 3 it means it goes to either the negative or positive pole. All questionnaire items were analysed according to this procedure. The analysis was completed during the summer of 1998.

Methodological and practical issues:

The researcher came across a few difficulties during the research. While the researcher was conducting the research, the researcher worked alone in this area and did four case studies. Miles & Huberman (1994) acknowledged the time demands made by qualitative studies and calculated that the analysis of each day of fieldwork per case requires from 4-7 days if processing field notes, or from 6-12 days if transcribing. This takes no account of time needed for cross-case comparisons. The researcher was trying to collect valid data for each participant in both training programmes. For these reasons, the researcher spent public holidays in Turkey collecting Turkish data.

If the researcher had an opportunity to conduct this research in Turkey again, the methods of the study in England would be adopted. Proper comparison requires the same kind of case studies in Turkey, to find out the similar and dissimilar things in both teacher training programmes and in how trainees learn to teach mathematics.

The following strategies would be adopted:

1. Bureaucracy would be taken into greater consideration.

2. The letter getting the permission of schools and universities might be written at a very early stage of the research period.

3. The initial research was conducted in Balikesir University and Balikesir secondary school. It needs to be conducted in other universities in Turkey to get the whole picture in Turkey.
4. Besides questionnaire and observations, other methods might be used for the research. More observation and interview would provide a richer data source for teacher training.

5. Data collection times need to be longer.

6. The questionnaire might be conducted at the end of the last term to find out what kind of differences occurred between the beginning and end of the teaching practice.

7. For a big sample, reliability and validity should be considered.

8. Teacher trainees might be tracked for the following two years to notice the differences and how they move from novice to experienced teacher or beginning stage to reflective teaching stage.

9. Secondary maths teachers’ lessons need to be observed on more than two occasions.

10. Financial support is needed to conduct the research in other city secondary schools and universities and also to trace trainees in subsequent years.

11. Teacher trainees’ social, cultural and financial backgrounds also need to be taken into account.

RELIABILITY AND VALIDITY

Reliability and validity were important aspects of this research. Kitwood, (1977) asserts that a solution to the problem of validity and reliability might lie in the direction of a ‘judicious compromise’. However, reliability and validity become ‘redundant notions’, for every interpersonal situation may be said to be valid, as such, whether or not it conforms to expectation, whether or not it involves a high degree of communication and whether or not the participants emerge exhilarated or depressed.

Miles&Huberman (1994) suggested that if the research questions are clear, then the researcher’s role is explicitly described and parallelism is found across the data. Data is collected in appropriate settings, coding checks are made, data quality checks are made, and then the research is reliable.

Hargreaves (1985) points to the literature in terms of interpretational difficulties and adds as another difficulty, ‘...failing to note for instance, that what teachers say to researchers during a brief interview may differ from what they say to one another or even from what they puzzle about themselves’(Sharp&Green, in cited Hargreaves,1985, p.28). Thus, there were questions of validity related to the presence of the researcher (ecological validity); there were questions of validity relating to what the researcher noticed or recorded as significant (researcher validity); and there were questions relating to how the researcher
interpreted the data (construct validity). Ecological validity cannot be easily claimed since, however much trainees are reassured about confidentiality, there was likely to be a feeling that care must be taken to say only those things considered appropriate. However, a number of steps could nevertheless be taken to increase ecological validity:

- Lesson evaluations made by trainees, which were likely to include personal, and therefore sensitive, reflections could be handed in after the course had ended.
- Interviews could take place after the first teaching practice had been completed.
- The tutor interview could take place at the end of the academic term.

Furthermore, it can also be argued that ethnographic methods themselves limit the danger to ecological validity, since ethnography takes place in social settings where it is possible to collect data of different kinds.

All items in the questionnaire were coded. Every interview extract, all school files, and assignments were also coded and one week later all interview extracts were coded. All coded interviews and questionnaires were checked. This procedure was also repeated for observation extracts, assignments I&II, and school files. As long as material is being coded according to themes, the reliability of the coding schemes should be assured. The researcher has considered both internal validity and external validity. All evidence was matched and compared. Intra-coded agreement was used for reliability and validity. The reasons for this were time and cost. But the most important factor was that the researcher was alone in the field. In this study data and method triangulation were used to ensure reliable and valid research.
FINDINGS

In the following two chapters excerpts are from the questionnaires unless otherwise indicated. The chapters comprises two major sections:

Chapter 4: Turkish questionnaire’ findings
Chapter 5: English questionnaires’ findings

In chapter 6 excerpts are from the case studies unless otherwise indicated. The chapter comprises four major sections:

The Case of Claire
The Case of Scott
The Case of Catherine
The Case of Linda
CHAPTER 4
TURKISH FINDINGS

See Appendix 12 for details of the Turkish educational system.

QUESTIONNAIRE'S FINDINGS

The Turkish version of the questionnaire was conducted on 23 December 1997.

BEd. teacher trainees' mathematics background

As Table 4.1 and Table 4.2 show, BEd. mathematics teacher trainees had a variety of backgrounds.

Table 4.1: Turkish Sample's Age Profile.

<table>
<thead>
<tr>
<th>Age groups</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-20</td>
<td>13</td>
</tr>
<tr>
<td>21-25</td>
<td>43</td>
</tr>
<tr>
<td>26-30</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>57</td>
</tr>
</tbody>
</table>

The 18-20 group started the BEd. Course as soon as they finished their secondary schooling; arguably they were too young to become secondary mathematics teachers.

Table 4.2: Turkish Sample's Secondary School's Subject Degrees Profiles.

<table>
<thead>
<tr>
<th>Subject Degrees</th>
<th>Maths</th>
<th>Science</th>
<th>Maths-Science</th>
<th>Computer</th>
<th>Turkish-Maths</th>
<th>Turkish Literacy</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trainees</td>
<td>22</td>
<td>23</td>
<td>3</td>
<td>2</td>
<td>5</td>
<td>2</td>
<td>57</td>
</tr>
</tbody>
</table>

In the mathematics teacher training programme in Turkey, trainees might be expected to have maths subject degrees. Table 4.2 indicates 23 out of 57 trainees have science subject degrees, and only 22 out of 57 trainees have a mathematics subject degree. Surprisingly, 2 out of 57 trainees have Turkish literacy subject degrees. This point needs to be taken into account! How do they choose to become a secondary mathematics teacher? Are they successful in their university education and if they graduate from university, do they become effective teachers? These issues need to be investigated in future research.

Half of teacher trainees had similar views about the BEd. Course and teaching practice; they reported that they did not learn new approaches to teaching mathematics in their undergraduate course. Strikingly the questionnaire results suggested there were no strong negative views at the beginning of training. They all wanted to become mathematics
teachers and that’s why they had a positive view at the start of the training. This agreed with idealism found in the qualitative data. 81% of the trainees had no teaching experience.

In the present study, questionnaire, observations, photographs, lesson plans and evaluation sheets were used to gather data from Turkey.

**Questionnaire and observations in Turkey**

In one study, cross-referencing with questionnaire responses and analyses of classroom observations (Edward & Collison, 1996) indicated that the presence of the researcher in the classroom did not appear to inhibit or distort the conversations which occurred (Edwards, 1997). In the present study, teacher trainees were asked to complete the questionnaire before a lecture in the middle of the last term of their teacher training in April. All completed questionnaires were collected by the researcher.

A questionnaire was designed which consisted of 30 statements (one of them was an open-ended statement). The main aim of the open-ended statement was to get information in a different way. The findings of the questionnaire will be related to the following particular aspects:

• different kinds of group work,
• attitudes towards teaching mathematics using an active learning approach,
• which teaching methods were preferred in the classroom to teach algebra and data handling,
• their courses.

The proportion of the secondary mathematics BEd. group by degree subjects while they were in secondary school and their age groups were indicated as above. An opportunistic sample usually cannot be used to generalize to a wider population because of the problem of possible bias. However, this questionnaire was presented to a relatively large group and therefore the results of the survey probably contain some potential for generalization.

In order to probe attitudes and beliefs towards teaching algebra and data handling using the active learning approach, feelings about teaching, learning new approaches, their backgrounds, their interests, why they are doing mathematics, their hopes for the future, and the impact of the university course and teaching practice, a follow-up interview was needed. Unfortunately the researcher had no time for the interviews in Turkey.

Trainees’ views changed in teaching practice because of the conflict between their idealism in training and the realism in teaching practice in schools. It might be useful for a
further study to explore the extent to which teacher trainees’ views change during their probationary year.

Table 4.3 and Table 4.4 represent frequencies from the questionnaire items. Items in the questionnaire were classified in two different categories according to their frequencies score: positive pole and negative pole. If the item mostly yielded agree and strongly agree, it was placed in the positive pole; if the item yielded mostly strongly disagree and disagree, it was placed in negative pole; if the item did not respond to a cluster at either negative or positive poles then this warranted further investigation.

As exemplars, open ended questions answers are represented. These yielded some interesting responses and gave wider information than closed or multiple choice or grade questions. Some respondents wrote long explanations in response to open ended items.

### Table 4.3: Grouping of Turkish Questionnaire Items

<table>
<thead>
<tr>
<th>Item</th>
<th>Missing</th>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly agree</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>I find mathematics topics fun to do.</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>24</td>
<td>32</td>
<td>57</td>
</tr>
<tr>
<td>I like arithmetic.</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>1</td>
<td>24</td>
<td>30</td>
<td>57</td>
</tr>
<tr>
<td>I like doing quadratic equations.</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>5</td>
<td>31</td>
<td>19</td>
<td>57</td>
</tr>
<tr>
<td>I like data handling.</td>
<td>-</td>
<td>10</td>
<td>11</td>
<td>17</td>
<td>12</td>
<td>7</td>
<td>57</td>
</tr>
<tr>
<td>I think mathematics is a challenge</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>8</td>
<td>19</td>
<td>29</td>
<td>57</td>
</tr>
<tr>
<td>I think data handling is useful.</td>
<td>-</td>
<td>2</td>
<td>5</td>
<td>17</td>
<td>20</td>
<td>13</td>
<td>57</td>
</tr>
<tr>
<td>I enjoy teaching algebra.</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>23</td>
<td>31</td>
<td>57</td>
</tr>
<tr>
<td>I enjoy teaching data handling.</td>
<td>-</td>
<td>7</td>
<td>9</td>
<td>11</td>
<td>20</td>
<td>10</td>
<td>57</td>
</tr>
<tr>
<td>I have adopted a new approach to teaching mathematics recently</td>
<td>-</td>
<td>2</td>
<td>7</td>
<td>23</td>
<td>16</td>
<td>9</td>
<td>57</td>
</tr>
<tr>
<td>I think mathematics needs to be taught in a different way to other subjects.</td>
<td>-</td>
<td>1</td>
<td>4</td>
<td>2</td>
<td>23</td>
<td>27</td>
<td>57</td>
</tr>
<tr>
<td>I have my own ways to teach.</td>
<td>-</td>
<td>-</td>
<td>4</td>
<td>10</td>
<td>34</td>
<td>9</td>
<td>57</td>
</tr>
<tr>
<td>I feel happy in my mathematics lessons.</td>
<td>-</td>
<td>2</td>
<td>2</td>
<td>-</td>
<td>21</td>
<td>32</td>
<td>57</td>
</tr>
<tr>
<td>I think most of the students in my classes enjoy studying mathematics</td>
<td>-</td>
<td>1</td>
<td>11</td>
<td>18</td>
<td>17</td>
<td>8</td>
<td>57</td>
</tr>
<tr>
<td>If students work hard they will be good at math.</td>
<td>-</td>
<td>2</td>
<td>7</td>
<td>8</td>
<td>22</td>
<td>18</td>
<td>57</td>
</tr>
<tr>
<td>My lessons have almost the same form or structure for each lesson.</td>
<td>-</td>
<td>1</td>
<td>2</td>
<td>18</td>
<td>8</td>
<td>24</td>
<td>57</td>
</tr>
<tr>
<td>My students have lots of opportunities to use math in other lessons (e.g. science,…)</td>
<td>-</td>
<td>-</td>
<td>6</td>
<td>6</td>
<td>31</td>
<td>13</td>
<td>57</td>
</tr>
<tr>
<td>Pupils find algebra difficult.</td>
<td>-</td>
<td>1</td>
<td>2</td>
<td>10</td>
<td>8</td>
<td>22</td>
<td>57</td>
</tr>
<tr>
<td>be more sympathetic</td>
<td>-</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>31</td>
<td>21</td>
<td>57</td>
</tr>
<tr>
<td>suggest that they ask their parents for help.</td>
<td>-</td>
<td>1</td>
<td>15</td>
<td>9</td>
<td>22</td>
<td>10</td>
<td>57</td>
</tr>
<tr>
<td>not be concern about it</td>
<td>-</td>
<td>32</td>
<td>17</td>
<td>5</td>
<td>3</td>
<td>-</td>
<td>57</td>
</tr>
<tr>
<td>use different way to help them understand</td>
<td>-</td>
<td>10</td>
<td>2</td>
<td>-</td>
<td>22</td>
<td>23</td>
<td>57</td>
</tr>
<tr>
<td>think learning depends on their own efforts</td>
<td>-</td>
<td>1</td>
<td>8</td>
<td>7</td>
<td>25</td>
<td>16</td>
<td>57</td>
</tr>
<tr>
<td>encourage them to use diagrams</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>7</td>
<td>29</td>
<td>18</td>
<td>57</td>
</tr>
<tr>
<td>encourage them to use computer</td>
<td>-</td>
<td>3</td>
<td>12</td>
<td>16</td>
<td>19</td>
<td>7</td>
<td>57</td>
</tr>
<tr>
<td>encourage them to use books/textbook</td>
<td>-</td>
<td>2</td>
<td>10</td>
<td>10</td>
<td>24</td>
<td>11</td>
<td>57</td>
</tr>
<tr>
<td>I have learned little new about mathematics during teacher training.</td>
<td>-</td>
<td>3</td>
<td>14</td>
<td>8</td>
<td>21</td>
<td>11</td>
<td>57</td>
</tr>
<tr>
<td>my understanding of mathematical ideas has changed in the process of teaching mathematics</td>
<td>-</td>
<td>5</td>
<td>13</td>
<td>10</td>
<td>23</td>
<td>6</td>
<td>57</td>
</tr>
<tr>
<td>I think my view of mathematics teaching has changed</td>
<td>-</td>
<td>3</td>
<td>7</td>
<td>11</td>
<td>30</td>
<td>6</td>
<td>57</td>
</tr>
</tbody>
</table>

Freq.: Frequencies

82
Table 4.4: Grouping of Turkish Questionnaire Items

<table>
<thead>
<tr>
<th></th>
<th>missing values</th>
<th>not important</th>
<th>quite important</th>
<th>important</th>
<th>very important</th>
<th>N (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>for algebra: practical simulations</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>23</td>
<td>33</td>
<td>57</td>
</tr>
<tr>
<td>for algebra: problem solving</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>17</td>
<td>38</td>
<td>57</td>
</tr>
<tr>
<td>for algebra: structured individual work</td>
<td>1</td>
<td>4</td>
<td>12</td>
<td>23</td>
<td>17</td>
<td>57</td>
</tr>
<tr>
<td>for algebra: mathematical projects based on extended work</td>
<td>2</td>
<td>8</td>
<td>12</td>
<td>24</td>
<td>11</td>
<td>57</td>
</tr>
<tr>
<td>for data handling: practical simulations</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>17</td>
<td>39</td>
<td>57</td>
</tr>
<tr>
<td>for data handling: set problem solving task</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>20</td>
<td>36</td>
<td>57</td>
</tr>
<tr>
<td>for data handling: use structured individual work</td>
<td>-</td>
<td>1</td>
<td>10</td>
<td>35</td>
<td>11</td>
<td>57</td>
</tr>
<tr>
<td>for data handling: mathematical projects based on a extended piece of work</td>
<td>2</td>
<td>3</td>
<td>14</td>
<td>28</td>
<td>10</td>
<td>57</td>
</tr>
</tbody>
</table>

All categorized items were grouped according to the following headings:

- **Table 4.5: Teaching and Enjoying Mathematics**

<table>
<thead>
<tr>
<th>questionnaire items</th>
<th>positive pole</th>
<th>negative pole</th>
</tr>
</thead>
<tbody>
<tr>
<td>I find mathematics topic fun to do.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I think mathematics is a challenge</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I feel happy in my mathematics lessons</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I enjoy teaching data handling</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I think data handling is useful</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I enjoy teaching algebra</td>
<td>I like data handling</td>
<td></td>
</tr>
<tr>
<td>I like arithmetic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I like doing quadratic equations</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Exemplars

- codetr43: I love and enjoy maths. I know that if student doesn't want to learn anything, I don't do nothing.
- codetr43: In my opinion, one of the reason for students not enjoying maths is their mathematics teacher.
- codetr32: Mathematics like a puzzle, if you start to solve it you enjoy much more than beginning to solve.

Turkish trainees found mathematics fun to do and a challenge. They had a positive attitude to mathematics especially secondary and university backgrounds. On the other hand, some trainees thought mathematics a puzzle. One trainee emphasized how mathematics could be interesting to teach and learn: ‘I learned how to make mathematics interesting (code tr53)’ and ‘Mathematics is like a puzzle, if you start to solve it you enjoy it much more than beginning to solve (code tr32)’. They seemed to like mathematics. One trainee wrote:
They also reported that they ‘love and enjoy maths’. This indicated positive attitudes about being in mathematics classrooms and teaching mathematics to their pupils.

56% of the trainee strongly agreed and 37% of the trainees agreed that they felt happy in mathematics lessons. Nearly all trainees agreed that mathematics needed to be differently taught from other subjects. 60% of the trainees agreed that they had their own ways of teaching mathematics. 32% of the trainees strongly agreed and 51% of the trainees agreed to use diagrams in teaching mathematics. 28% of the trainees sometimes, and 10% of the trainees usually claimed to use group work in the classroom. But group work was not chosen to teach mathematics in Turkish mathematics classroom as observed. On the other hand, individual work was used commonly (44% usually, 37% sometimes) but pair work was not popular in mathematics classrooms. 26% of the trainees reported that they used whole class teaching usually. 21% of the trainees did not want to use whole class teaching. 69% of the trainee usually wanted to use books.

Curiously, they reported that they ‘enjoy teaching data handling’ but they ‘don’t like data handling’. Trainees had negative attitudes to data handling. On the other hand they reported that they thought ‘data handling is useful’. One possible reason they did not like data handling is their backgrounds and their teachers. One of the respondents wrote that: ‘In my opinion, one of the reason for students not enjoying maths is their mathematics teacher’ (Codetr43.)

On the other hand teacher trainees reported that they enjoy teaching algebra. They also report that they like arithmetic and quadratic equations. This showed that they had positive attitudes to algebra and its teaching.

- **Table 4.6: Active Learning Elements for Algebra and Data Handling:**

<table>
<thead>
<tr>
<th>positive pole</th>
<th>negative pole</th>
</tr>
</thead>
<tbody>
<tr>
<td>practical simulations for algebra</td>
<td>practical simulations for data handling</td>
</tr>
<tr>
<td>problem solving for algebra</td>
<td>problem solving for data handling</td>
</tr>
<tr>
<td>structured individual work for algebra</td>
<td>structured individual work for data handling</td>
</tr>
<tr>
<td>project work for algebra</td>
<td>project work for data handling</td>
</tr>
<tr>
<td>practical simulations for data handling</td>
<td></td>
</tr>
<tr>
<td>problem solving for data handling</td>
<td></td>
</tr>
<tr>
<td>structured individual work for data handling</td>
<td></td>
</tr>
<tr>
<td>project work for data handling</td>
<td></td>
</tr>
<tr>
<td>Exemplars code tr.10: Maths needs to be taught differently, not just memorizing things.</td>
<td></td>
</tr>
</tbody>
</table>

Turkish trainees reported that practical simulations, problem solving, structured individual work and project work were appropriate for teaching of algebra and data handling. They had positive attitudes to the use of these in their teaching.
They had a less positive attitude to the use of structured individual work and project work for algebra. The reason was they did not meet these methods in their backgrounds. They reported mathematics needed to be taught differently, not just by existing methods. One of the respondents wrote that 'Maths needs to be taught differently, not just memorizing things'. Although trainees have positive attitude to the use of structured individual work and project work for data handling, but they did not use these kinds of methods to teach this topic. This item needs further investigation to find out the real reason why they think like this.

The majority of them reported that they liked algebra. 90% of the trainees found problem solving and practical simulations very important in teaching algebra. 55% of the trainees reported that they never and 35% of the trainees reported that they rarely used cinema and video in their teaching. Multi-media tools were not popular in mathematics teaching. 75% of the trainees reported that they disagreed with the use of computers in mathematics teaching.

- **Table 4.7: Teacher trainees’ teaching**

<table>
<thead>
<tr>
<th>positive pole</th>
<th>negative pole</th>
</tr>
</thead>
<tbody>
<tr>
<td>questionnaire</td>
<td>I think mathematics need to be taught in a different way to other subjects.</td>
</tr>
<tr>
<td>items</td>
<td>I’ve my own ways to teach.</td>
</tr>
<tr>
<td></td>
<td>My lessons have almost same form or structure for each lesson.</td>
</tr>
<tr>
<td></td>
<td>My students have lots of opportunities to use maths in other lessons (e.g. science).</td>
</tr>
</tbody>
</table>

Although, they had positive attitudes to ‘mathematics need to be taught in a different way to other subjects’, they had a positive attitude to: ‘almost the same form or structure for each lesson’. This item needs further investigation to find out whether their lesson is the same form for each lesson or not. One of the respondents wrote that (code tr10) ‘Maths needs to be taught differently’. They also had positive attitudes to ‘they have own ways to teach’. What kinds of ways do they have to teach, and how different might teaching be? This needs further research.

They had positive attitudes to ‘pupils have lots of opportunities to use maths in other lessons (e.g. science)’. They accepted that mathematics was related with other subjects specially sciences; their pupils needed to study mathematics and to realize the importance of mathematics. On the other hand they had negative attitudes to ‘most of the pupils in their
classes enjoy studying mathematics’. Although mathematics is a basis for other lessons, pupils do not like studying mathematics.

They reported pupils did not like mathematics. Why? How might they change pupils’ attitudes to mathematics? According to their report, pupils did not like to study mathematics and pupils also did not like data handling (but they liked algebra). This is thinking about their pupils. Is this their actual thinking and belief or not?

- **Table 4.8: BEd. Course**

<table>
<thead>
<tr>
<th>questionnaire items</th>
<th>positive pole</th>
<th>negative pole</th>
</tr>
</thead>
<tbody>
<tr>
<td>I’ve adopted a new approach to teaching mathematics recently</td>
<td>I have learned little new about mathematics during teacher training</td>
<td>My understanding of mathematical ideas has changed in the process of teaching mathematics</td>
</tr>
<tr>
<td>I have learned little new about mathematics during teacher training</td>
<td>My understanding of mathematical ideas has changed in the process of teaching mathematics</td>
<td></td>
</tr>
<tr>
<td>My understanding of mathematical ideas has changed in the process of teaching mathematics</td>
<td>I think my view of mathematics teaching has changed.</td>
<td></td>
</tr>
<tr>
<td>I think my view of mathematics teaching has changed.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Exemplars

code tr48: I learned how difficult teaching is.

code tr24: I understand how difficult to teach mathematics.

codetr5: I believe that I might teach much more theory and proof all the theorems’

codetr53: I learned how to make mathematics more interesting.

codetr44: You teach whether use story, play or writing it doesn’t matter but you have to teach effectively.

codetr9: if we do not go to schools for teaching practice, we don’t learn how to teach it.

codetr14: I have difficulty to manage mixed ability class.

codetr16: I feel teaching in secondary school is different from primary school.

codetr8: Theory and application might be connected to each other in maths and maths teaching’.

codetr43: I learned how to motivate pupils to learn maths in teaching practice.

They had positive attitudes to ‘adopted a new approach to teaching mathematics recently’. The BEd course had a positive effect on their beliefs and attitudes to learn new approaches to teach mathematics. On the other hand they reported that ‘they have learned little new about mathematics during teacher training’.

A majority of trainees reported that they had positive attitudes to ‘their understanding of mathematical ideas has changed in the process of teaching mathematics’. Has their view of mathematics teaching changed and how? But a substantial minority reported that they also had negative attitudes to ‘their understanding of mathematical ideas has changed in the process of teaching mathematics’.

Trainees’ views and understanding were expected to change during teaching and learning mathematics in university education and teaching practice. Their beliefs and ideas
were well developed during teacher education, but the teaching skills needed to support these aspirations were not developed. In the teacher training course (Sanemoglu, 1991), trainees take 62.5% subject matter knowledge; 12.5% general culture; 25% pedagogical matters but not specific to teaching mathematics. Trainees need pedagogical content knowledge not only pedagogical knowledge. Their teaching approaches were developed during the course. They may change their views and beliefs by the end of their teaching practice and courses. It was not possible to conduct the questionnaire study a second time. This was a limitation of the study.

Trainees found teaching mathematics very difficult. After they started to teach mathematics they realized how difficult it is to teach. One trainee reported that ‘I learned how difficult teaching is (codetr48)’; another trainee reported that ‘I understand how difficult to teach mathematics (codetr24)’. In teaching practice they faced reality. They emphasised how important the teaching practice is. Codetr9 reported that ‘If we do not go to schools for teaching practice, we don’t learn how to teach it’. Teaching practice also had a direct effect on trainees’ teaching, especially how to motivate pupils, and how to make mathematics more interesting. Trainees reported that ‘I learned how to make mathematics more interesting (codetr53)’, and ‘I learned how to motivate pupils to learn maths in teaching practice (codetr43)’.

They emphasised that pupils’ learning was the key element, and, whatever methods or techniques were used for teaching, the most important thing was pupils’ learning. One of the trainees reported that ‘You teach whether you use story, play or writing. It doesn’t matter but you have to teach effectively (codetr44).

Trainees raised other issues which included teaching in a mixed ability classroom (one trainee reported that ‘I have difficulty to manage mixed ability class’ (codetr14)), and teaching different age ranges. They found a contrast between primary and secondary classrooms: ‘I feel teaching in secondary school is different from primary school’ (codetr16).

They realized in their teaching, theory was different from application and they wanted to combined theory and application: ‘Theory and application might be connected to each other in maths and maths teaching’ (codetr8). Turkish secondary mathematics teacher education gives trainees mostly theoretical knowledge and they graduate as mathematicians but they do not know how to teach mathematics topics to their pupils. They do not know how to translate their learning to different learning situations and real life settings.
• Table 4.9: Usage of Grouping Activities in Maths Classroom

<table>
<thead>
<tr>
<th></th>
<th>missing values</th>
<th>usually</th>
<th>sometimes</th>
<th>occasional</th>
<th>rarely</th>
<th>never</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>group work</td>
<td>1</td>
<td>6</td>
<td>16</td>
<td>9</td>
<td>17</td>
<td>8</td>
<td>57</td>
</tr>
<tr>
<td>individual work</td>
<td>1</td>
<td>25</td>
<td>13</td>
<td>10</td>
<td>6</td>
<td>2</td>
<td>57</td>
</tr>
<tr>
<td>pair work</td>
<td>1</td>
<td>6</td>
<td>21</td>
<td>14</td>
<td>13</td>
<td>2</td>
<td>57</td>
</tr>
<tr>
<td>whole class</td>
<td>1</td>
<td>15</td>
<td>10</td>
<td>8</td>
<td>11</td>
<td>12</td>
<td>57</td>
</tr>
</tbody>
</table>

Trainees showed positive attitudes to using individual work in mathematics lessons but this item related to pupils' own effort in learning mathematics. That's why they mostly ticked this item. Group work and pair work were not popular ways to teach mathematics. They had either negative or positive attitudes to using whole class teaching. On the other hand, they were not sympathetic to pair and group work. They accepted maths needed to be taught differently: 'Maths needs to be taught differently, not just memorizing things (codet10)' . They realized they needed to use different teaching methods not just whole class teaching.

50% of the trainees strongly disagreed and 30% of the trainees were neutral that their students enjoyed mathematics. Mathematics is not a popular lesson for Turkish pupils. Turkish pupils do not enjoy mathematics. The results suggested that new teachers need to learn how to make this lesson enjoyable to pupils. 60% of the trainees reported that their pupils found algebra difficult, and most of them reported that pupils needed to get parental help. 44% of the trainees agreed and 28% of the trainees strongly agreed that learning mathematics depended on pupils' efforts. It would seem reasonable to assume that if pupils were having trouble with their mathematical work that they would ask the teacher for help. Otherwise, they applied for help to parents or other friends.

• Table 4.10: Usage of Active Learning Materials in Maths Classroom I

<table>
<thead>
<tr>
<th></th>
<th>missing values</th>
<th>usually</th>
<th>sometimes</th>
<th>occasional</th>
<th>rarely</th>
<th>never</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>books</td>
<td>13</td>
<td>39</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>2</td>
<td>57</td>
</tr>
<tr>
<td>library sources</td>
<td>1</td>
<td>14</td>
<td>13</td>
<td>10</td>
<td>13</td>
<td>6</td>
<td>57</td>
</tr>
</tbody>
</table>
| computer, dupli
cated sheets etc. | 2          | -       | 6         | 6          | 8      | 35    | 57 |
Trainees had positive attitudes to using books in mathematics teaching. They had neither negative nor positive attitude to using library resources, but this item needs to be further examined. On the other hand, they had positive attitudes to using exercises and duplicated sheets, but they had negative attitudes to using lecturer notes, cinema, video, OHP and computer. Up to 1997, materials for information technology did not exist in the teacher education programme in primary and secondary schools. They did not come across these materials in mathematics classrooms. One of the respondents wrote that: ‘If I did not meet new materials such as OHP, computer, computer programmes in university, how can I use them in my own teaching in future?’ (codetr17).

Lesson planning is crucial for teaching especially as less experienced trainees and teachers build a wider repertoire and learn to interpret pupils’ responses. Trainees’ lesson plans were, therefore, a series of personally important incidents and some associated reflections on their teaching. They can be seen as incidents that can be shared and linked— an example of how trainees and teachers can reflect on their own classrooms and study their own teaching.

Observation in Turkey indicated that trainees and teachers did not closely follow their lesson plans.

They emphasised planning lessons using different sources. According to trainees, different sources meant different textbooks, exercises books or different publishers’ books. The majority of trainees wanted to ‘use their own notes and different textbooks’ and to prepare different kind of examples and exercises from them.

Trainees suggested equation numbers and arithmetic as projects for algebra and probability for data handling. Turkish trainees’ enjoyable teaching topics were as follows: integral, derivation, equation, geometry, trigonometry, and numbers. It seemed that data handling topics were not popular to teach.
How can we develop initial teacher education approaches that encourage trainees and teachers to use active learning, to listen to pupils, to take account of pupils’ interests and pupils’ right level of understanding?

- Table 4.11: Usage of Active Learning Elements in Maths Classroom II

<table>
<thead>
<tr>
<th>positive pole for active learning</th>
<th>negative pole for active learning</th>
</tr>
</thead>
<tbody>
<tr>
<td>encourage them to use diagrams</td>
<td>encourage them to use computer</td>
</tr>
<tr>
<td>encourage them to use computer</td>
<td>not be concern about it</td>
</tr>
<tr>
<td>encourage them to use books/ textbok</td>
<td></td>
</tr>
<tr>
<td>If students work hard they will be good at maths</td>
<td></td>
</tr>
<tr>
<td>learning depends on their own efforts</td>
<td></td>
</tr>
<tr>
<td>suggest that they ask their parents for help</td>
<td></td>
</tr>
<tr>
<td>use different way to help them understand</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
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</tr>
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</tr>
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<td></td>
<td></td>
</tr>
<tr>
<td>agree</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strongly agree</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>If students work hard they will be good at maths</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>suggest that they ask their parents for help</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>not be concern about it</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>use different way to help them understand</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>learning depends on their own efforts</td>
<td></td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>encourage them to use diagrams</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>encourage them to use computer</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>encourage them to use books/ textbok</td>
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<td></td>
</tr>
</tbody>
</table>

Turkish trainees had positive attitudes to ‘if their pupils struggle, they encourage them to use diagrams, and to use books and textbooks’. They had either negative or positive attitudes to using computers to help their pupils’ learning.

They had concern about their pupils’ learning. They had positive attitudes to ‘if pupils work hard they will be good at maths’ and ‘learning depends on pupils own efforts’. In this respect pupils’ individual attitudes are an important factor in learning mathematics, irrespective of the teaching: ‘if pupil does not want to learn, you cannot do too much, and it is difficult to change this, (codetr44))’.

The findings of the questionnaire data indicated that most of the teacher trainees displayed a generally positive view of the active learning approach to teaching mathematics. The findings also indicated that there was a tendency on most statements for female teacher trainees to indicate greater agreement than that expressed by male teacher trainees.
Gender and age had little effect on their positive and negative attitudes to teaching algebra and data handling.

Photographs in Turkish Trainees' Lessons:

Photographs were used as a source of data for the Turkish study. Photographs were used to show a typical mathematics lesson, especially secondary maths lessons in Turkey (see Appendix 7). It can be seen that: pupils sat in a row; they wore uniform (which is compulsory and every school has its own uniform); the teacher was in front of the class; the teacher used the chalk and talk method and a few question-answer sessions but mostly exposition; classes were very crowded with at least 40 in the class. The first two rows were actively involved in the lesson but others were mainly ignored for the teaching. Those pupils who were sitting in the first two rows were mainly able and successful students and the others were not.

Observation

Three mathematics teachers and three mathematics teacher trainees were observed in different schools in Balikesir, Turkey. The three teachers comprised a man with 30 years experience, a man with 13 years experience and a woman with 3 years experience. The three mathematics teacher trainees (two male and one female) were observed while they were teaching mathematics. All observation took place in April 1998. The observations took two-lessons (each of them 45-60 minutes) for each.

In naturalistic observation in Balikesir, Turkey, the researcher looked at the secondary mathematics teacher trainees' and mathematics class teachers' methods of teaching mathematics, teacher-pupil interaction, pupil-pupil interaction, trainee-teacher interaction, what kind of questions were used, comparison of the group activities they used in the class, pupils' involvement in the lesson, what kind of working settings were being used and what kinds of equipment. All these kinds of information were recorded. The researcher also discussed some issues after the lesson with trainee and teacher. The researcher looked at which instruments, resources and equipment were used to teach mathematics; what kind of teacher's and pupils' behaviour were observed; what was the target pupil's behaviour, and progress. After collecting all these observations from trainees' and teachers' lessons, they were coded and categorized. The researcher also kept a research journal of her observations to record some notes e.g. when, and how, small group, large group and individual classroom organizations were used. Every observed lesson's teaching documents were collected (e.g. written materials, class handouts, content notes, students notes, text materials, work sheets and other materials). Teacher trainee's lesson plans were collected after the trainee's lesson. These might show how and to what extent trainees'
learning to teach mathematics was affected by the university courses. Observation captured classroom processes as they actually occurred and provided data to determine what the participants actually did in relation to what they described. Field notes were made during the observations to include what each participant and their students did during instruction and how their actions interacted: for example, when and how the students asked questions; when and how the teacher responded. Examples of field notes are included in Appendix 6.1 and Appendix 6.2.

Typically, there were no discussion sessions and no group or pair work in maths lessons. Teachers used the board and made students copy everything from the board. Pupils just copied from the board and if pupils asked a question like ‘I don't understand sir’, the teacher replied: ‘If you don't talk to your friend, you can easily understand, and next time you have to listen carefully’. If teachers just asked: ‘Do you understand?’ but no one replied to this question, then it was not clear whether they all understood what the teacher meant or not!

According to observations, the teacher acted as a role model for trainees but trainees had a difficulty adapting their theoretical learning to practice. Trainees wanted to teach how to prove the theorems to the pupils. On the other hand, the researcher noted that trainees copied whatever the teacher did in the class. Trainees used the same kind of teaching methods to teach mathematics, with no grouping activities and no different sources. Teachers and trainees show the same pattern of teaching. One teacher said: ‘When I was at university I did not know to how to use different teaching methods, materials, and grouping activities. But even if I had know, it is difficult to adapt this to a big classroom (around 40-50 pupils) (teacher13)’. Trainees find teaching practice very useful. They reported that they gained experience in teaching topics during the teaching practice. They also reported that they did not know how to apply their learning to their teaching.

In maths lessons, teachers did not use any kind of materials such as posters, OHP or computers. These teaching materials may be unknown or the teachers may not know how to use them. One teacher trainee responded to an open ended question ‘If I did not meet new materials such as OHP, computer, computer programmes in university, how can I use them in my own teaching in future? (code tr17)’. However, some of teachers and teacher trainees did prepare their own worksheets.

The sample teachers largely adopted a similar pattern: use exposition, demonstration, drill, solve exercises, a few pupils come to board to solve problem, not much pupil-teacher, pupil-pupil interaction, no grouping activities. On the other hand, teacher3 with three years’ experience, showed more interaction with her pupils, tried to encourage them to participate in the lesson and to co-operate in homework. She tried to bring some
practical examples into the classrooms (e.g. a few bags of different kinds of marbles for data handling), but this was very limited. This showed that there were some individual differences among teachers. Other individual differences were noted in their classroom control, manner, discipline and relationships to pupils, and their personalities were different from each other. One teacher used a technique to gain pupils’ attention. He (teacher30) said to the class ‘Please stand up for 2 minutes and, after, sit down at your desks’. On the other hand another (teacher13) said to the class: ‘Come on, wake up! It is not a sleeping time!’

In conclusion, first the teacher introduced the topic and wrote a few problems or exercises on the board to be solved in the lesson. If the time was not enough to finish the exercises, it was given to pupils as homework which was checked by the next lesson. Pupils wrote down the solutions of exercises not knowing whether they were correct or not, and this homework may be pupils’ work or mother’s or father’s or another teacher’s work!

Another point is that the Turkish educational system pushes trainees and pupils to memorize things. The questionnaire findings and observation findings supported this. Although trainees and teachers were open and sympathetic to using active learning elements in their lessons, they did not use them. Both teachers and trainees used the same methods and techniques for teaching algebra and data handling.

Teachers and tutors have the potential to change this situation. The big challenge is communication between tutors and teachers. Teacher educators in teacher education programmes and teachers in schools need to know how to use new methods and techniques, and grouping activities in their lessons. That’s why they need in-service education.

One Turkish trainee wrote: ‘Maths needs to be taught differently, not just memorizing things (code tr10)’. Hence, in teacher training, newly qualified teachers might be encouraged to use different teaching methods apart from the memorizing of things. Most teachers did not meet a variety of teaching methods and then they used old well established methods. They may use a few new techniques but this was exceptional. Not only the teachers and tutors but also government, the Ministry of Education and teacher training programmes have a responsibility for this situation. Are they exercising their roles appropriately or not?

Flexibility in teaching method depends on teachers’ experience as well as their teaching competence. Flexibility involves knowing which kind of method in teaching would suit which particular classroom situation; adopting miscellaneous different methods to meet pupils’ different needs; making everyone in the classroom motivated and involved; and choosing teaching syllabus and materials. Such methods might not only attract and maintain pupils’ attention, but also make them fully involved in the task they were doing. All pupils must be encouraged to develop self-esteem and to exercise self-restraint.
Teachers also need to communicate clearly what they expect pupils to learn and to do, provide encouragement rather than criticism, and give pupils ownership and control over their learning. The teachers should be helpful and patient, working collaboratively with the pupils, open, not only talking but also listening, motivating pupils to learn, controlling the classroom well in a relaxed atmosphere. Turkish teacher training programmes might also address these priorities.
CHAPTER 5

ENGLISH FINDINGS

QUESTIONNAIRE'S FINDINGS

The English version of the questionnaire was administered twice. The first administration was on 11 December 1997 and the second on 26 June 1998. In this English Questionnaire's findings section, Questionnaire I findings will be presented followed by Questionnaire II findings. Finally, the results of both questionnaires will be discussed.

In the Leicester sample, the PGCE Secondary Mathematics Teacher Training Course had only 4 male and 8 female secondary mathematics teacher trainees. Table 5.1 below gives their age profile.

Table 5.1: Leicester Sample’s Age Profile.

<table>
<thead>
<tr>
<th>Age groups</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-25</td>
<td>7</td>
</tr>
<tr>
<td>26-30</td>
<td>2</td>
</tr>
<tr>
<td>31-35</td>
<td>1</td>
</tr>
<tr>
<td>36-40</td>
<td>1</td>
</tr>
<tr>
<td>over 40</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>12</strong></td>
</tr>
</tbody>
</table>

Although PGCE mathematics teacher trainees were mostly in the 21-25 age range, there were mature trainees on the course.

Table 5.2: Leicester Sample’s Degree Profile

<table>
<thead>
<tr>
<th>Subject Degrees</th>
<th>Maths</th>
<th>Maths &amp; Computing</th>
<th>Maths &amp; Psychology</th>
<th>Management &amp; Science</th>
<th>Physics</th>
<th>Maths &amp; Physics</th>
<th>Engineering</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trainees</td>
<td>6</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>12</td>
</tr>
</tbody>
</table>

PGCE mathematics teacher trainees had a variety of backgrounds. Some of them graduated in mathematics and related subjects and some of them had taken their degrees up to 15 years ago. Six of the teacher trainees were taught in mixed ability classrooms while they were in secondary school (4 male, 2 female), and 6 of them were in ‘set by ability’ classrooms (4 female, 2 male).

Most of the teacher trainees had work experience: code5 (F): ‘I worked in an independent, non-selective tutorial college with pupils aged 15 to 23’; code6 (F): ‘I worked as a private tutor with pupils aged 6-14 years old’; code9 (F): ‘I have two years’ teaching experience in India’.
The findings of the questionnaire data will show that most of the teacher trainees displayed a generally positive attitude to the active learning approach to teaching mathematics. The overall findings from Questionnaire I are summarized in Table 5.3.

**QUESTIONNAIRE I:**

**Table 5.3: Grouping of English Questionnaire items**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>I find mathematics topics fun to do.</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>3</td>
<td>7</td>
<td>12</td>
</tr>
<tr>
<td>I like arithmetic.</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>4</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td>I like doing quadratic equations.</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>5</td>
<td>5</td>
<td>12</td>
</tr>
<tr>
<td>I like data handling.</td>
<td>-</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>12</td>
</tr>
<tr>
<td>I think mathematics is a challenge.</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>8</td>
<td>4</td>
<td>12</td>
</tr>
<tr>
<td>I think data handling is useful.</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>1</td>
<td>6</td>
<td>4</td>
<td>12</td>
</tr>
<tr>
<td>I enjoy teaching algebra.</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>8</td>
<td>2</td>
<td>12</td>
</tr>
<tr>
<td>I enjoy teaching data handling.</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>7</td>
<td>3</td>
<td>-</td>
<td>12</td>
</tr>
<tr>
<td>I have adopted a new approach to teaching mathematics recently.</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>5</td>
<td>5</td>
<td>1</td>
<td>12</td>
</tr>
<tr>
<td>I think mathematics needs to be taught in a different way to other subjects.</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>3</td>
<td>6</td>
<td>2</td>
<td>12</td>
</tr>
<tr>
<td>I have my own ways of teaching.</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>2</td>
<td>8</td>
<td>1</td>
<td>12</td>
</tr>
<tr>
<td>I feel happy in my mathematics lessons.</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>6</td>
<td>5</td>
<td>12</td>
</tr>
<tr>
<td>I think most of the students in my classes enjoy studying mathematics.</td>
<td>-</td>
<td>-</td>
<td>5</td>
<td>5</td>
<td>2</td>
<td>-</td>
<td>12</td>
</tr>
<tr>
<td>If students work hard they will be good at maths.</td>
<td>-</td>
<td>1</td>
<td>4</td>
<td>2</td>
<td>5</td>
<td>-</td>
<td>12</td>
</tr>
<tr>
<td>My lessons have almost the same form or structure for each lesson.</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>2</td>
<td>7</td>
<td>-</td>
<td>12</td>
</tr>
<tr>
<td>My students have lots of opportunities to use maths in other lessons (e.g. science).</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>7</td>
<td>2</td>
<td>12</td>
</tr>
<tr>
<td>Pupils find algebra difficult.</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>3</td>
<td>5</td>
<td>2</td>
<td>12</td>
</tr>
<tr>
<td><em>... suggest that they are more sympathetic.</em></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td><em>... suggest that they ask their parents for help.</em></td>
<td>-</td>
<td>1</td>
<td>3</td>
<td>6</td>
<td>2</td>
<td>-</td>
<td>12</td>
</tr>
<tr>
<td><em>... not be concerned about it.</em></td>
<td>-</td>
<td>11</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>12</td>
</tr>
<tr>
<td><em>... use different ways to help them understand.</em></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>4</td>
<td>8</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td><em>... think learning depends on their own efforts.</em></td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>7</td>
<td>-</td>
<td>12</td>
</tr>
<tr>
<td><em>... encourage them to use diagrams.</em></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>4</td>
<td>7</td>
<td>1</td>
<td>12</td>
</tr>
<tr>
<td><em>... encourage them to use computers.</em></td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>9</td>
<td>2</td>
<td>-</td>
<td>12</td>
</tr>
<tr>
<td><em>... encourage them to use books/textbook.</em></td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>4</td>
<td>7</td>
<td>-</td>
<td>12</td>
</tr>
<tr>
<td>I have learned little new about mathematics during teacher training.</td>
<td>-</td>
<td>2</td>
<td>7</td>
<td>-</td>
<td>3</td>
<td>-</td>
<td>12</td>
</tr>
<tr>
<td>My understanding of mathematical ideas has changed in the process of teaching mathematics.</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>9</td>
<td>1</td>
<td>12</td>
</tr>
<tr>
<td>I think my view of mathematics teaching has changed.</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>4</td>
<td>8</td>
<td>-</td>
<td>12</td>
</tr>
</tbody>
</table>

Freq. : Frequencies
* ... : If my students are struggling with their mathematics, then I would

The detailed findings and discussion in each of the major categories investigated now follow.
Trainees had positive attitudes to ‘mathematics topics are fun to do’, ‘mathematics is a challenge’, ‘feel happy in my mathematics lessons’, and their students ‘find algebra difficult’. Furthermore, they had generally positive attitudes to data handling, and they found data handling useful. On the other hand, they had neither positive nor negative attitudes to ‘they enjoy teaching data handling’. This was very surprising, because they liked the topic and found it useful. In addition to this, they all had positive attitudes to algebra and related topics in algebra, and they also enjoyed teaching algebra. Why did they enjoy teaching algebra, but not data handling? This question will be considered in the context of the individual case studies.

---

### Table 5.4: Teaching and Enjoying Mathematics

<table>
<thead>
<tr>
<th>Questionnaire items</th>
<th>Positive Pole</th>
<th>Negative Pole</th>
</tr>
</thead>
<tbody>
<tr>
<td>I find mathematics topic fun to do.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I think mathematics is a challenge</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I feel happy in my mathematics lessons</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I enjoy teaching data handling</td>
<td>mostly neutral</td>
<td>mostly neutral</td>
</tr>
<tr>
<td>I think data handling is useful</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I enjoy teaching algebra</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I like arithmetic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I like doing quadratic equations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pupils find algebra difficult</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

### Table 5.5: Active Learning Elements for Algebra and Data Handling

<table>
<thead>
<tr>
<th>Questionnaire items</th>
<th>Missing values</th>
<th>Not important</th>
<th>Quite important</th>
<th>Important</th>
<th>Very important</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>for algebra: practical simulations</td>
<td>-</td>
<td>-</td>
<td>5</td>
<td>5</td>
<td>2</td>
<td>12</td>
</tr>
<tr>
<td>for algebra: problem solving</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>8</td>
<td>3</td>
<td>12</td>
</tr>
<tr>
<td>for algebra: structured individual work</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>8</td>
<td>1</td>
<td>12</td>
</tr>
<tr>
<td>for algebra: mathematical projects based on extended work</td>
<td>-</td>
<td>-</td>
<td>4</td>
<td>5</td>
<td>2</td>
<td>12</td>
</tr>
<tr>
<td>for data handling: practical simulations</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>8</td>
<td>3</td>
<td>12</td>
</tr>
<tr>
<td>for data handling: set problem solving task</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>7</td>
<td>2</td>
<td>12</td>
</tr>
<tr>
<td>for data handling: use structured individual work</td>
<td>-</td>
<td>-</td>
<td>4</td>
<td>6</td>
<td>2</td>
<td>12</td>
</tr>
<tr>
<td>for data handling: mathematical projects based on extended work</td>
<td>-</td>
<td>1</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>12</td>
</tr>
</tbody>
</table>
• Table 5.5 continued:

| Questionnaire items |  
|---------------------|---
| positive pole       | negative pole |
| practical simulations for algebra | |
| problem solving for algebra | |
| structured individual work for algebra | |
| project work for algebra | |
| practical simulations for data handling | |
| problem solving for data handling | |
| structured individual work for data handling | |
| project work for data handling | |

At the end of the first teaching practice, trainees reported that they had positive attitudes to using problem solving, structured individualized work and project work for algebra teaching. Most of them (7 out of 12) reported that they were using practical simulations for teaching algebra. On the other hand, the remaining trainees had less positive attitudes to using practical simulations for teaching algebra. Again, this will be investigated in the case studies.

Trainees reported that they had positive attitudes to using all active learning elements for teaching data handling. They thought all these were appropriate for teaching data handling.

• Table 5.6: Teacher Trainee’s Teaching

| Questionnaire items |  
|---------------------|---
| positive pole       | negative pole |
| I think mathematics needs to be taught in a different way to other subjects. | |
| I’ve my own ways of teaching. | |
| My students have lots of opportunities to use maths in other lessons (e.g. science). | |
| My lessons have almost the same form or structure for each lesson. | |
| Code4 (M): I understand the problems pupils come across better now. | |
| Code10 (F): There is a need to go right back to basics. | |
| Code12 (F): A lot harder than I thought it was; have to try and get into the mind of someone who can’t do mathematics. | |

They reported that they had positive attitudes to ‘mathematics need to be taught in a different way to other subjects’. They also reported that ‘they had their own ways of teaching’.
They also reported that they had negative attitudes to 'their students were enjoying mathematics,' and they reported that 'their students had lots of opportunities to use mathematics in other lessons'. Again, this will be investigated in the case studies.

They had positive attitudes to 'their lessons were the same structure' which suggests that they did not try to use different teaching methods and techniques in their teaching. After they started to teach mathematics, they realized how difficult teaching could be. One responded: 'I understand the problems pupils come across better now Code4 (M).'

They also reported that they had difficulty in going back to basics. One trainee wrote: 'It is not easy need to go right back to basics Code10 (F)' and the other one wrote that: 'A lot harder than I thought it was; have to try and get into the mind of someone who can't do mathematics Code12 (F)'.

- Table 5.7: PGCE Course

<table>
<thead>
<tr>
<th>Questionnaire I items</th>
<th>positive pole</th>
<th>negative pole</th>
</tr>
</thead>
<tbody>
<tr>
<td>-I've adopted a new approach to teaching mathematics recently</td>
<td>- I've adopted a new approach to teaching mathematics recently</td>
<td></td>
</tr>
<tr>
<td>-My understanding of mathematical ideas has changed in the process of teaching mathematics</td>
<td>-I have learned little new about mathematics during teacher training</td>
<td></td>
</tr>
</tbody>
</table>

They reported mixed attitudes to 'they had adopted a new approach to their teaching'. They also reported that they had positive attitudes to change in 'their understanding of mathematical ideas' and 'their view of mathematics teaching'. They also reported that they had negative attitudes to 'they had learned little new about mathematics during teacher training'. Overall this suggests that they had learned more things during their teacher training and their teacher training course had started to affect their approach.

- Table 5.8: Usage of Grouping Activities in Maths Classroom

<table>
<thead>
<tr>
<th>Questionnaire I</th>
<th>missing values</th>
<th>never</th>
<th>rarely</th>
<th>occasional</th>
<th>sometimes</th>
<th>usually</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>group work</td>
<td>-</td>
<td>-</td>
<td>5</td>
<td>5</td>
<td>1</td>
<td>1</td>
<td>12</td>
</tr>
<tr>
<td>individual work</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td>pair work</td>
<td>-</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>4</td>
<td>-</td>
<td>12</td>
</tr>
<tr>
<td>whole class</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>3</td>
<td>7</td>
<td>12</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Questionnaire I items</th>
<th>positive pole for active learning</th>
<th>negative pole for active learning</th>
</tr>
</thead>
<tbody>
<tr>
<td>-individual work</td>
<td>-group work (mostly)</td>
<td></td>
</tr>
<tr>
<td>- pair work</td>
<td>-pair work</td>
<td></td>
</tr>
<tr>
<td>- whole class</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Trainees reported that they had positive attitudes to using individual work and whole class teaching in their teaching. They had negative attitudes to using group work in their teaching. On the other hand, they had no particular attitudes to using pair work in their teaching.

- **Table 5.9: Usage of Active Learning Materials in Maths Classroom**

<table>
<thead>
<tr>
<th>Questionnaire I</th>
<th>missing values</th>
<th>never</th>
<th>rarely</th>
<th>occasional</th>
<th>sometimes</th>
<th>usually</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>books</td>
<td>-</td>
<td>8</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>12</td>
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<tr>
<td>library sources</td>
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<td>1</td>
<td>-</td>
<td>12</td>
</tr>
<tr>
<td>cinema, video</td>
<td>-</td>
<td>2</td>
<td>3</td>
<td>-</td>
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<td>-</td>
<td>12</td>
</tr>
<tr>
<td>computer</td>
<td>-</td>
<td>2</td>
<td>4</td>
<td>5</td>
<td>1</td>
<td>-</td>
<td>12</td>
</tr>
<tr>
<td>duplicated sheets</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>7</td>
<td>4</td>
<td>12</td>
</tr>
<tr>
<td>lecturer notes</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>12</td>
</tr>
<tr>
<td>pupil’s notes</td>
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<td>2</td>
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<td>1</td>
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<td>-</td>
<td>12</td>
</tr>
<tr>
<td>exercises</td>
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<td>-</td>
<td>-</td>
<td>2</td>
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<td>3</td>
<td>12</td>
</tr>
<tr>
<td>OHP</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>12</td>
</tr>
</tbody>
</table>

Trainees reported that they had positive attitudes to using books and duplicated sheets in their teaching. On the other hand, trainees reported that they had negative attitudes to using library sources, cinema, video, OHP and pupils’ notes in their teaching. They had no particular attitudes to using computers and lecturer notes in their teaching. The reasons for this might be that at this stage they do not know how to use the computer in their teaching or understand the use of lecturer notes in their teaching.

- **Table 5.10: Usage of Active Learning Elements in Maths Classroom**

<table>
<thead>
<tr>
<th>Questionnaire I</th>
<th>positive pole for active learning</th>
<th>negative pole for active learning</th>
</tr>
</thead>
<tbody>
<tr>
<td>questionnaire</td>
<td>items</td>
<td>items</td>
</tr>
<tr>
<td></td>
<td>books</td>
<td>library sources library sources</td>
</tr>
<tr>
<td></td>
<td>computer</td>
<td>cinema, video computer</td>
</tr>
<tr>
<td></td>
<td>duplicated sheets</td>
<td>pupil’s notes lecturer notes OHP</td>
</tr>
<tr>
<td></td>
<td>exercises</td>
<td></td>
</tr>
</tbody>
</table>

- If students work hard they will be good at maths
- ...suggest that they ask their parents for help
- ...encourage them to use diagrams
- ...encourage them to use computers (mostly neutral)
- ...learning depends on their own efforts
- ...use different ways to help them understand
- If students work hard they will be good at maths
- ...suggest that they ask their parents for help
- not be concerned about it
- encourage them to use computers (mostly neutral)
- ...suggest that they ask their parents for help

**Exemplars**

Code03 (M): *I find maths easy, I did not think others found it hard. This I feel now is not so.*

Code10 (F): *There is no need to go right back to basics*

Code12 (F): *A lot harder than I thought it was; have to try and get into the mind of someone who can't do mathematics.*

* ... : If my students are struggling with their mathematics, then I would
Trainees reported that they had positive attitudes to ‘if their pupils struggled, they had suggested their pupils use diagrams’, and they had felt concern for their pupils. In addition to this they reported that they had used different ways to teach them. They had neither negative nor positive attitudes to ‘suggest their parents help’ and ‘encourage them to use a computer’. They also reported that they had positive attitudes to ‘learning depends on pupils’ own efforts’. Furthermore, they reported that they thought if pupils worked hard they would be good at mathematics. They also reported that, in learning mathematics, there were individual differences. One of the trainees reported that: ‘I find maths easy. I did not think others found it hard. This I feel now is not so, code03 (M)’. They realize that it is very difficult to go back to the pupils’ own level of understanding ‘It is not easy to go right back to basics Code10 (F)’ and one wrote: ‘A lot harder than I thought it was; have to try and get into the mind of someone who can’t do mathematics Code12 (F)’.

In the view of 3 trainees, responding to an open-ended question, project work was not applicable to algebra. On the other hand, others reported that algebra projects were investigation, patterns&number sequences, equations, balancing, and the painted cube (an investigation).

Data handling topics mentioned were: statistics, questionnaires, measurements, time tables, calculation of interest rates, and colour distribution of Smarties and M&M’s.

The topics which teacher trainees ‘most enjoyed teaching’ revealed some gender differences, for example, male: Newton mechanics and angles&shapes; female: shape, statistics, mechanics and equations. These topics related to the trainees’ background. Whilst males preferred arithmetic, females preferred statistics (data handling). Common topics were shapes and mechanics.

According to male trainees, effective teaching depends on enthusiasm, teaching style, teaching methods, empathy with pupils, presentation, knowledge, practice, adaptability. According to female trainees, effective teaching depends on enthusiasm, teaching style, teaching methods, empathy with pupils, presentation, ability, sources/materials, relationships, clarity and patience. In contrast to male trainees, female trainees emphasise personal qualities such as relationships and patience.

They reported that they need to learn not just the subject knowledge but also pedagogical content knowledge. One of the trainees wrote that: ‘It is not just about being good at a subject but also about taking a step backwards and almost trying to un-learn knowledge, so that you can present it effectively, code8 (M)’. 

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QUESTIONNAIRE II

The findings of the questionnaire II data will show that most of the teacher trainees displayed a generally positive attitude to the active learning approach to teaching mathematics. The overall findings from Questionnaire II are summarized in Table 5.11.

Table 5.11: Grouping of English Questionnaire Items

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>I find mathematics topics fun to do.</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>7</td>
<td>2</td>
<td>12</td>
</tr>
<tr>
<td>I like arithmetic.</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<td>9</td>
<td>2</td>
<td>12</td>
</tr>
<tr>
<td>I like doing quadratic equations.</td>
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<td>-</td>
<td>-</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>12</td>
</tr>
<tr>
<td>I like data handling.</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>3</td>
<td>6</td>
<td>2</td>
<td>12</td>
</tr>
<tr>
<td>I think mathematics is a challenge</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>2</td>
<td>9</td>
<td>12</td>
</tr>
<tr>
<td>I think data handling is useful.</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>10</td>
<td>1</td>
<td>12</td>
</tr>
<tr>
<td>I enjoy teaching algebra.</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>I enjoy teaching data handling.</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>4</td>
<td>6</td>
<td>2</td>
<td>12</td>
</tr>
<tr>
<td>I have adopted a new approach to teaching mathematics recently</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>10</td>
<td>-</td>
<td>12</td>
</tr>
<tr>
<td>I think mathematics needs to be taught in a different way to other subjects.</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>5</td>
<td>7</td>
<td>-</td>
<td>12</td>
</tr>
<tr>
<td>I have my own ways of teaching.</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>10</td>
<td>-</td>
<td>12</td>
</tr>
<tr>
<td>I feel happy in my mathematics lessons</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>10</td>
<td>2</td>
<td>12</td>
</tr>
<tr>
<td>I think most of the students in my classes enjoy studying mathematics</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>7</td>
<td>5</td>
<td>-</td>
<td>12</td>
</tr>
<tr>
<td>If students work hard they will be good at maths</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>5</td>
<td>4</td>
<td>-</td>
<td>12</td>
</tr>
<tr>
<td>My lessons have almost the same form or structure for each lesson.</td>
<td>-</td>
<td>-</td>
<td>6</td>
<td>4</td>
<td>2</td>
<td>-</td>
<td>12</td>
</tr>
<tr>
<td>My students have lots of opportunities to use maths in other lessons (e.g. science,..)</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>2</td>
<td>7</td>
<td>1</td>
<td>12</td>
</tr>
<tr>
<td>Pupils find algebra difficult.</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>4</td>
<td>7</td>
<td>1</td>
<td>12</td>
</tr>
<tr>
<td>*...be more sympathetic</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>9</td>
<td>1</td>
<td>12</td>
</tr>
<tr>
<td>*...suggest that they ask their parents for help</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>8</td>
<td>2</td>
<td>-</td>
<td>12</td>
</tr>
<tr>
<td>*...not be concerned about it</td>
<td>-</td>
<td>10</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>12</td>
</tr>
<tr>
<td>*...use different ways to help them understand</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>5</td>
<td>7</td>
<td>2</td>
<td>12</td>
</tr>
<tr>
<td>*...think learning depends on their own efforts</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>*...encourage them to use diagrams</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>6</td>
<td>4</td>
<td>-</td>
<td>12</td>
</tr>
<tr>
<td>*...encourage them to use computers</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>5</td>
<td>7</td>
<td>-</td>
<td>12</td>
</tr>
<tr>
<td>*...encourage them to use books/ textbook</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>8</td>
<td>4</td>
<td>-</td>
<td>12</td>
</tr>
<tr>
<td>I have learned little new about mathematics during teacher training</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>9</td>
<td>-</td>
<td>12</td>
</tr>
<tr>
<td>My understanding of mathematical ideas has changed in the process of teaching mathematics</td>
<td>-</td>
<td>5</td>
<td>5</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>12</td>
</tr>
<tr>
<td>I think my view of mathematics teaching has changed</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>9</td>
<td>1</td>
<td>12</td>
</tr>
</tbody>
</table>

Freq.: Frequencies
*...: If my students are struggling with their mathematics, then I would
The detailed findings and discussion in each of the major categories investigated now follows.
Teacher trainees reported that they had positive attitudes: they found mathematics fun to do; thought mathematics was a challenge; felt happy in mathematics lessons. Teacher trainees reported that they had a positive attitude to ‘like data handling’; and they think ‘data handling is useful’. Teacher trainees reported that they had a positive attitude to all related algebra items: they enjoy teaching algebra; they like arithmetic; and they like doing quadratic equations.

They reported in both Questionnaires I and II that they had neither negative nor positive attitudes to teaching of data handling. Their attitudes to teaching and enjoying mathematics were positive and there was no change between the end of their first teaching practice and last teaching practice.

### Table 5.13: Active Learning Elements for Algebra and Data Handling:

<table>
<thead>
<tr>
<th>Questionnaire II</th>
<th>missing values</th>
<th>not important</th>
<th>quite important</th>
<th>important</th>
<th>very important</th>
<th>N</th>
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<tbody>
<tr>
<td>for algebra: practical simulations</td>
<td>-</td>
<td>6</td>
<td>-</td>
<td>4</td>
<td>2</td>
<td>12</td>
</tr>
<tr>
<td>for algebra: problem solving</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>7</td>
<td>3</td>
<td>12</td>
</tr>
<tr>
<td>for algebra: structured individual work</td>
<td>-</td>
<td>4</td>
<td>-</td>
<td>7</td>
<td>1</td>
<td>12</td>
</tr>
<tr>
<td>for algebra: mathematical projects based on extended work</td>
<td>1</td>
<td>3</td>
<td>-</td>
<td>7</td>
<td>1</td>
<td>12</td>
</tr>
<tr>
<td>for data handling: practical simulations</td>
<td>-</td>
<td>3</td>
<td>-</td>
<td>4</td>
<td>5</td>
<td>12</td>
</tr>
<tr>
<td>for data handling: set problem solving task</td>
<td>-</td>
<td>5</td>
<td>-</td>
<td>5</td>
<td>2</td>
<td>12</td>
</tr>
<tr>
<td>for data handling: use structured individual work</td>
<td>-</td>
<td>4</td>
<td>-</td>
<td>7</td>
<td>1</td>
<td>12</td>
</tr>
<tr>
<td>for data handling: mathematical projects based on an extended piece of work</td>
<td>-</td>
<td>3</td>
<td>-</td>
<td>8</td>
<td>1</td>
<td>12</td>
</tr>
</tbody>
</table>
Teacher trainees reported that they had a positive attitude about using problem solving, structured individualized work and project work, for algebra teaching. But they had no specific attitudes about using practical simulation in their algebra teaching.

On the other hand, they reported that they all had positive attitudes towards using practical simulations, structured individualized work and project work for teaching data handling. They had no specific attitudes about using problem solving for data handling teaching. They had a contrasting view about using active learning elements in algebra and data handling teaching. This will be considered in the context of individual case studies.

They reported in both questionnaires that they had similar attitudes to the use of active learning elements. Their attitudes had not changed between the end of their first teaching practice and their last teaching practice.

- **Table 5.14: Teacher Trainee's Teaching**

<table>
<thead>
<tr>
<th>Questionnaire II</th>
<th>positive pole</th>
<th>negative pole</th>
</tr>
</thead>
<tbody>
<tr>
<td>questionnaire</td>
<td>= I think most of the students in my classes enjoy studying mathematics</td>
<td>= I think most of the students in my classes enjoy studying mathematics.</td>
</tr>
<tr>
<td>items</td>
<td>= My students have lots of opportunities to use maths in other lessons (e.g. science).</td>
<td>= My lessons have almost same form or structure for each lesson.</td>
</tr>
<tr>
<td></td>
<td>= I think mathematics needs to be taught in a different way to other subjects.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>= I've my own ways of teaching.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>= I feel happy in my maths lessons</td>
<td></td>
</tr>
</tbody>
</table>
positive attitudes to 'their pupils had a lot of opportunities to use maths in other lessons'. This suggests that their pupils applied their mathematical knowledge to other lessons, such as Science.

They reported in both questionnaires that they had similar attitudes to the teacher trainees' teaching items. Their attitudes had not changed between the end of their first teaching practice and the last teaching practice, except for the item 'their lessons had almost the same form and structure for each lesson'. In Questionnaire I, they reported that they had the same form for their lessons, but they reported in Questionnaire II that they had a negative attitude to 'their lessons took the same form' which suggests that they had become more open to other methods.

- **Table 5.15: PGCE Course**

<table>
<thead>
<tr>
<th>Questionnaire II</th>
<th>positive pole</th>
<th>negative pole</th>
</tr>
</thead>
<tbody>
<tr>
<td>questionnaire</td>
<td></td>
<td></td>
</tr>
<tr>
<td>items</td>
<td>=I've adopted a new approach to teaching mathematics recently.</td>
<td>= My understanding of mathematical ideas has changed in the process of teaching mathematics</td>
</tr>
<tr>
<td></td>
<td>= I have learned little new about mathematics during teacher training</td>
<td></td>
</tr>
<tr>
<td></td>
<td>=I think my view of mathematics teaching has changed.</td>
<td></td>
</tr>
</tbody>
</table>

Teacher trainees reported that they had a positive attitude to 'adopted a new approach to teaching maths'. They reported that they had learned little new about mathematics (not mathematics teaching!), but their views had changed during the course. They had a negative attitude to 'their understanding of mathematical ideas has changed during the teaching of mathematics' which suggests that their understanding of the subject, as opposed to pedagogical content knowledge had not changed.

They reported that in both questionnaires they had shown a positive attitude to 'adopting a new approach to teaching mathematics'. On the other hand, they also reported that they had shown a positive attitude to 'learning little new about mathematics'.

- **Table 5.16: Usage of Grouping Activities in Maths Classroom**

<table>
<thead>
<tr>
<th>Questionnaire II</th>
<th>missing values</th>
<th>never</th>
<th>rarely</th>
<th>occasional</th>
<th>sometimes</th>
<th>usually</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>group work</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>7</td>
<td>3</td>
<td>-</td>
<td>12</td>
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<tr>
<td>individual work</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>11</td>
<td>12</td>
</tr>
<tr>
<td>pair work</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>8</td>
<td>4</td>
<td>-</td>
<td>12</td>
</tr>
<tr>
<td>whole class</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>1</td>
<td>5</td>
<td>4</td>
<td>12</td>
</tr>
</tbody>
</table>

- **Table 5.16 continued**

<table>
<thead>
<tr>
<th>Questionnaire II</th>
<th>positive pole for active learning</th>
<th>negative pole for active learning</th>
</tr>
</thead>
<tbody>
<tr>
<td>questionnaire</td>
<td>=individual work</td>
<td>=group work (occasionally)</td>
</tr>
<tr>
<td>items</td>
<td>=pair work</td>
<td></td>
</tr>
<tr>
<td></td>
<td>=whole class</td>
<td></td>
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</tbody>
</table>
Teacher trainees reported that they had a positive attitude to using individual work and whole class teaching in their mathematics teaching. They had a negative attitude to using group work in their teaching.

They reported in both questionnaires that they had similar attitudes to use of grouping activities in mathematics classroom items. Their attitudes to pair work had changed.

- Table 5.17: Usage of Active Learning Materials in Maths Classroom

<table>
<thead>
<tr>
<th>Questionnaire II</th>
<th>missing values</th>
<th>never</th>
<th>rarely</th>
<th>occasional</th>
<th>sometimes</th>
<th>usually</th>
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<tbody>
<tr>
<td>books</td>
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<td>2</td>
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<td>-</td>
<td>12</td>
</tr>
<tr>
<td>cinema, video</td>
<td>-</td>
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<td>3</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>12</td>
</tr>
<tr>
<td>computer</td>
<td>-</td>
<td>-</td>
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<td>9</td>
<td>2</td>
<td>-</td>
<td>12</td>
</tr>
<tr>
<td>duplicated sheets</td>
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<td>-</td>
<td>-</td>
<td>2</td>
<td>6</td>
<td>3</td>
<td>12</td>
</tr>
<tr>
<td>lecturer notes</td>
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<td>2</td>
<td>4</td>
<td>5</td>
<td>-</td>
<td>-</td>
<td>12</td>
</tr>
<tr>
<td>pupil's notes</td>
<td>1</td>
<td>4</td>
<td>1</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>12</td>
</tr>
<tr>
<td>exercises</td>
<td>-</td>
<td>-</td>
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<td>4</td>
<td>5</td>
<td>12</td>
</tr>
<tr>
<td>OHP</td>
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<td>4</td>
<td>6</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>12</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Questionnaire II</th>
<th>positive pole for active learning</th>
<th>negative pole for active learning</th>
</tr>
</thead>
<tbody>
<tr>
<td>questionnaire items</td>
<td>=books</td>
<td>=library sources</td>
</tr>
<tr>
<td></td>
<td>=computer</td>
<td>=cinema, video</td>
</tr>
<tr>
<td></td>
<td>=duplicated sheets</td>
<td>=computer</td>
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<tr>
<td></td>
<td>=pupil’s notes</td>
<td>=lecturer notes</td>
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<tr>
<td></td>
<td>=exercises</td>
<td>=pupil’s notes</td>
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<td></td>
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<td>-OHP</td>
</tr>
</tbody>
</table>

Teacher trainees reported that they had a positive attitude to using books, duplicated sheets, exercises and home made materials in their teaching. On the other hand, they had a negative attitude to using library sources, cinema, video, lecturer notes and OHP in their teaching. Conversely, they reported that they had neither negative nor positive attitudes to using computers and pupils’ notes in their teaching.

In both questionnaires, their attitudes had not changed about adopting active learning materials.
### Table 5.18: Usage of Active Learning Elements in Maths Classroom

<table>
<thead>
<tr>
<th>Questionnaire II items</th>
<th>positive pole for active learning</th>
<th>negative pole for active learning</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>&quot;...suggest that they ask their parents for help&quot;</td>
<td>&quot;...suggest that they ask their parents for help&quot;</td>
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<tr>
<td></td>
<td>&quot;...encourage them to use computers (mostly neutral)&quot;</td>
<td>&quot;...encourage them to use computers (mostly neutral)&quot;</td>
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<td></td>
<td>&quot;...learning depends on their own efforts&quot;</td>
<td>&quot;...learning depends on their own efforts&quot;</td>
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<td></td>
<td>&quot;...use different way to help them understand&quot;</td>
<td>&quot;...not be concerned about it&quot;</td>
</tr>
<tr>
<td></td>
<td>&quot;...encourage them to use books/textbook&quot;</td>
<td>&quot;If students work hard they will be good at maths&quot;</td>
</tr>
<tr>
<td></td>
<td>&quot;...encourage them to use diagrams&quot;</td>
<td></td>
</tr>
</tbody>
</table>

*...*: If my students are struggling with their mathematics, then I would

Teacher trainees reported that they had a positive attitude to ‘encouraging their pupils to use diagrams, and using books and textbooks’.

In the case of projects for algebra, female trainees reported that they preferred to use investigation, number patterns, equations and painted cubes/cuboid; while male trainees reported that they preferred equations and the Frog investigation. The common topic was equations. These were similar responses to those in the first questionnaire. Identified projects for data handling were surveys (4 female), favourite sports, TV programmes, preferred school subjects (2 male and 2 female reported the same topics.), probability (1 male and 1 female), and 2 no response. According to Questionnaire II, teacher trainees' most enjoyable teaching topics were different for male and female respondents: male trainees reported Newton mechanics and algebra as the most popular, and female trainees reported algebra. According to Questionnaire II, male respondents emphasized that effective teaching depended on: enthusiasm; knowledge; teaching style; motivation of pupils; Female respondents emphasized mostly personal qualities such as relationships, patience. Also, female respondents emphasized the environment, and class management. Males and females held similar views on effective teaching of mathematics after the first teaching practice and the last teaching practice. However, the two sexes suggested different topics for projects in algebra and data handling.

In the light of the findings obtained from the questionnaire completed by 12 PGCE secondary mathematics teacher trainees, further discussions related to the theories of active learning will be included in the case studies chapter and in the concluding chapter.
CHAPTER 6
INTRODUCTION TO THE CASE STUDIES

This chapter focuses on the attitudes, beliefs, thoughts, and actions of four of the Leicester teacher trainees, during their PGCE course, three of them female, and one male. The trainees were recruited to this study on the basis of various criteria: age, gender, their mathematics backgrounds, trainees’ work experience and teaching experiences, year of graduation from university, teaching algebra and data handling in teaching practice and assignments related to the algebra and data handling. All four case study candidates volunteered to participate. Two of them had relatively strong mathematics backgrounds and teaching experiences (Linda Hackett and Catherine Penn) and two relatively weak backgrounds and limited teaching experiences (Claire O’Neill and Scott Holligan); two were mature (Linda Hackett and Scott Holligan) and two were new graduates (Catherine Penn and Claire O’Neill).

The case studies cover interview, observations, school files (lesson plans, lesson evaluations, assessment of pupils, school policies, class lists, lesson documents, materials, etc.) and GTTR data. Through the analyses of all these sources, it was possible to compare trainees’ attitudes, beliefs, thoughts about teaching mathematics and their use of active learning approaches in PGCE university sessions and teaching practice. All the data were collected, reduced and interpreted (Miles&Huberman, 1994).

In each case exemplar, the participant was involved in a semi-structured interview by the researcher after the first teaching practice. All interviews were audio-taped, after which all tapes were transcribed and all transcripts of the interviews were checked with the tutor. Some of the observations were preceded by a period of classroom teaching and mathematics sessions in the PGCE. All participants were observed teaching. During the observations, specific instances were recorded, illustrating the influences on learning to teach and the stage they had reached (beginning teaching stage to reflective teaching stage). These stages were also considered in relation to trainees’ planning and school files. After each interview, trainees filled in a form to put into order some items which were helpful and unhelpful to their learning to teach.

Every case exemplar’s interview took between 1 hour 10 minutes and 1 hour 45 minutes and observations were based on trainees’ teaching of algebra and data handling topics. Algebra teaching observations took place in the autumn term and data handling observations took place in the spring term. Interview data was also supplemented by a questionnaire. One of the data collection rounds also involved trainees’ and tutor’ s video
extracts to illustrate how they adapted the active learning approach to their teaching. The main aim of coupling interview and observation was to be able to probe more effectively into trainees' understanding of their teaching while they were learning. In addition, the mathematics subject tutor was also interviewed at the end of the second term to get his ideas about the training course and trainees' progress during the course. This course's inspection result was also used as another source of data to compare this study's result with the inspection result of the course. All interviews were audio-taped and some observations were audio recorded. Transcription and ongoing analysis was used to inform further data collection. In each case all the exemplars' related documents were photocopied and their lesson documents and materials collected. Their lesson plans and assignments were ordered according to time sequence. The reason for this was to observe how their learning affected their teaching, to show progression in their learning and to show how this was reflected in their writing and behaviour during the time period.

The analysis of interview transcripts often raised some issues and dilemmas. At this point observations and written documents helped. For example, in one interview trainees talked about their classroom management and control and said they had no problem with it. On the other hand, observations and other written documents did not support this.

The data collection yielded a substantial volume of transcribed and coded material. Although some ongoing analysis occurred during the data collection procedure and the research process, the final analysis still required all of the transcribed and coded materials to be reviewed again. The main aim of reviewing was to produce a case history on a one year period of their PGCE teacher training. On the other hand, the construction of case histories was a very time-consuming process, involving at least fifteen to twenty drafts and redrafts. But it did, however, develop and become richer every time. In the final stage of the case studies, attention was given to the fact that these would be read by people who might or might not be related to teaching. That is why, there was a need to provide the necessary contextual detail to make the accounts meaningful to their audience.

Ongoing analysis helped to identify areas where change might be expected to occur and which it might be useful to monitor over the course of the study. A few trainees gave detailed information about learning to teach and changes during the process of teacher training.

In the case studies, the main concern was validity of the data and its interpretations. Similarly, all qualitative research is faced with this problem.

In this study, the accuracy of trainees' own records and writings was emphasised. How do these records and writings reflect their own feelings, attitudes and beliefs? That is why the following strategies were adopted:
• the researcher obtained permission to use their records, interviews and all their data,
• the researcher joined them during their sessions and teaching practice to develop trust and honesty with them,
• the aim of the research was explained to them at the beginning of the study,
• after observation, issues were raised and discussed with the trainees.

In case studies, another influence on validity was data interpretation. Transcribed materials and coded materials were open to different interpretations. For this reason the following strategies were adopted:

• trainees and tutor read the whole interview extract and commented on it,
• all data collected and its analysis needed constant verification, elaboration and checking out of interpretations,
• each version of a case study was read and commented on by a tutor.

Checking was conducted at all strategies. Nevertheless, the data collection and analysis attempted to guard against the major areas of bias that might influence the study.

The main aim was to explore the trainees’ attitudes to teaching mathematics and using the active learning approach and how this was reflected in their learning to teach. These kinds of studies use ‘data of narrative inquiry’ (Connelly and Clandinin, 1990). As Connelly and Clandinin (1990) asserted, narrative inquiry is ‘derived from filed notes of shared experience, journal records, interviews, story telling, letter writing and autobiographical and biographical writing’ (pp. 5-6). Loughran (1996) stated that ‘Case studies have been adopted, as they best portray the form of inquiry conducted as well as the type of practitioner-research relationship necessary to develop such rich data’ (p.120). The researcher used most of these methods to answer the research questions.

These case studies will show that attitudes changed over two distinct periods: after the first teaching practice and the last teaching practice. Each trainee’s experience of learning to teach mathematics was very different and the stages through which they passed to the reflective teaching stage were also unique to each trainee. Each of them started and finished at different stages during their teacher training. The emphasis on active learning in the course will be shown to have helped them to reflect on their learning to teach and to have helped their progression through the stages in learning to teach.

The case studies have been written to give the reader a context for how each trainee approached learning to teach mathematics using active learning approaches. Each case exemplar is important in helping to develop an understanding of how and why each individual varied in their approach to reflection. Each case exemplar develops and extends
the links between the four stages: beginning teaching stage, supervised teaching stage, from teaching to learning stage, and reflective teaching stage. Details of progress for each of the four trainees is described. Learning to teach, stage theory and reflective process studies were discussed in earlier chapters.

This research has traced trainees' learning from and through their experiences, as they individually developed their own approach to reflection as a result of their involvement in a secondary mathematics teacher education programme, which attempted to model reflective practice using the active learning approach.
CHAPTER 6

6.1 THE CASE OF CLAIRE

Claire is 24 years old. She received a Maths and Science degree from a local University in East Midland before gaining primary school experience with ages 7-11 pupils, through a work placement. She had previously attended sixth form, where she completed her A level courses, but only achieved a grade E in maths. Almost all Claire's beliefs about good mathematics teaching were verbalized in the interview.

In the account which follows data was obtained through observation, interview, Claire's own lesson evaluations, and her own university assignments. As part of her course she had to conduct a piece of research into an aspect of learning and teaching mathematics, she chose to focus on 'teaching algebra' (University assignment II). She kept a reflective learning journal which included lesson plans, lesson evaluation sheets, self assessment and assignments. Her records during the PGCE course, including records of teaching practice, which are analysed in this chapter, show plenty of evidence of her capacity to reflect on her practice and develop into a 'reflective practitioner'.

Claire's case highlights some of the different perceptions of mathematics through particular examples of trainee's beliefs and considers how these beliefs affect their teaching. Her case addresses some key questions. What do trainees learn and how do they learn to teach mathematics? What changes occur over the training course? How do trainees' views interact with the important experience of training? Claire's case study illustrates the influence of her prior mathematics background, secondary and undergraduate education. In addition to this, it illustrates her views, attitudes and beliefs about learning to teach, which any mathematics teacher trainee initially brings to an initial teacher training course. During the course, PGCE maths sessions, and teaching practice in mode A and mode B attachment all influenced Claire's learning to teach mathematics, as did both her PGCE tutors and co-tutors in the schools.

Claire's secondary school background and mathematics experience

Claire went to a Catholic school which she described as very disciplined.

The school I went to was a very strict Catholic school to start off with, very disciplined, with a school uniform, and the class sizes I would say, were about 25 because we did have about six classes of maths each year. It was streamed all the way through (interview).

According to Claire, the streams and set groups were not flexible in her secondary school.

We were actually streamed into tutor groups before we arrived at the school. We were put into tutor groups which were slightly streamed because it was a split year.
So the first three years we were in top groups and then you had your other three years where you were in low ability groups, split like that, which was pretty bad because it meant that you didn't have much opportunity to move maths groups you have to move with the whole form, so you basically changed for all subjects because it was split down the middle like that. I was in the second set to the top but again within the top three sets there was the opportunity to be moved up and down within when it comes to Maths, English, and so on (interview).

Claire went on to describe how moving from one set to another was determined by performance.

We had a test as soon as we were a few weeks into the term. When I first started we had a test and that was basically to place people into streamed maths classes. They were basic tests that were written up by teachers. I think each classroom teacher wrote up their own test. Each class had a different test set by their teacher (interview).

She also described her secondary education as very traditional mathematics teaching.

In my first few years doing maths it was actually 'chalk and board', open the books right now do this, do that, sort of teaching (interview).

We didn't do any IT in maths, we didn't have anything except the teacher standing up at the front of the class with a piece of chalk and the blackboard. There weren't a lot of different activities or anything like that. It was pretty poor (interview).

From these extracts, it can be seen Claire's main experience of secondary mathematics teaching was largely one in which topics were taught, examples were practised and pupils were tested. However, not all of Claire's secondary schooling involved this type of teaching. There was one period when she was part of a trial group following a GCSE examination course. Although it was an experimental course, she actually did exams, with no allowance given for course work.

I didn't have course work, I just had two exams, that's it (interview).

... they brought in GCSEs when I was at school. I wasn't quite the guinea pig, I was in the second year. I didn't have course work that was brought in afterwards (interview).

Thus she associated most of her memories of secondary school and university mainly with traditional mathematics teaching such as 'chalk and talk'. According to her responses, her most successful mathematics lessons involved groups and partnerships such as when she took the experimental GCSE course. However, although enjoying her GCSE lessons there was a down side, because they didn't adequately prepare her for a return to more 'traditional mathematics' at advanced level. When she faced her post-GCSE education, Claire was in shock. She had had little experience of different teaching methods and thus she developed a real concern in continuing her education. One reason for this was that Claire's experience of GCSE had not equipped her for an A level Mathematics course.
I found GCSE a big shock. I also found it a shock to go from GCSE maths to A level maths. It’s a very big jump. My older sister found there wasn’t much of a jump between O level maths and A level maths but to go from GCSE maths to A level maths is a massive jump. From A level maths to degree HND maths level I found it wasn’t just a case of learning different methods, it was a case of looking at things more in depth, so simple subjects like doing differentiation integration at degree level involved looking at this scenario and that scenario and in so much depth. Generally you found that you needed a more independent approach. You have to find things out for yourself and you had to use the actual theory that you were given (interview).

Thus, Claire found a sharp contrast between straight-forward, traditional mathematics teaching and teaching for GCSE mathematics. She preferred the practice and investigative approach. However, this caused problems because a traditional type of mathematics predominated both her ‘A’ level and university courses.

Once at university, however, the style of teaching was much more formal like her early experience of mathematics at school.

At university you go into a lecture and the lecturers just stand up in front while you were expected just to sit and take notes, that was it. You had all the theory then you had a tutorial where you look at the theory and answer the questions (interview).

During her undergraduate education, Claire faced some personal problems, which involved her personal mathematics tutor at University. Her tutor was reluctant to answer her questions.

The other thing about being at university and being at school which is different is a lot of the lecturers are paid an hourly rate. They were there to help but they weren’t as committed as a school teacher would be because obviously a school teacher is there from 8.30 to 3.30 so a school teacher is then very committed to the pupils and helps them all the way through school. At university I found that lecturers change every year so you didn’t really get to know them that well and you found that they won’t put themselves out for you. They thought you should be able to stand up on your own two feet and get on with it (interview).

Claire’s secondary and undergraduate education (independent learning) and relationship with teachers

As in her earlier description of mathematics teachers, Claire makes similar distinctions about her art lessons, contrasting teachers who show a human side and provide support against those who ‘leave you to get on with it’.

I would say the best lessons I used to have were my art lessons. It was practical I always love practical lessons I like to be doing things. I did get a lot of help from the teacher, he was very approachable, and he was very soft. He had lots of ideas. He wouldn’t take over, just let you think about your ideas and help you out and make suggestions. On the other hand, I had another art teacher who used to say: ‘Oh! Claire! You are all right you can get on with it’. I didn’t get any kind of enrichment. I didn’t feel like I got any teaching in some of my lessons because the teachers thought I should be able to do without them (interview).
These descriptions of Claire’s own experience of mathematics were not enthusiastic. She talked a lot about tests. From Claire’s perspective, university education was hard and involved particular problems for her.

*Lecturers think you have all the basics from your GCSE and A level work and that you should be able to figure it out. It wasn’t until I started this course that I actually looked at different structures, looked at why we should do things and thought that is how we should teach it* (interview).

Claire stressed the importance of working independently at university.

*I found that a lot of the work we did was getting the information that we needed and then working through using that information to figure out how to do it. You had to work a lot of things out for yourself and it was quite independent learning. I found that they left it up to you* (interview).

Claire’s progress on the basics of mathematics was, notwithstanding her anxieties, a perfectly respectable average for that of the class. She constantly needed motivation from her teachers and tutors in her education but she did not find this in university undergraduate education. Some of her lecturers were insensitive, and didn’t understand her needs.

At school, if you weren’t doing very well, your marks would get lower, but if your marks were getting higher they would say ‘well done you are doing really well’. University lecturers aren’t like that. It’s up to you to study, it’s up to you to get on with it, so if you get a low or high grade it’s no skin off their nose. They are not bothered. That is why I would prefer to be a teacher in a school rather than a lecturer at college, because I like to take that personal interest, I enjoy the more caring attitudes. (interview).

These comments illustrate Claire’s sensitivity and concern to build relationships in teaching. Throughout the interview, in which Claire described her mathematics experience, she often made reference to her teachers. At school, for example:

*I would say there were quite a lot of bad maths lessons where basically the teacher just stood up in front, wrote something on the board and said get on with it. There were a few maths teachers in the maths department that were really strict as well. I actually got smacked in front of the classroom because I had forgotten something, or got it wrong which was embarrassing* (interview).

*I haven’t had any good experiences of maths being taught in an interesting and exciting way. That makes it harder to know what makes pupils actually want to come to maths lessons, with bad experiences I find it difficult* (interview).

This linking of unsatisfactory personal experience with traditional forms of teaching continued at university. In one case, in which she asked her tutor for help he replied:
I have to go or I will miss my train. I said ‘you are supposed to be here a full hour’. He said ‘I don’t care’ and he left. He should have been there an hour to help me with whatever problems I had (interview).

It seems that Claire’s view of the teaching is very much influenced by her personal experience of teachers. The GCSE teacher who provided opportunities for problem solving and exploratory activities, also spent time discussing things and encouraged students to work together and help each other.

I often found algebra with my GCSE teacher was really good. He went into depth and looked at where algebra comes from (interview).

I found it a little bit more interesting plus the fact that he had his classroom arranged in group desks, so that we didn’t sit in lines, which was what all the other classes were like. This gave the opportunity for working in groups to help each other and things like that. They were probably some of my best lessons. In fact I don’t know why I actually went on to do maths (interview).

Without exception, Claire’s best lessons were her GCSE lessons. She liked the contrast in teaching and the emphasis on understanding and investigation.

The best lessons I had were with a GCSE teacher that took me, who was head of department, in the same school. That was much better, he actually went into depth and we had to find things out giving you a deeper understanding (interview).

In contrast to this warm and investigative approach, the traditional teacher in her secondary school actually smacked her for not knowing something while the university tutor couldn’t be bothered to wait and answer her questions. Not suprisingly, therefore, Claire feels ‘real teaching’ is an activity in which you are involved with the students and where their problems are your concern.

I just have never seen the lecturers in the university as real teachers, they just hand the knowledge out and you do with it what you want, whereas I see teaching at school as you getting more involved with the students, if they have got problems and things like that (interview).

Claire’s enthusiasm for active learning approaches to mathematics would appear to be based not so much on her view that such methods are more effective, but rather because these methods were used by the kind of teacher she admires, one who is warm, friendly, approachable and has time for students’ demands. Claire makes a link between traditional teaching and the stereotype of the traditional teacher who is only interested in their subject and remains aloof from the students. She wants to teach mathematics more interestingly, to care about her pupils, and to do this she feels the need to use more active learning elements.
Claire's concepts of a teacher and motivation for teacher training

Claire's reasons for wanting to teach are mainly based on personal relationships. She wants to be a school teacher as opposed to a lecturer.

I actually always wanted to teach from this high to this high (she always wanted when she was so small kid) (interview)

I never ever changed my mind about it (interview).

I want to be a school-based teacher rather than a lecturer because I do like the more personal approach, I do like to take an interest in my students' lives and get the whole picture, not just sorting out lists of names who are supposed to turn up to a lecture.

I prefer to be actually bothered about whether a student is doing well or not and so I definitely decided I didn't want to teach in college (interview).

On the other hand her mother wanted her to have a career either as a nurse or in another profession.

My mum wanted me to nurse but I always wanted to teach and I wanted to be a teacher (interview).

In fact, Claire wanted to be a special needs teacher, but this needed at least three years experience before she could undertake the necessary training. For this reason, she decided to train as a subject teacher first, so that after gaining experience she could start to become a special needs teacher.

I would like to teach deaf and sign language. I found that I can only do that after three years experience of teaching. I was going to have to teach a particular subject and then specialise after a little bit of experience (interview).

According to Claire, she feels good at art, but thinks art is very competitive and that she wouldn't succeed.

I thought of teaching art, because I like art and really enjoyed it. But an art degree is too competitive. I am not really competitive, so I thought that as there are not many jobs in art and there doesn't seem to me that much call for art teachers, I just want to keep it as a hobby (interview).

Claire's reason for choosing mathematics teaching was the lack of mathematics teachers.

When I chose my A-levels I was thinking about teaching and I knew that there was a lack of mathematics, language, and science teachers. (interview).

Despite her early negative experiences, she chose mathematics for its employment opportunities rather than because she enjoyed it. Claire chose the PGCE route because it kept her options open.

I couldn't go on to do a BEd. So I decided it was probably a better idea to do a degree then the PGCE because it keeps your options open. It means that at least once you have done a PGCE that if you go into teaching and you don't enjoy it then
you still have a maths degree to fall back on, to get another job. Basically I kept my options open (interview).

Claire, therefore, chose Mathematics teaching because she thought it would be easier to start and make progress.

For demographic and social reasons she chose a local PGCE course:

I didn't want to move out of Leicester. I was happy, my friends were here, so I just stayed here (interview).

Her close friends who had taken the PGCE in the previous year, recommended it to her.

One of my friends who was on the course last year talked to me quite a lot about the course... (interview)

As shown earlier Claire has a caring view about teaching.

My strength is my enthusiasm for teaching and I find it’s a big help (interview).

In summary, Claire emphasises teaching as a caring profession and points to her enthusiasm for teaching as a career to good opportunities for maths as opposed to art; and to an aspiration for special needs teaching in her early career. So far then, we are able to see Claire as someone who although not doing particularly well at her mathematics degree course, became a teacher in this subject because of the offer of better employment possibilities. Her views about teaching mathematics are closely bound up in her personal vision of what she sees a teacher as being: someone who is, above all else, a warm and caring person. It does not seem surprising that Claire’s alternative ambition is to cease teaching mathematics and to become a remedial specialist working with children with special needs.

Class and time management, and control

Class control is the main concern for most trainees in the early stages of their teaching and planning. Although observation of her first term teaching practice was to show that Claire had problems in these areas in her interviews, class management and control did not seem to be a major problem for her during teaching practice.

Classroom control / management doesn't bother me. I know that I have got them under control. Kids don't scare me (interview).

I think I managed a certain amount of control within the classroom (statistics lesson9, 19 November, 1997)

She had managed to deal with some disruptive pupils.

... Hasim, Ismail, Nazral are still very disruptive in the lesson (28 November, 1997, algebra)"
On the other hand, in her lesson evaluations, she had admitted having some difficulty with time management.

Didn't manage to cover as much of my planned lesson as I thought I would (3rd October 1997)

Managed to cover lesson plan and managed to keep to the time of the lesson (6 November, 1997)

Managed to cover a lot, the class seemed to respond and sat and worked well. Have managed to gain attention from beginning of the lesson, which I have been practising. I like to do the register first because if I don't I may forget (10 November)

First time managed to keep to my time and complete my lesson plan (12 November 1997)

My time keeping wasn't very good as the bell went before I could recap or pack up. Felt I was in control of the lesson and it went quite smoothly. Managed to not keep stopping and starting which meant the pupils worked harder (13 November 1997)

In her lesson evaluations she focused her concerns on gaining pupils' attention, and keeping them working on the task quietly at the last term of her teaching practice.

They were quiet, I could get their attention (8 May 1998)

Pupils work, although I think they could have worked a little harder and they talked a bit more than normal (8 May 1998)

Pupil work was excellent. They were on task. Slightly changed lesson plan, found that pupil understanding of the topic was good and they were able to start work without me going the board (23 April 1998)

Pupils worked extremely well in this lesson, managed to go through the work really well (22 April, lesson evaluation)

I was pleased with the amount of the work they seemed to get through and they all appeared to be on task 90-95% of the time (1 May 1998)

This lesson, they were for finishing off work, they got their heads down and worked quite hard, getting through the questions (6 May 1998)

According to Claire, her weakest area is her organisation.

My weakness is probably my organization, but it's getting a little bit better (interview)

In addition, she feels the need to use more varied resources.

Organization to some extent, resources and getting more interesting resources; the organization of the lesson, that is one of my weaknesses. I do need to try to collect these types of resources to use with the classes, rather than just going through the book (interview)
Coping with individual needs of pupils and using everyday examples

Research evidence confirms that learning mathematics is very different from individual to individual. Some find it easy, some do not. If learning mathematics includes everyday examples, it makes it much easier and more relevant (Lave et al, 1988). Claire’s experience also supported this.

I find it easy to learn mathematics if it’s related to everyday experiences. If you do maths and you don’t know where it comes from, then you think ‘well, what is the point? If you can relate it to everyday life where you use it in practical situations you find that is probably the easiest way to learn maths. (interview).

She found that she wanted to use different resources, and techniques to make mathematics more interesting for pupils.

I try to use a lot of different resources and different ideas. It is my idea to make maths interesting. It’s always been an ideal for me to make mathematics pupil friendly enough for them to say: ‘Oh! excellent. I’ve got algebra’ (interview).

Tried different techniques of substituting answers into the original equation to show how both sides equal each other. (6 November 1997).

Resources could have been a bit better (6 May 1998)

In my experience of teaching algebra there are many different ways of teaching particular aspects of algebra. Different pupils will respond to different methods (assignment II).

Research evidence has confirmed that teaching from a constructivist perspective requires trainees to be aware all the time that different pupils construct mathematical ideas in different ways. Claire emphasised the fact that other teacher colleagues helped her to decide upon the needs of special classes and different pupils because pupils have different backgrounds, and different expectations from the teachers. Claire’s own views on this aspects of her teaching were as follows:

I just find I pick up things from other teachers. Different classes use different methods, some classes might like be quite friendly, other classes are so quiet you can’t breathe. I tend to pick up things from other teachers about how they teach (interview).

I’ve high expectations. I do tend to think that even in the low ability groups there are no such things. I think I could be quite a pushy teacher and I think I would try to push them on but at the same time be realistic about the expectations (interview).

Claire seemed to face a dilemma here; on the one hand, she seems to favour specific methods, on the other she seems to be willing to follow what she sees other teachers do. She tried to be flexible and adaptable, however, she was insecure and lacking in confidence. She was also concerned about her pupils’ learning.
I am concerned about one pupil. I know he is one of the more able students but he said he didn't understand. I tried explaining it to him but he just constantly interrupted. I decided to take the books in again to see how much everyone had done (28 November, 1997, algebra).

Teaching for understanding or by rote?

To explore in greater depth the way in which Claire’s teaching attempted to develop pupils’ understanding and motivation we look in greater detail at her teaching in specific areas, where she identifies contexts and pupils’ misunderstandings.

From Claire’s point of view, algebra means letters and numbers and she thinks this confuses pupils, as it always has and probably always will:

Letters, numbers that's about it. Put the algebraic equation up and show the method. That’s it (interview).

In teaching algebra I have found the whole idea of using symbols or letters to represent numbers confuses students (assignment II).

...letters are used to represent the words and an equation is formed. There is an opportunity to use real life situations in order to develop a deeper understanding. This brings us to graphical representation of functions that are linear and square. There is a lot of scope here to use graphical calculators or computers. I found using spreadsheets to create straight line graphs helped to generate a more visual approach for pupils. (assignment II)

Algebra will always be one of the subjects in maths that will confuse students. Most of the common misconceptions arise when we start using letters instead of numbers, as maths is associated with numbers. There is evidence to show that children interpret letters as standing for a specific number with different letters standing for different numbers. Also in interpreting letters many students confuse the distinction between letters as representing the value or number relating to a measure or object (assignment II).

I mean for algebra we thought, like, swap it over to the other side, change the sign and that was it. In fact I don't think it wasn't allowed. It was not until I got to GCSEs that I actually found out why we swap it over to the other side. We have written this number on both sides so take the same number away from both sides, that was never explained to me until I was in year 10 (interview).

She emphasised that she hadn’t really had the opportunity to ask any questions in mathematics lessons until A level.

I have never ever questioned anything until I actually got my degree even when it came to A level (interview).

According to Claire, pupils do not like algebra.

The pupils don't particularly enjoy algebra and they found it difficult to understand that the answer would be formulae rather than a numerical value. I feel I should try a different approach for the next lesson as this didn't work very well (29 November 1997).
And the main problem with teaching algebra for her was the pupils’ expectations of answers to the questions.

One of the biggest problems that I have found in teaching algebra is that the students expect to have a single numerical answer at the end of the question and don't think the answer is correct if they are left with an algebraic statement with two or more terms (assignment II).

Active learning: as a learner and as a teacher

A combination of traditional and active learning elements are present in Claire’s experience as a learner and as a teacher. This includes whole class teaching, a few group activities, and pupils needing to raise their hands if they wanted to ask something.

For Claire as a pupil:

Usually just whole class teaching with the teacher at the front setting some examples. Occasionally we split into groups for GCSE. That's the opportunity for a little peer teaching because if you don't understand something you ask your friend how to do it. I found I was doing most of the peer teaching anyway because people tended to ask me how to do things so I was spending a lot of time explaining to people how to do things (interview).

Pupils put their hands up and asked for help but lots of people got embarrassed about things like that and didn’t like to put their hands up. They would prefer to sit there and talk. I can say lots of people don't like to admit that they don't understand something in front of the whole class (interview).

She described her first algebra lesson in year 9. Using real examples and demonstrations gives pupils a deeper understanding using modelling algebraic processes.

I tried the approach of balancing equations on either side of equals sign as I feel it gives a deeper understanding. Using scales I went through a few examples. ... after I gave the class a set of homework to hand in. For my next lesson I had to look at 2 difficulties the pupils had with the equations. When looking at the addition and subtraction of x terms I found it useful to use a number line. This time I tried to use colours, all the x terms including the sign in front were green and all the whole number terms including the sign in front were red. This method solved the problem of the mix up of which sign to change. After setting some work for the pupils to do I found that most of the class now seemed to understand simple equations and I felt that the pupils were ready to move on to the next step (November, school file, evaluation).

She sees important links between algebra and data handling and applies this to her teaching.

Moving on to graphs in algebra, we use graphs in a number of different subjects and it can be related to other attainment targets. One obvious link is data handling (assignment II).

...letters are used to represent the words and an equation is formed. There is an opportunity to use real life situations in order to develop a deeper understanding. (assignment II)
She believed that with this understanding pupils could solve real life examples and see the connections between and among the topics in the curriculum.

She thinks algebra teaching is one of the very hardest topics. That's why we need to have a great variety of teaching methods to teach this.

Algebra is probably thought of as one of the hardest topics in mathematics from a pupils’ point of view. As we can see it has many links in the maths NC as well as playing an important role in many other subject areas. The important point to make is that if approached in the correct way algebra can be taken from basics and taught in many different and interesting ways (assignment II).

Claire recognises that algebra is a difficult subject which is disliked by many pupils. She is working hard to make algebra understandable by linking it to relevant contexts and visual representations.

According to Claire, her own learning methods in mathematics were based on pattern and understanding methods.

I picked up the method and it made me think. I can do maths, I am confident at maths and I understand the method. I find that I look for patterns so when somebody gives me some maths I see right away what has to be done. (interview).

She also remembered that peer teaching was used a lot in her algebra lessons.

There was quite a lot peer teaching in our lessons from probably from year 7 to year 11. I found, in fact, even in junior school there tended to be peer teaching (interview).

She was keen on giving homework projects to pairs. She also considered project work as an enrichment and an extension of study.

I've actually given project work, when it comes to questionnaires they often do group work. I tend to give them homework that relates to class work then I'd like to give a final question which is more a problem solving question just to basically separate the higher abilities and I know who is capable of doing an extension work, enrichment work. Pair work basically you can see when you get the homework in, and I think kids do tend to work together but I don't mind that as long as they have not been getting things wrong.

Claire states that materials and resources for mathematics in her secondary school were mainly books.

We didn't have different kind of materials or resources to use. It was just the book, the teacher and get on with it (interview).

Books, questions, equations, blackboards (interview).

It wasn't too bad. You could actually look through the book and it showed you worked examples. Lots of people just looked at the method and got on with the questions. Today I look at some of the text books and the investigative work, the practical side of it and number patterns. I think we were basically dropped in at the deep end. We didn't look at number patterns or how to find rules for number
patterns and to work up to formulas. I think it was because I was in the top set so we were expected to understand straight away (interview).

According to her, data handling was different from algebra, it covered more statistics and was also more practical. In contrast to liking algebra, she did not like statistics.

In data handling she used mainly group work, and also questionnaires and she managed to use these tools in her teaching.

The aim of the lesson was to revise illustrating data, bar-charts, frequency polygons so there was a bit of practical work in constructing bar-charts etc. (2 November, 1997)

We worked in groups, usually about four or five of us, something like that, usually applied group work, we got together and we picked it up in questionnaires (interview).

Managed to sort out the groups for the questionnaire and they roughly chose the topic they wanted to look at (11 November 1997)

What we were doing, questionnaires and hypothesis, it was brilliant to work with groups (interview).

She did not have much experience with data handling in secondary school, and that's why she didn't choose statistics as an A-Level topic.

We had probably done about one project in just a week. I think that's why I didn't choose to do statistics when I came to A level, because I hadn't done that much on it. I just thought it was about numbers and finding out mean and medians. I didn't think there was any more to it than that. So I just went for the pure and mechanics (interview).

The materials used to teach data handling consist of one book and a questionnaire.

I can say probably Integrated Maths again-just a book and obviously we were doing questionnaires (interview).

Claire’s secondary school experience of data handling influenced her teaching. In addition to this, she used hypothesis forming and testing, and wanted pupils to represent their findings as a poster, or as pictures.

I actually taught pretty much the same way that I had been taught it (interview).

I did similar things. I had the kids get into groups, worked out the one hypotheses to do their own survey, come back with the results and then look at the results and make a booklet on it (interview).

Probably a bit more in depth than the data handling than I have done at school but obviously I did teach the methods, it wasn't straight into looking at the hypothesis. We had to learn all about hypothesis and what would be good or bad questions, so we did all that before I let them loose on the questionnaires. I think I actually handled it well and enjoyed it (interview).
She used the data handling and grouping activities and presented the results together.

I found that kids actually enjoyed working in groups. They actually worked harder because they would produce something to put on the wall and actually got quite competitive as well. I have got very interesting covers as, well, pictures on the front, because it was quite a practical thing to do and they have done about 3 or 4 lessons actually looking at the data and making the charts and then putting them in the booklets (interview).

I found it more appropriate for them to create their own questionnaires on a subject that interested them. Then they had to collect the data and using the data produce a booklet containing bar charts, pictograms and pie charts. I thought it would be better to use a friendship group. I found the task to be successful and it gave me a good idea of what they had understood from the topic. The other important factor was that the class seemed to enjoy the lesson, therefore they worked hard and produced some brilliant work (school file, evaluation).

She wanted to use all kinds of grouping activities in her teaching.

I used whole class work, I worked with groups, worked in pairs as well. I actually worked with 6 pupils on the computer while the rest of the class did work (interview).

She is happy to use an investigative approach and deepen understanding with everyday activities. She made some cross reference to her own prior experience as a learner working on similar lines.

Mathematics as a challenge and investigation

Claire uses investigations of number patterns in her algebra teaching. On the other hand she realises that these teaching methods are not enough and are not an effective way of teaching. She welcomes new methods into her own algebra teaching. Also she emphasises teaching methods in algebra in her written assignments.

I think it was a bit different in the fact that, you were looking at things like drawing bar charts, quite arty, which I did enjoy. I did get confused by it as well. I always hated statistics. I always liked algebra and always hated statistics. I find algebra like a puzzle and I enjoy doing puzzles and I enjoyed working things out. Data handling was a bit more of practical. We did some questionnaires and things like that. We did more algebra than data handling (interview).

Claire’s beliefs and knowledge about teaching mathematics particularly algebra and data handling were revealed by her responses to a series of questions about what it means for a student to be a good at mathematics, how s/he tackles maths and algebra in contrast with data handling.

Next term, I am teaching algebra again, and this time I think I am going to look over the algebra that I have done with year 9 and year 8. Key maths for year 8 is quite good, it has quite a few interesting different methods of teaching in it and I will see if I can improve on that and look at the common mistakes. It has influenced my teaching because I did start blackboard style and went on to looking at more
different ways of teaching. Plus, it is something I want to do in my assignment (interview).

From Claire’s perspective, mathematics seems to be a puzzle and a challenge. Although kids like puzzling, she considers they do not like algebra.

It is a challenge. Students don't see it as a challenge. I'd like to prepare some mathematics full of puzzles (interview).

Kids like to work out puzzles but they don't like maths. I find it very strange (interview).

I find mathematics to be a puzzle and I enjoy working out puzzles (assignment II).

She enjoys doing investigation, and giving investigative study to her pupils. However, she does realise that some pupils do not like investigative work, and that they need some traditional teaching, ‘chalk-talk’.

I've given quite a lot of investigative work where the pupil has to work it out and so on. I think that's fine and fair if you want to get deep understanding but I don't think it works for all pupils (interview).

I think some pupils need that blackboard work and the examples, I don't think it necessarily works all the time (interview).

Claire finds mathematics a challenge involving fun with some games. Her teachers also influenced what kind of teacher she wanted to be.

Claire developed her views about mathematics through the training course. She met new role models in the teacher training course. Claire’s beliefs, prior knowledge and experience of mathematics as learner have all affected her teaching as a student. Now we look to see how far what was done on her course helped her or hindered this development.

- Teaching methods on the PGCE course

She did not like big group lecturing in PGCE sessions. She liked small intimate groups. She always wanted to know people in the group.

I don’t like to sit in that hall over there (that is the big hall where lectures are given to PGCE trainees) or sit in any big groups (interview).

It is nice to meet the other people on the course but I don't like being thrown into situations where you go to this lecture with a hundred people sitting in there and then being thrown into these groups and told: you work together on this. I just feel slightly uncomfortable working with people who I don't know (interview).

You do things like role play and I hate it, really really hate it. You get thrown into a group of people that you meet once (interview).
I like the sessions we have with Mike (PGCE secondary mathematics tutor). I enjoyed those days when you get to discuss, you get lots of ideas. I find them really helpful (interview).

National Curriculum and planning for teaching

The Secondary Mathematics Handbook emphasised that teacher trainees need to prepare lesson plans according to National Curriculum topics. In addition to this, it included teaching approaches, teaching resources, content, and equal opportunities. Claire had early difficulties in using the National Curriculum (NC) for teaching and planning.

When I first got it and when I was trying to use it for my lessons I just thought I didn't have a clue what I was supposed to be looking at. Now, I feel I am a bit more confident with the NC. I feel like I've actually got to grips with it in a way. I do think it is a good system that has set down things for you. Specific, sorting things that must be learned and so on. It is not too bad (interview).

All teachers need to plan for their lessons. Some aspects of a lesson can be planned beforehand and some develop as a reaction to classroom events. For trainees, planning needs to be overt and is essential. Claire emphasised that she believed many secondary school teachers had a great deal of experience of teaching mathematics that's why they did not prepare plans as she did. The teachers liked to manage their classroom and use materials that were available in the school. What influences their planning is their philosophies and beliefs about the nature of mathematics teaching.

Of course they don’t plan. They are supposed to. I mean in Moat College I found that, a lot of them because they’ve been teaching so long they’ve been teaching the same lessons, same years and so on. They do have a specific scheme of work. They do have a lesson plan. But they can generally just walk into the classroom and get on with it. They know what they’ve got to get through (interview).

Claire also uses assessment to inform her planning.

I have also found it useful to plan a lesson round completed homework, emphasising mistakes that occur quite a lot. I only do this after the class has covered quite a bit of the topic (school file, evaluation).

She wanted to assess not only work in the class but also to look at pupils’ books.

Most of the time it was the case that most of them were able to do it, but they made a few minor mistakes. I decided to take the books in to assess their work properly (20 November 1997).

She used her secondary school reflections in her teaching, remembering that when she was at secondary school, if she wanted to ask something, she had to put her hand up. In her teaching, she wanted pupils to put their hands up too.

When the pupils can't do the work they do tend to get restless and disruptive. I find a lot of them put their hands up and need me just to check work (interview).
Her placement was in an inner city school in Leicester for 11-16 year olds. The experience provided by teaching in a multicultural school allowed her the opportunity to meet new cultures.

With a subject such as maths there are possibilities of using a more visual approach to the subject but problems can arise when pupils find it difficult to understand what the teacher is saying. I did find that it was also an educational experience for me I was made more aware of the culture and religion surrounding this community (school file, evaluation).

**Variety of teaching methods including ICT**

Claire started her PGCE course after various negative experiences of teaching methods and teachers. Claire believes her teaching changed during the period of the PGCE course. She feels that she has developed an insight into individuals’ and class needs and is developing flexibility in choice of teaching methods.

When I first went into teaching when I started at Moat, I found that I did start teaching with blackboard and doing it like that (interview).

When I was at Moat, teaching my year 9 class, algebra, I wouldn't use the same method that I used for my year 8. My year 9 responded well to being given a list of questions and getting through the work. My Y8 didn't like that. My Y8 liked to know everything, liked to know why we were doing something, what it means, but I don't like talking too much I think you get to know your class, you get to know students in your class you get to know how they like to be taught. I do like to use different methods because it makes it interesting for me -like working in groups, doing investigations and doing a list of questions. Sometimes it does help using different resources to make lessons a bit more interesting. I like to use games because I find kids get involved -for instance I played bingo with Y8 but instead of just pulling the number out of the bag, I actually I put sums in the bag so it’s a bit of mental arithmetic for them. They have a laugh and get a few prizes (interview).

My worst teaching experience was my Y9s where I did investigation with them in groups. It just didn't work out at all. They didn't like it. They didn't want to work in groups, and they didn't want to investigate. They preferred the list of questions and working through them (interview).

The best experience was with a Y7 class. We were doing number patterns and I was doing a robot, something into a robot, what ends x+2 and what comes out. I actually got the class to interact with it. The pupils saw this as a bit of a game (interview).

The university PGCE course introduced Claire to new teaching methods and situations.

You do learn different methods of teaching. When we first came here we learnt quite a lot of methods we did role play, some classroom situations: Somebody was naughty, somebody was,...and on. Somebody had to get up and try to teach for five minutes to see what classroom management was like and discuss ways of dealing with situations. We have done quite a lot through looking at dilemmas as well with teachers, so that has been quite good (interview).

According to Claire, teaching practice and university lectures were well balanced.
I think I probably was doing 5 weeks teaching and then 5 weeks at university but I found it's been a really good course (interview).

Claire also reported that she had some tensions and anxieties in her teaching, and this was reflected in her written documents and interview.

She had some difficulty in choosing appropriate materials and methods according to the topics, but has found some interesting computer based materials.

I am still just trying to get out of that blackboard teaching when it comes to algebra and trying to teach myself, trying to look at different resources for teaching algebra. I found that great things for algebra are in computer packages that you can do relating the graphs and so on. That in a way its probably related to data handling as well. I do agree that its nice to bring in computers as much as possible to maths and the world today is getting so computer dominated that kids need to be comfortable doing anything on computers.

Trainees develop an awareness of using active learning materials in their own teaching, such as calculators, practical apparatus, and computers. Although the use of computers and calculators is emphasised in the National Curriculum, for some trainees this is still a problem. They need to gain experience of using computers, spreadsheets, and some databases in their teaching as tools for exploring mathematical topics. Although she has a limited experience with computers, she has started to use computers in algebra teaching.

Straight line graphs and trying to relate back to the algebra that they had been doing simple equations, and I used the computer as well (interview).

She also uses an OHP to aid her teaching. Her main aim in using an OHP was to compensate for her height, she doesn’t reach the top of the board and she wants to be face to face with the pupils and to make the topics interesting.

OHPs are brilliant. I love OHPs because I am short in height. I find it's difficult to turn around and write on the blackboard. I find OHPs are very helpful, when I was standing and my face looks to the classroom. When I am at the blackboard, I turn my back on the class (interview).

I used OHPs in order to show them how to plot their quartiles (21 November).

Claire did experience some difficulties using an OHP, but she found using OHPs on the whole made her lesson very interesting.

Need to write larger on the OHP. Generally the pupils worked and seemed to grasp the topic well. Unfortunately I had to interrupt the lesson often to return to the board because my explanation was not understood the first time. (12 November 1997).

Started the lesson with visual aid to keep a bit of interest. (26 November 1997).
OVERVIEW

To explore the shifting emphases in Claire's reflections on her own teaching, her written lesson evaluations were coded for both teaching practice and the results are summarised in Table 6.1.

Table 6.1: Lesson Evaluation

<table>
<thead>
<tr>
<th>C</th>
<th>Lesson's Evaluation (First Term)</th>
<th>Lesson's Evaluation (Last Term)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
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<td>Class, time, behv., man. contrl.</td>
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<tr>
<td></td>
<td>Freq. 14</td>
<td>% 34</td>
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<tr>
<td>R</td>
<td>Pupil's learning</td>
<td>Pupil's learning</td>
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<tr>
<td></td>
<td>Freq. 4</td>
<td>% 10</td>
</tr>
<tr>
<td>E</td>
<td>Pupil's learning diff., needs</td>
<td>Pupil's learning diff., needs</td>
</tr>
<tr>
<td></td>
<td>Freq. 1</td>
<td>% 2</td>
</tr>
<tr>
<td>O'</td>
<td>Confidence</td>
<td>Confidence</td>
</tr>
<tr>
<td></td>
<td>Freq. 1</td>
<td>% 2</td>
</tr>
<tr>
<td>N</td>
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<tr>
<td></td>
<td>Freq. 3</td>
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</tr>
<tr>
<td></td>
<td>Freq. 5</td>
<td>% 12</td>
</tr>
<tr>
<td>I</td>
<td>Active learning elements</td>
<td>Active learning elements</td>
</tr>
<tr>
<td></td>
<td>Freq. 3</td>
<td>% 7</td>
</tr>
<tr>
<td>L</td>
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</tr>
<tr>
<td></td>
<td>Freq. 3</td>
<td>% 7</td>
</tr>
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</table>

For Claire, managing time, managing classes and managing pupil behaviour covered 34% of her lesson evaluations in the first term, but in the second term, this gradually declined. The second major categories, in her writing in the first term, were teaching methods (19%) and teaching materials (12%). On the other hand, she mentioned other active learning elements (7%). The emphasis was mainly on the variety of management and teaching. For the lesson evaluations in the second term, teaching materials and methods, and active learning elements were the main elements in her lesson evaluation; she also emphasised pupils' learning and their learning difficulties in her lesson evaluations. The inclusion of these elements increased in frequency between the first and the second term.

In addition to her lesson evaluations, these same elements were also mentioned in her assignments. The frequency of these topics related to the nature of the assignments. Again, her reflections were coded for Assignment I (Autumn Term) and Assignment II (Spring Term).

Table 6.2: Assignment Evaluation

<table>
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<th>C</th>
<th>Assignment I</th>
<th>Assignment II</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Freq. %</td>
<td>Freq. %</td>
</tr>
<tr>
<td>I</td>
<td>Class, time, behv., man. contrl.</td>
<td>Class, time, behv., man. contrl.</td>
</tr>
<tr>
<td></td>
<td>Freq. 3</td>
<td>% 8</td>
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<td>R</td>
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<td>Pupil's learning</td>
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<td></td>
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<tr>
<td>E</td>
<td>Pupil's learning diff., needs</td>
<td>Pupil's learning diff., needs</td>
</tr>
<tr>
<td></td>
<td>Freq. 4</td>
<td>% 11</td>
</tr>
<tr>
<td>O'</td>
<td>Confidence</td>
<td>Confidence</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>N</td>
<td>Knowing pupils</td>
<td>Knowing pupils</td>
</tr>
<tr>
<td></td>
<td>Freq. 2</td>
<td>% 5</td>
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<tr>
<td></td>
<td>Freq. 8</td>
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<td>Active learning elements</td>
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<tr>
<td></td>
<td>Freq. 4</td>
<td>% 11</td>
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<tr>
<td>L</td>
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For Claire, managing time, managing classes and managing pupil behaviour covered 34% of her lesson evaluations in the first term, but in the second term, this gradually declined. The second major categories, in her writing in the first term, were teaching methods (19%) and teaching materials (12%). On the other hand, she mentioned other active learning elements (7%). The emphasis was mainly on the variety of management and teaching. For the lesson evaluations in the second term, teaching materials and methods, and active learning elements were the main elements in her lesson evaluation; she also emphasised pupils' learning and their learning difficulties in her lesson evaluations. The inclusion of these elements increased in frequency between the first and the second term.

In addition to her lesson evaluations, these same elements were also mentioned in her assignments. The frequency of these topics related to the nature of the assignments. Again, her reflections were coded for Assignment I (Autumn Term) and Assignment II (Spring Term).
In fact, both assignments were related to the same topics and her lesson evaluations. Class management and time management elements decreased.

Her first assignment concentrated mainly on teaching methods and teaching materials, but also covered elements connected to the pupils. In addition to this, the second assignment also focused mainly on teaching methods and materials, and pupils’ learning difficulties and pupil related elements.

She made a link between algebra and data handling in both assignments. She also learnt how to make a forward plan. Her school file illustrates (including lesson evaluations and lesson plans) that she learnt to use a blend of teaching methods. As can be seen from tables 6.1 and table 6.2, although at the beginning of the first teaching practice she was keen on traditional methods, by the last teaching practice she seemed to be more confident in using active learning elements in her teaching.

The majority of the lessons observed by the researcher reflected the active learning values of her interview and documentary evidence.

Broadly speaking, the common characteristics of most of Claire’s lesson evaluations and assignments are a combination of managerial elements and some teaching elements, such as teaching methods, materials and active learning elements.

In summary, for Claire, it seems the significance of what was to be learned and how it was to be learned were almost inseparable on the PGCE. It covered secondary maths sessions, PDP sessions, teaching experiences, preparing lesson files, lesson notes, lesson evaluations, and university assignments. In considering these issues we can note the greater confidence she showed in relation to the use of the active learning method which was facilitated by the training course. Overall, she is motivated enough to become an enthusiastic and approachable mathematics teacher. In particular, she was able to draw on all her experiences to develop her teaching methods. She took account of the uses of new teaching methods, organizations, selection of materials, and pupils’ needs and ideas. At the end of teaching practice she seemed more confident with class control and using IT.

Summary of Stage Theory and Claire’s Progress
The evidence, both quantitative and qualitative, illustrates her passing through the four stages of the Stage Theory. In the beginning teaching stage, she struggled to solve the complexities of the classroom; she was dominated by class control issues and was developing a new persona. It was a highly stressful time in her teaching practice. In the
supervised teaching stage, she started to develop some varied teaching methods, she
developed teaching competence and much better classroom control. In the from teaching to
learning stage, she focused mostly on pupils’ learning and individual differences, but she
also focused on teaching methods. Claire had a rapid growth in self confidence in teaching
mathematics and in using different methods, strategies and organisation. It was during her
second term that she became more confident and relaxed about teaching mathematics. She
had little problem with class control and organising time and she was keen to use different
methods, materials, and organisation and made some significant breakthroughs in her
learning to teach. As regards the third stage of the stage theory, she should be focused on
pupils’ learning rather than her own teaching- developing more effective teaching. This
suggests that she was still in the third stage at the end of the first term and at the end of the
last term she had reached the reflective teaching stage. In the reflective teaching stage, it is
expected that she has developed into a reflective practitioner and critical self evaluator.
Evidence has shown that she was at the beginning of this stage by the end of her second
teaching practice.

Influences on Claire’s Teaching

According to Claire, PGCE secondary maths sessions, set readings, discussion with a
university tutor and cotutor, helped her teaching. Besides, teaching in an actual classroom
and developing lesson plans also helped her to learn to teach.

She recognised learning to teach maths as different from previous learning and became open
to using active learning elements, which she met on the PGCE course.
The major influences on her teaching may be summarised as follows.

The first influence was her maths teachers and tutors with regard to classroom settings,
choosing activities, behaving and showing caring attitudes. The second influence was her
major course tutor on the PGCE course, who inspired her with visions of active learning and
whose judgment she valued. The third influence was Claire’s teaching practice which made
a great impact on her. She took her tutor and mentor as role models for teaching maths.

Claire, like many other novice teachers, drew upon her own experiences as a student in the
mathematics classroom, her PGCE course mathematics session experiences, and her
experiences as a student teacher to develop her personal beliefs about the characteristics of
good mathematics teaching (Britzman, 1986). These beliefs seemed to have their origins in
her own experience of secondary school mathematics.
As time went by, Claire relied more heavily on her experience of secondary and university mathematics education and her own teaching when discussing her beliefs. In spite of her prior mathematics experiences (secondary and undergraduate) affecting her beliefs, her later experiences caused her to change her beliefs. Claire retained and developed a strategy during the years. She felt uncomfortable and lacking in confidence during the early part of her undergraduate education, but towards the end she became more confident with mathematics. She has a very positive attitude towards teaching algebra despite some bad personal experiences of maths teachers, when she herself was a pupil.

What do we learn from this one case study? What main themes can be drawn upon to inform the thesis overall? Generalizing, uniqueness and implication for teacher training are discussed at the end of the fourth case study. It must be admitted that it is difficult to generalize to other trainees and training programmes. Each trainee must respond to PGCE course requirements in some way. But every trainee learns to teach differently and courses should take account of the needs of each trainee.

In this case study different kinds of influence on the ‘mathematics teacher to be’ were illustrated, between pre-PGCE and post-PGCE. This study gives us a flavor of the trainees’ thinking, beliefs, and attitudes to teaching mathematics. Trainees’ personal ‘theories’ and how they use teaching methods and teaching materials will be explored in the cases which follow.
6.2 THE CASE OF SCOTT

The second case study is about Scott. Scott is 32 years old. He has a B. Sc. degree in maths. He achieved A in his GCSE and an A/S level in mathematics. He failed at A level maths. Before the PGCE, he had 6 months’ work experience with 6 year old and 14 year old children for IT. He also worked in the retail sector as a shop assistant and decided to take his A levels on a part-time basis. He also took some other courses. His mathematics background was limited.

This case study focuses on Scott’s learning to teach mathematics on a local PGCE course. The researcher observed while the trainee was teaching and learning algebra and data handling in PGCE mathematics sessions, and teaching practice. Scott’s lesson evaluations and lesson plans were collected to provide evidence of his reflection. In addition to this, his assignments were also collected. This documentary evidence was collected at the end of the second term as a data source. The other source of information about Scott’s beliefs about teaching and learning mathematics was a baseline interview, which was administered at the end of the second teaching practice, like Claire. Also, in the interview, he was asked to explain some questionnaire responses. All Scott’s data were initially reviewed and coded according to a coding as given in the methodology chapter.

This case study examines the factors which influence his teaching and learning mathematics.

Scott’s secondary background and mathematics experience

Scott’s secondary school was a comprehensive school which he described as crowded.

I went to a 12-16 comprehensive school. The class size possibly numbered between 27-30 students (interview).

He described himself as being in the top set in mathematics and he enjoyed maths during that time. His mathematics teaching was textbook-based.

Since I was in the top set of maths all the time, there were no problems in there. It was a good learning experience for me and it was text-book based learning (interview).

While Scott was in secondary school, he described the typical mathematics teaching method as traditional, with some everyday problem solving.

It was actually textbook based. At the time calculators were not used. It was all pen and paper or mental. It included a lot of problem solving such as a bus travelling and having to work out how many people are on the bus if people get on and off at various stops. Other similar maths problems were used (interview).
Computers were not commonly used in his school maths. When he was at secondary school they were only used for simple things.

Other than doing pie charts and things like that, none of the computers were used when I was at school. We did have a lesson based on computer programmes. We did put some data, tally charts and graphs onto a computer (interview).

Data handling was mainly individually taught when he was in secondary school. Scott's learning style was mainly individual working.

When we were in class it was mainly one per desk system, face the front with no real group work. I can remember basically working on my own (interview).

But, he also described his learning style as involving pair working.

Being left by myself, any work that I did I knew it was my work and I was capable of doing that. I had a word with the person sitting next to me and they told me how to do it and I really learnt it (interview).

From these extracts, it can be seen Scott's main experience of secondary mathematics teaching was largely traditional, board representation and text-book based. Some of his lessons included a few everyday problem solving examples.

His experience in data handling, IT teaching methods and co-operative work will be seen to be reflected in his teaching.

Scott's undergraduate education and influences on his teaching

He did his A level as a part-time course.

I did my A levels part-time before doing a part-time 3 year degree course. The degree course included teaching in the schools and combined studies: Maths, English, Art and Social Studies in Education for a basic degree (interview).

He found post secondary education very difficult describing a big gap between school and university. Scott describes his own experiences of mathematics as very hard and difficult. According to him, the reason for his doing education only part-time was because he was mature and he had two children.

I personally found it very difficult at university. I went to a local College. Obviously such a big gap between school and going to university was scary, it really was. Going from doing A levels I found quite difficult. Because it was a part-time course it wasn't very concentrated and I got only A/S levels. I nearly did not do half of the course. Going to university, obviously there were people who knew a lot more than I had done in a two year A level course. I found it difficult, it was hard (interview).

In a similar way Claire complained about the gap between going to school and university. But Scott pointed to other contributory factors:
Actually, mature students have responsibilities such as having a part-time job and looking after the house. I have two children who don't live with me, but I have to see them weekends so, whereas other students will probably have time at weekends, I don't. I don't know the effect on the children (interview).

From the above comment, Scott’s responsibility for his own children meant that his ability to cope with ‘A’ level mathematics was a problem. He entered higher education with the view that he knew less than his fellow students and consequently he struggled continuously but survived. His children need time and so he had less time for private study.

I would have probably done better on my exam results when I was younger. I learnt how to do it then left it seventeen years and went back to do it. It is hard to do it. Going into school now and teaching kids, I can say to them you really need to try first time round. I wouldn't advise anybody to leave it and come back to it. (interview).

Scott argued that age factor, and part-time education influenced his exam results, and the effectiveness of his study. For Scott, personal and social circumstances were different from his other trainee colleagues.

**Scott’s relationships with his teachers**

Scott’s teachers in higher education influenced him. Scott described his university mathematics lecturers as being much younger, and he knew some of them. He often made reference to his teachers and lecturers. One had a negative effect on him and he found him unapproachable and scary. Another was more approachable.

I am older than one of the teachers. It is far more relaxing if you are able to get to know the person (interview).

One of the tutors we had, I found very unapproachable. So this was very scary for me. It was like he taught the stuff and you were expected to know it and if you said, well I am not quite sure, he may not give any advice. The other one was adaptable, and approachable (interview).

This unsatisfactory personal experience is linked with traditional forms of teaching in university. University lecturers quickly go through material and the learning depends on students’ own capabilities. In one case, he wanted the tutor to give him feedback after the exam.

I tend to think the university tutors go quickly through the work whether you know it or not (interview).

They give you test papers to see if you can do the work, but they don’t give a lot of feedback from the test papers, until at the end of the exam. Only when the exam came round, so it was a bad experience (interview).
Not surprisingly Scott's view of teaching contrasts with his unfavourable experiences as a student. Therefore, Scott feels that one of a teacher's characteristics should be enthusiasm for the topics.

The tremendous enthusiasm for the topic made the teaching of it all the more easy. (assignment II).

He also tries to be approachable, friendly and calm in his manner as a teacher. He cares about his pupils too.

In my mode A school, I didn't shout at the kids. I taught in a calm manner. I am a calm person, it takes a lot to annoy me, and basically I see my personality being OK.

This may partly be seen as a reaction to a negative role model.

**Motivation for teaching and mathematics**

Although Scott liked mathematics, he realised that his subject knowledge was limited. For that particular reason, his first idea was to be a primary teacher when he started the PGCE.

I was a lot more confident when I first started to teach. At first, I felt that if I am going to teach I wanted to be a primary teacher, but then, you have to be able to teach everything and I probably wouldn't be confident. I am more confident with the secondary option as I said (interview).

His second career aspiration is to be a deputy head (middle manager) in the near future, not only to be a mathematics teacher.

So, as far as aspirations go, I might be a deputy head one day, not a head but deputy head definitely (interview).

The main reason for choosing to train at Leicester University was recommendation by other people which was based on the reputation of the PGCE course.

Because of recommendation from other people, I applied to a local (Nene) College as well. I had an interview there and I actually got a place, but I wanted this one, because people said the course was good. It's one of the best ones in the country (interview).

**Scott's subject knowledge**

He knows that his subject knowledge is not enough for teaching Key Stage 4 classes, but he had good motivation for learning new things in mathematics.

I like maths. I am good at maths. I wouldn't say my subject knowledge is 100% because it isn't. There are things I'd like to learn (interview).

After defining his weakness, he realised that his subject knowledge was not enough to teach a Year 12 class, and he decided to give up this class and take a Year 7 class in his first teaching practice.
My subject knowledge caused me a few problems. For this reason I gave up Y12 for Y7 (assignment I).

He stated that his subject knowledge needs to be developed and improved by learning new topics such as trigonometry, shape, space and measurements.

Some of the areas lacking in subject knowledge included trigonometry, especially shape, space and measures (interview).

My weakness areas were definitely shape, space and measurement. Because, when I was in school all the work we did on geometry was 2-D shapes. I actually have to teach it to people. These were all new to me. So, I just need to find out a lot more about teaching of shape, space and measurement. It is just definitely a weakness (interview).

He had difficulty in teaching A level classes and topics. His subject knowledge is not enough for this. He knows his weaknesses and he complained about some sessions in the PGCE course, especially some key stage 4 sessions. He was not interested in them. The reason for this is that he wants to teach high school KS3 pupils. He does not see himself teaching KS4 pupils.

Shape and space and measurement is done for key stage 4 topics in the course. I haven't actually done anything related to them. I do want to go to high schools, so I am sure it has helped other people as far as I know on the course. I attended the seminars and listened to them. I tried concentrating hard on them, but I don't really see it as being really of much use to me in the future (interview).

According to this extract, Scott still feels a lack of confidence in his mathematics knowledge. Thus, he has complained about some PGCE sessions focused on higher level work at KS4.

It is easy to see his limited subject knowledge and reflection on this in his evidence. For Scott, knowledge and potential confusion were important factors in his teaching. His anxiety was not knowing and getting confused in front of the pupils. Teachers as well as trainees might share similar anxieties.

Getting to the classroom not knowing anything, but I think that the same thing applies for everybody. I always panic before I am getting asked any questions (interview).

Even teachers get confused and need help. (Evaluation 24 November, 1997).

This extract shows his lack of confidence during the first term.

Scott's motivation for mathematics teaching

At secondary, Scott was not good at physics and chemistry that's why he did not enjoy them. As far as science is concerned, I didn't like it in school. I wasn't very good at physics or chemistry. I know that physics involved a lot of mathematical theory, I wasn't finding it interesting at all (interview).
From these extracts, it can be seen, Scott’s reason for wanting to be a mathematics teacher was because he was better at mathematics than other subjects.

He was only good at maths while he was in secondary education. Later, he saw his weaknesses, but he insisted on becoming a maths teacher.

**May be I wanted to be a maths teacher before I left school. In fact, apart from maths I was getting bad results. At A level phase, I felt I wasn't capable of doing other subjects (interview).**

It is possible that Scott’s reason for becoming a mathematics teacher is liking of the subject.

**The main reason was that I always liked maths (interview).**

**Influences of the PGCE course**

According to Scott, the PGCE course gave him the opportunity to practise his learning in the teaching practice. He wanted more teaching experience in class and less background reading and paper work.

**I think you can do with more time in the classroom. You can do less paper work because to me practical experience is more important than the reading. If you are going to learn something you need to actually learn it. I definitely think time in the class was more interesting (interview).**

He believed that the art of teaching should be learnt by teaching. According to Scott, he also picked up some tips and hints for teaching in the training course.

**You pick up tips, not only in the teaching practice but also at university (interview).**

For example, in the data handling sessions in the PGCE course, he felt the lecturers gave him good advice and tips. Some of this advice was reflected in his data handling teaching during teaching practice.

**We did some work with our subject tutor. We used a word tree and it really did relate to data handling. She gave us an idea from newspaper articles: classified and then just cut them up and asked us to classify and sort them out without giving them any categories. It worked really well and then I had to give them headings and sort them out again. I think they are some really good tips for us (interview).**

**Reflection on teaching and recording lesson evaluations**

He does not like paperwork. As a result of this he does not enjoy preparing school files. He complained that time was very limited in his case, as he also had a part-time job.

**A lesson plan is just a record of what you have done. As far as I am concerned that is what it is for. You have to prepare the lesson plan and the school files beforehand and you have to evaluate lessons. Surely you know whether a lesson has gone well or badly. I think it seems all clear. Obviously you have to bring something back to university and let them see you have done the work, but the file, I think, is a bit excessive as far as the paper work goes (interview).**
My worst experience is paperwork, I hate paper work. It really get me down sometimes (interview).

I had a part-time job as well. It's like being at school and work as well. Time is very short. So, I have a lot of paper work to get through and I do the best I can.

Evidently, the main reason for not liking paper work was having a part-time job and he does not find enough time to complete everything. Scott wants to carry plans in his head because he hates paper work and he does not want to prepare detailed lesson plans. He supported his argument by arguing that secondary maths teachers do not prepare lesson plans the same as he or other trainees do.

No, they don't. I don't know why, probably because they have been at it for so long. It's probably all in their heads (interview).

He wants to take the secondary mathematics teachers as role models and so he prepares his lesson plans very basically and not in much detail. He wants to use the same plan again and again.

If I start to teach, I obviously have to do lesson plans. I just do my own things in my mind so I get on with it. I am not gonna be stuck. I do like my lesson plans, but they are basic (interview).

He claimed to use the same lesson plans again and again. According to him, it needs to be typed with a word processor. Using a word processor gives him an opportunity to add some questions for pupils to respond to.

I am gonna be doing lesson plans, but some of them are a bit reusable anyway, which means you have a useful resource. (interview).

I wanted my lesson plans to be useful, and at the same time easy to follow during the lesson. I prepared each lesson plan using a word processor. I also drafted a separate sheet of final points that I wanted to pick up on during the lesson - questions to be asked, expected responses, possible misconceptions which might arise, references to particular pupils and so on (Assignment I).

**Perceptions of his own role as a teacher in relation to his former teachers**

Scott’s adoption of the active learning approach in mathematics stems not so much from his view that such methods are more effective but rather from the kind of teacher he wants to be. He admired one of his teachers who was friendly, approachable and caring. He gives the teacher as the reason for pupils not liking mathematics. He called one of them horrible. And he sees teachers as horrible in the way their lessons are very serious.

I am very friendly with the kids. I can talk on any subject with them even if I am older (interview).

I didn't really like maths because teachers were horrible. You make mathematics fun for them. A lot of people think maths is just one big worry. It is fun, anyway. (interview).
According to him, every teacher has his/her own way to teach each lesson. Teaching methods vary from subject to subject and also teacher to teacher in the same subject. Teacher’s personality and teaching methods are important influences on the pupils’ learning. He contrasted passive learning and active learning which are used by different teachers.

Teachers’ roles are different. Everybody teaches in a different way. Because they are different teachers, not the same. I have seen geography teachers who really say, shut up and listen to me, but another geography teacher may want to discuss, want to involve the class. The same thing happens in maths, some want to be keep kids quiet, and heads down and work. And some want to involve them (interview).

Throughout the interview in which Scott described his mathematics teachers, he made frequent reference to pupils’ enjoyment and attitudes.

**ACTIVE LEARNING ELEMENTS**

Scott shows enthusiasm for using active learning elements in his teaching. Throughout the interview and in his lesson evaluations and assignments, he said that he was keen to use all kinds of active learning elements in his teaching.

Teaching whole class through discussion, group work, and obviously individual work. I do it a bit from books but I produce my own work sheets. I am trying to encompass everything. I ask them to write out sentences when they are doing answers. We have discussions and obviously they do the reading automatically reading from books. I try to encompass as much as I can, with different ways (interview).

For Scott, a new topic might be started as follows: discussion, group work, recap, discussion, board work, worksheet and pupils’ involvement.

When I am starting new topics I always like to have discussion first and see what they already know. So that’s where the discussion comes in and then obviously with the setted group they are all working at level 6. I knew that they had prepared for level 6 so it was a case of recap, and a bit of level5 and bringing it to level 6 with discussion and a little bit of board work, and then go on to the worksheets (interview).

**Enjoyment and challenge**

For Scott, mathematics is a challenge to encourage pupils to think and to make maths interesting.

What they were doing must be easy for them. I wanted to ask my students but my prejudices said don't ask them because they don't know it but I want to ask because I want to push them a little bit further, let them have a go. It doesn't matter if they do not get it right but as it turned out they did get it right. I knew that they were capable and you need to push the boundaries constantly. They are sitting and doing the things in half of the time. So you have to prepare work that will take them beyond level 6. They need a challenge to keep them interested (interview).
**Group work**

Scott mainly used group work during the second teaching practice. Group work and investigations were favoured teaching methods in his lessons. Scott used posters to represent pupils' results.

In my mode B school, I did more group work than I did in my mode A school. I did do some group work in mode A school, but not as much as was done here. We were having problems with trial and improvement. Individually they couldn't grasp the concept and were guessing the answer, so I put them into groups and got five problems to solve, and they had to produce an A2 sheet and display how they had solved the problem and we got some very good work. It was really good. They all begun to understand the idea, what was supposed to be done. Having a guess and changing it. It is right that sort of thing. The idea of learning for themselves, that's what I wanted (interview).

Scott emphasised that in the second teaching practice, he did more group work. He feels that he started to become confident to use group work in his teaching. He supported his work with some resources such as posters.

He tried some friendship grouping and non-friendship grouping; and he decided to use non-friendship grouping in his teaching. Scott realized that this was the best way of grouping to teach them.

I got the responses I wanted, it was just a trial. I split them into groups so they didn't get in touch with their own friends (interview).

I decided I wanted to split them from the usual friends. They drew lots and they did it quite well. It got them talking to people whom they normally didn't talk to which was another good thing (interview).

He describes his best teaching in the teaching practice (Mode B). He used both discussion and group work at the same time. He commented on the benefits of it.

A great majority of them understand while discussing (interview).

Group work is good as well. Because it took the emphasis off me. I was able to actually see them talking among themselves about the work (interview).

Here Scott is pointing to advantages for assessment.

**Resources: Board Work**

In his first teaching practice, Mode A, Scott reflects his initial mathematics experiences in his teaching. Because of his prior experience and knowledge, he decided to use board work for his teaching. This makes him feel secure and confident.

Board work was fully understood eventually. All worked well from the B2book, completing at least one section in science surroundings (in a science-laboratory (Evaluation 2 December 1997, year 9).
Behavior improved as many recognized the concept of enlargement and boardwork went smoothly. I was a little unsure of this topic but I was encouraged by the usual teacher being in the classroom. Worksheets were quickly and correctly completed and we moved on to enlarging shapes via coordinates (Evaluation 9 December 1997, year 9).

He emphasised that boardwork might be done in advance. Thus, if the teacher had some complicated work, the teacher needed to prepare the board beforehand. It gave more time for teaching and explanation.

Complicated boardwork must be prepared beforehand. Had I not done this, I would have wasted a lot of time (Evaluation 14 November 1997, year 9).

In the first term, Scott mainly used boardwork for his teaching. He felt confident and secure in the use of boardwork. In the second practice, there is little mention of boardwork for his teaching. He just used boardwork as a supplementary aid.

Resources: Books

When he was in secondary school, his teacher used to teach mathematics mainly from text books and some work on the board.

My secondary mathematics education was basically based on text books and work on the board (interview).

For Scott, his secondary school teaching method influenced his teaching and he mainly used books and boardwork as teaching tools.

He found some books very helpful, providing extensive materials for his teaching.

I had looked at other texts such as Focus Algebra (Extension), and Oxford Mathematics Intermediate GCSE, but the PoS Maths books proved to be the most accessible and user friendly and provided material. Thus, no pupil was without work for the whole four lesson topic (assignment II).

He also mentioned that some books’ exercises can assess pupils very easily.

As the school follows the SMP scheme of work, assessment of students' ability was made easy by using the review sheets for each booklet (assignment II).

Books and equipment were handed out without a problem and the pupils got on without delay. The set up of the desks eased packing away (Evaluation 26 November, 1997).

No book work today, mostly board work, and discussion as well as problem solving, explanations (Evaluation 8 December, 1997, year 8).

I found that the PoS Maths books were a valuable resource for these introductions and a source of inspiration for further worksheets. (assignment II).

Not all lessons have to be book based (Evaluation 8 December, 1997, year 8).
At the end of his first teaching practice, Scott had started to use other teaching methods not only books and boardwork in his teaching. On the other hand, he emphasized the difficulty in using books when there are not enough for the class and most of them cannot be photocopied because of the copyrights.

I found that the SMP 11-16 booklets contained useful progressive materials, but unfortunately, there were very few copies available and copyright restrictions prevented me from reproducing them. (assignment II).

**Resources: Worksheets, Booklets, and Spreadsheets**

Apart from books, his main materials for teaching were his own worksheets, booklets and spreadsheets (ICT). For example for algebra, worksheets and books were prime resources for him. On the other hand, for data handling, his own worksheets and booklets were the main teaching aids.

We used worksheets and books mainly for algebra. In data handling, I actually produced my own worksheets and booklet. It’s my collaborative project for year 9 in Mode A. They had to do a statistical piece of work. They just produced tally charts based on books. How many words are there in the charts and compare them to another book, just the usual stuff (interview).

... just basically board work, and the books and worksheets which I prepared myself (interview).

His experience of algebra was only related to various types of books. He had learnt and taught algebra traditionally. Each level was one book.

Different books for different levels. I can't think of the name of it, as it was so long ago (interview).

For Scott, his prior background influenced his teaching methods particularly in the first term.

**Resources: ICT Facilities**

According to Scott, computers were useful for the data handling teaching.

Computers were useful with spread sheet work, but nothing else (interview).

He emphasises the physical difficulties of using the computer room during his teaching practice. In addition to this, there were not enough computer programmes and books.

They do have worksheets at the schools ready for log on, and they have small packages on the computers, but it is so difficult to get in to the room. Because some other people booked it, time is limited (interview).

I wasn’t aware of the class-teacher system for the booking of the room. I was keen to get them settled quickly (Evaluation 14 November 1997).

At the end of this, he had seen the problems in using and reproducing materials. That’s why he decided to produce his own materials. He wanted them to use these materials as extension work too.
I therefore decided to reproduce some of the material using a PC drawing package. To make effective use of what materials I had, I needed to establish pupil ability. This was easy for year eight. These records showed which booklets each student had covered and the grades obtained were on each review sheet. Once I had this information I was able to ensure there were enough booklets to go around, albeit one between two in some cases. One student in year eight was performing at a higher level and I needed to prepare extension work for him. (assignment II).

Resources: OHP

Besides using his own materials, he wants to use OHPs. The reason for this was that Scott wanted to be face to face with the class.

OHPs do help, because you have to stand up and face the class. It is better than turning ones back to the class. OHP is good I think (interview).

One presentation was on the board, the other with an OHP (assignment II).

Scott used board work and OHPs at the same time to see the class.

Individual differences: pupil needs

Each class’s and each individual’s needs are different. Teachers should take account of each individual’s and class’ s needs, and choose the right methods for those needs.

Scott asserts that each class’s readiness for learning was different from another. For example, for year 9 negative numbers was not easy to teach. On the other hand, for year 8, formula teaching was easy.

The concept of negative numbers is not as easy for year9 as I had expected (Evaluation 10 November 1997).

Formulas is not too difficult a concept to teach year 8 (Evaluation- year 8 Monday, 17 November 1997).

His selection of the organization and teaching methods was based on the individual needs of the pupils.

I had always been teaching them to find out the right answer. Now, I said that they should try to guess if they can’t quite get it, so I put it to them that if they have got problems, they must have a go and discuss among themselves (interview).

Teaching for understanding versus rote learning

Using diagrams clearly expressed the point which needed to be made.

I feel it was a good introduction to this part of the topic-using diagrams to express a point so that the pupils see the concept literally (Evaluation 5 May 1998).

Scott’s teaching has been based on understandable learning for pupils. This can be seen as a reflection of his background and PGCE course. He found pupils lacked confidence and had difficulty grasping some basic mathematics skills. That’s why he wanted to use modelling for algebra topics to help pupils to understand.
They lack confidence and really do not understand. They cannot follow the basic concepts which are essential to their understanding of what is being taught. One example happened in a year 9 class. I was explaining equations using the notion of balancing scales. One girl managed to reduce her scales to a point where she had four bricks on one side and a weight of nine on the other. To begin with she couldn't see that to find the weight of one brick the weight of nine needed to be divided by four. When she finally realized what to do, she had a problem dividing nine by four. Not having been prepared for a situation like this, I found myself getting very frustrated -to a point where I told her to think about it and went to help someone else. I returned later and she was still in the same position. (assignment 1).

His aim in teaching algebra was not to teach mechanical methods at the end of the first teaching practice. He gave some alternative teaching methods for algebra teaching.

My aim was to ensure the students could begin to solve algebraic linear equations. I am keen that they understand the concepts of the topic. To teach a mechanical method, with no subsequent conceptual understanding, is not my aim, unless the student is not able to advance beyond the mechanical. (Evaluation 4 December 1997).

Pupils do not receive knowledge passively, ready-made. He thinks that pupils need to take responsibility for, and an active part in, their own learning.

Year 8 expect to be spoon fed and they don't listen to instructions properly. They show a disturbing lack of initiative and are obviously not used to doing this for themselves or taking charge of their learning. (Evaluation- year 8 Tuesday, 25 November 1997)

These kids take part and they are more keen when actively involved (Evaluation 8 December, 1997).

Scott asserts that algebra teaching should be active learning not by rote, mechanical and passive. He wants his teaching to be pupil-centered leading to pupils' understanding and their active part in investigating. He had used different teaching methods to teach algebra, such as using investigation, using diagrams and whole class discussion to teach algebra.

How I was taught formula is different from the way the students have been taught (Evaluation 24 November, 1997).

A few were struggling with the basic concepts, but most are moving quite swiftly through discovering rules and formulae. Some pupils are beginning to qualify their answers, i.e. \( w=12, b=15 \) instead of just writing 12, 15 etc. (Evaluation- year 7 Wednesday, 26 November 1997, did they learn?).

Scott explained some misconceptions and mistakes which pupils make. He mainly identified formulae and brackets. To get rid of these mistakes, one solution was to make a board presentation and explanation to the whole class via whole class discussion. Another way was to use diagrams, and posters.

Students were so keen on the subject. They tended to jump straight in without reading the question properly and this, in the main, is where most of their mistakes
and misconceptions were found. One example in the year seven group involved a formula for red and white tiles. The students were asked to copy and complete a diagram. Most of them, however, didn't complete the diagram as asked. Another major problem was the insertion of brackets. Students were coming up with the wrong solution because they were performing each operation in no particular order i.e. \( r \times 4 + 10 = w \) was usually treated as \( r \times 14 = w \). These general mistakes needed board presentation to correct (assignment II).

**Discussion-based teaching**

In his teaching practice, he used different activities in his teaching to make lessons more interesting and exciting. He realised that some of his students found his lessons were tiresome. He found a solution for this was to use whole class discussion.

I consider that my lessons were possibly rather tedious for some students. I tried to vary the activities to add some variety. In one lesson I tried to initiate a whole-class discussion rather than working from the book (assignment I).

Discussion was part of his data handling lessons. That makes pupils take part and take responsibility for their own learning.

The topic was statistics, and, as I subsequently came to realize, the norm for year 12 students was to say very little during their lessons. The initial introduction to the topic involved some very lengthy discussion on differing pieces of data presented in graph, pie chart, and pictogram form and the lesson was complicated by their lack of participation (assignment I).

His reflection about using different teaching methods in his teaching illustrates his increased confidence in using a variety of teaching methods for topics such as algebra and data handling. Data handling is most appropriate for using practical activities, different kinds of materials, discussion, and questioning. In contrast to his algebra teaching, he actually used a blend of teaching methods including practical activities. In data handling teaching, he asserts that using practical work makes pupils more active in their own learning. On the other hand, it causes some management problems in the class. After the second term, he gained confidence to use a blend of methods in his teaching. He started to use active learning elements to get rid of the management and control problems.

The reason for using discussion and questioning was to make pupils less passive.

In the second term, Scott's teaching was characterised by a pupil-centered approach. He took account of active learning elements in his teaching. His teaching was mostly summarised as an introduction or reintroduction to the topic, 15 minutes discussion, question-answer session, wait until pupils hands were raised and recap, ask them whether they understand or not, get response from one pupil, look for errors and ask them again, and show and demonstrate the right solution on the board.
He describes his teaching methods as very open and he wanted his pupils to be honest with him.

My usual method of teaching, especially with a new or reintroduced topic, is to spend 10-15 minutes at the beginning of the lesson involving the class in discussion. This enables me to ascertain the students’ basic understanding. I don't simply pick the first hand that goes up. I wait until hopefully at least half of the class have their hands up. I also deliberately went through one part of my introduction very quickly and then, knowing that they couldn't possibly have understood, asked who didn't understand. Usually only a few are brave enough to raise their hands, and so I commend them on being so brave and honest and tell the rest that I am going to pick one of them to explain. Once I have noted the looks of horror, I ask the question again. This time all hands are raised and I explain that I expect them to tell me if they don't understand. This little seed is well and truly planted. (assignment II).

The students learnt that I expected them to be honest and say when they did not understand my explanation (Evaluation 14 November, 1997).

Having spotted these general mistakes, it was only a matter of another board presentation to correct them. (assignment II).

Perception of role as teacher at the end of Mode A
He sees himself differently as a result of his teaching practice. According to him, his role is to impart learning, to develop and to achieve the lesson’s aims and to develop his own skills as a teacher.

I do expect many of the same things, but my aim is to develop my own strategies to accomplish what I have to do. My role is to impart learning to my students, my goal is to achieve the aims of my lessons as far as possible. I feel that I have accomplished what I set out to do and in the process have developed my own skills as a teacher. (evaluation-year9, Thursday 4 December 1997).

Practical work
He also used alternative methods such as practical work. Using active learning elements in his teaching caused some problems in the first term. According to Scott, using practical work caused some misbehaviour. He faced some problems using practical work.

It was a difficult group who used practical work as an excuse to misbehave. If I took the group in the long term, I think I would have to abandon practical work altogether (Evaluation 21 May 1998).

He emphasises that practical work is linked with management issues, namely, classroom management and control

Classroom management
In his teaching, he had anxiety about classroom management as well as his lack of knowledge.

Most of my fears revolved around classroom management. I had the fears I imagine the vast majority of new entrants to the teaching profession have. Lack of
knowledge, difficult students, difficult groups, class riots, the ultimate nightmare of being totally ignored and just finding out I was no good. In fact, I was worried about the whole teaching-learning scenario (assignment I).

He had gained confidence about managing the class during the block attachment.

By the end of the block attachment, I was feeling a lot more confident about my abilities in terms of managing the behavior of students. The students realized that when they came into the room they were expected to take their seats as quickly as possible and be ready to work (assignment I).

According to him, strategies for class management are not shouting, but being authoritative. In addition to this, some challenging games, using a variety of teaching methods and pupils' involvement are used in his teaching.

I needed strategies. I did not believe that shouting was the answer. They could not be seen to succeed in their challenge to my authority (assignment I).

I need to develop strategies to get through to the disruptive half of the class (Evaluation 23 April 1998).

Moreover, Scott developed some strategies to gain pupils' attention. The first one is pause in the middle of the sentence. The second one is make eye contact. The third one is get responses from them.

The level of noise was acceptable and easily controlled. The best strategy for this was to pause mid-sentence and look directly at the perpetrators (Evaluation 7 November 1997).

Furthermore, another strategy for gaining attention was to set up challenging strategies for them. He used games for this.

The year seven students were mostly keen to get on. Challenges had been set and they had different tiles to 'play with', funny pictures to study, and, as mentioned before, logical problems to solve (assignment II).

The last strategy which he developed during the teaching practice was using a blend of teaching methods with pupil involvement.

The strategies I developed to help with classroom management over the period of the block practice were using a variety of teaching methods and involvement of students as much as possible (assignment I).

Control is linked with active learning, promoting effective learning and behaviour, using a mixture of methods. The lessons included a balance of some active learning elements according to the lesson's aim, and pupils' needs. The last purpose of using a blend of teaching methods was to keep pupils on task and to make the lesson interesting for pupils.

A good lesson with good boardwork session and involvement and discussion from all. All stayed on task. A good balance of practical and book work makes for an interesting lesson (Evaluation 1 December 1997).
Throughout the lesson evaluations and university assignments, therefore, he developed some strategies for class management and control during the teaching practice. He found it difficult to cope with the class at the beginning of the teaching practice but he managed better at the end of the teaching practice.

- A few problems today (Evaluation 24 November, 1997).
- The lesson was better than yesterday. I had major problems with one boy who had been away yesterday (Evaluation 20 April 1998).
- Classroom control seems to have been my most successful areas (assignment II).
- I made progress with my classroom control (Evaluation 29 May 1998, year 8).

He put his reflections into practice in his class management and control.

- A more practical approach appears to work better than discussions (Evaluation 12 November 1997).

He also had difficulty with time control but he had the ability and strategies to master the problem. He used some alternatives such as discussions and pupils’ active involvement.

- I had expected a whole lesson of discussion and hadn’t prepared for anything else. This made the lesson seem twice as long as it actually was and the tensions grew instead of diminishing. The next lesson was filled with appropriate talk, each student taking an active part (assignment I).

He did not control the time effectively and it ran out before the exercise was finished. However, he tried to control time through effective planning. At the end of the first teaching practice, timing does not seem a problem for him.

- The work I prepared finished about 15 minutes from the end. All I could think of to do was repeat the exercise with different co-ordinates. The problem was that there was not enough time to complete the new exercise which was consequently left unfinished. This was highly unsatisfactory (assignment I).

- My timing is getting better—at least I had an appropriate amount of work prepared. A few finished all the work, a few completed most of it (Evaluation 11 November 1997).

He learned to control his timing by the end of the first teaching practice after gaining experience and confidence. He also learned how to control his voice effectively by the end of the first teaching practice.

- I still needed to raise my voice sometimes (Evaluation—year 7 Wednesday, 26 November 1997).

He developed different tactics in the class, for example he started to use his voice more effectively.

- Towards the end of the attachment, I began to use my voice more effectively than before (assignment I).

He also had strategies for controlling noise:
I learned more strategies for controlling noise: pausing, waiting, drawing attention to the culprits, using their names (Evaluation 7 November, 1997).

He gives another reason for pupils' noise: presence of a new teacher in the lesson.

They were noisy, no doubt due to the presence of a new teacher in the department today (Evaluation 28 May 1998).

He emphasises that both student teachers and qualified teachers have a problem with classroom management.

Naturally class control is important to a student teacher and it is a skill which is very difficult at the start. I felt the need to congratulate the students on their behavior as I would have been quick to criticise them if their behavior had been just mechanical (Evaluation 4 December 1997).

Even qualified teachers have problems with pupils and there is always someone to call on for help. On reflection, I might have been a bit hard on the reluctant boy, but I really could not keep him in the room (Evaluation 20 April 1998).

At the end of the first term, he noticed some changes. He was more confident and coping well and saw himself as a different person.

I had successfully completed the term, more in awe of the role of a teacher, more confident that I could cope and most definitely a different person! (assignment I).

Experience in teaching was very important. If you teach the same topic again and again it gives the teacher more confidence.

I found it a great help that I was teaching the same topic to year seven and eight- I was able to modify my approach where I felt it needed to be changed (assignment II). I taught a particular lesson twice and my confidence also increased the second time. (assignment II).

**OVERVIEW**

Scott's lesson evaluations and assignments were categorised and coded in the same way as Claire's.

**Table 6.3: Lesson Evaluation**

<table>
<thead>
<tr>
<th>Lesson's Evaluation (First Term)</th>
<th>Freq</th>
<th>%</th>
<th>Lesson's Evaluation (Last Term)</th>
<th>Freq</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class,time,behv.,man. contrl.</td>
<td>10</td>
<td>14</td>
<td>Class,time,behv.,man. contrl.</td>
<td>9</td>
<td>11</td>
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<tr>
<td>Pupil's learning</td>
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<td>14</td>
<td>Pupil's learning</td>
<td>15</td>
<td>19</td>
</tr>
<tr>
<td>Pupil's learning diff., needs</td>
<td>6</td>
<td>9</td>
<td>Pupil's learning diff., needs</td>
<td>9</td>
<td>11</td>
</tr>
<tr>
<td>Teaching methods</td>
<td>18</td>
<td>25</td>
<td>Teaching methods</td>
<td>10</td>
<td>13</td>
</tr>
<tr>
<td>Confidence</td>
<td>3</td>
<td>4</td>
<td>Confidence</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Knowing pupils</td>
<td>4</td>
<td>6</td>
<td>Knowing pupils</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Teaching materials</td>
<td>11</td>
<td>15</td>
<td>Teaching materials</td>
<td>19</td>
<td>24</td>
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<td>Active learning elements</td>
<td>4</td>
<td>6</td>
<td>Active learning elements</td>
<td>16</td>
<td>21</td>
</tr>
<tr>
<td>Plan, preparation</td>
<td>5</td>
<td>7</td>
<td>Plan, preparation</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>71</strong></td>
<td><strong>100</strong></td>
<td><strong>Total</strong></td>
<td><strong>79</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

behv. : behaviour  diff. : difficulties  man. : management  
contrl. : control  Freq : Frequencies  

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His lesson evaluations place emphasis on teaching methods, teaching materials, management and pupils' learning and needs. Teaching methods and materials were prominent in his planning. Confidence, planning, and management were not major problems for him by the end of the first teaching practice. In the last term's evaluations, he concentrated mostly on individual pupil's learning and needs and placed most emphasis on teaching materials and active learning.

Table 6.4: Assignment Evaluation

<table>
<thead>
<tr>
<th>SCOT</th>
<th>Assignment I</th>
<th>Assignment II</th>
</tr>
</thead>
<tbody>
<tr>
<td>T</td>
<td>Class, time, behv., man. contrl.</td>
<td>Class, time, behv., man. Contrl.</td>
</tr>
<tr>
<td></td>
<td>Freq.</td>
<td>%</td>
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<tr>
<td>T</td>
<td>18</td>
<td>26</td>
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<tr>
<td>Pupil's learning</td>
<td>11</td>
<td>16</td>
</tr>
<tr>
<td>Pupil's learning diff., needs</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>Teaching methods</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Confidence</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Knowing pupils</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>Teaching materials</td>
<td>20</td>
<td>29</td>
</tr>
<tr>
<td>Active learning elements</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>Plan, preparation</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>69</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

The first assignment emphasises issues surrounding management and teaching materials. The second assignment focuses on teaching methods, materials and active learning elements. The latter assignment showed that he was keen to use active learning. Evident from both pieces of his writing was growth in the attention to active learning elements.

His questionnaire responses illustrated that he liked arithmetic, quadratic equations and data handling. Similarly, he had enjoyed teaching these topics. He judged that practical simulations, problem solving and individual work were appropriate for teaching algebra, and individual work and project work were appropriate for data handling.

Summary of Stage Theory and Scott's Progress

The same evidence base was used to illustrate his passing through the four stages of the Stage Theory and the progress is clear from the evidence.

Like Claire, Scott's lesson evaluations and assignments reveal a combination of teaching elements, teaching methods, teaching aids and active learning elements. This evidence shows how he moved from the first stage to the other stages. He was at the beginning teaching stage when he started the PGCE course. During the training, he gradually passed through the other stages, but he did not advance far into the reflective teaching stage. This might be because he has an unusual background and work experiences. In his development, active learning was helpful to his learning to teach. During his training he developed some
strategies, a variety of teaching methods and teaching aids and concentrated on pupils’ understanding and learning.

Influences on Scott’s Teaching

All his prior experiences of mathematics influenced his teaching. Like other trainees, he took one of his teachers as a role model and decided to become a teacher. His maths teacher used textbooks (different books for different levels) and boardwork, and this influenced Scott’s teaching. Ultimately, Scott’s prior belief and attitudes about teaching mathematics were positively improved during the course. He knows his own weaknesses and wants to work on them. Scott attributes his decision to enter teaching to the influence of his teachers during his secondary education. At the end of the course, he has confidence to using active learning elements in his teaching. He has comfortably developed strategies for each of his weaknesses. He said, ‘I can do it’. Overall, he is well motivated to become an adaptable, approachable and confident mathematics teacher.

He took his teacher’s teaching methods as a role model. His experience of mathematics depends on traditional teaching and includes teacher exposition, and a few real life examples such as the bus travelling problems. According to Scott, pupils’ attitudes to mathematics depend on their teachers.

During his secondary school years, in algebra, his teacher used text books and board. The teaching style of algebra was traditional in his secondary school. In data handling sessions, during the secondary school years, it was based mostly on individual work and some practical examples such as real life examples, pie charts and graphs.

On the other hand, he faced a big gap and change during his undergraduate education. His response to his teachers depended on whether they were approachable and adaptable or not. He admired one who was adaptable and approachable: again a role model for Scott.

He tested a blend of active learning elements during the PGCE Course. The PGCE course allowed him to use group work, discussion and pair work and to prepare his own sheets for his own lessons: ‘I try to combine everything’. And he wanted to use board work, books, worksheets, OHP and logo with computers in his teaching. He had also wanted to use his own booklet which was produced during his collaborative project. Scott’s ideas about education are much more pupil-centered by the third term. He was reassured by the PGCE, which seemed to reflect his views on teaching and learning and gave him a sense that what he was doing was right. This shows that his observation of practice during his teaching
practice seemed to be strongly at odds with his views when he started. By the second term, he was taking account of pupils’ learning and their understanding. He felt more confident to use a blend of teaching methods according to pupils’ understanding and the lesson’s aim. He admires and seeks to emulate ‘the approachable friendly teachers’. His aim is to increase his confidence about subject knowledge and to become more comfortable in his teaching.

At the end of the third term, Scott feels he has learned a great deal, particularly about class management and control, although he still clings to the notion of pupils’ understanding and learning and active participation in their own learning. He recognizes that he has compromised his ideals and that his teaching style overall became more didactic in the first term, but by the third term it is gradually moving towards active learning methods. Nevertheless, he still feels he has much to learn.

Moreover, all the evidence shows that Scott moved forward steadily towards reflecting on his own teaching. He mostly emphasised effective teaching methods for the pupil’s right level of understanding. He also considered individual differences in his teaching. In the PGCE course, he learnt many things: planning, managing, teaching tips and so on. He does not like detailed planning because of its paperwork. He hardly finds time for preparing his plans. The teaching practice also influenced his belief about teaching. He said that ‘teaching should be learnt in teaching’.

In summary, the major influences on his teaching may be summarised as follows. The first influence was his experience of mathematics and his teachers. Like Claire, he had some bad relationships with his teachers and tutors. He also had limited subject knowledge and teaching experiences. These all influenced his teaching in a reflective way. He tried to use whole-class-interactive teaching, questioning methods, understanding versus rote learning, active learning as opposed to passive learning, group work and use of pupil’s own mistakes, plus strategies of class management and control. Like other trainees in the course, the second influence was his major course tutor on the PGCE course, who opened up the potential of active learning and whose judgment he valued. The third influence was Scott’s unusual background which made a great impact on him. His beliefs about teaching depend centrally on relationships between teachers and learners.

Age and work experience are very important elements in Scott’s case. Trainees’ prior and present education are also important. If somebody did education part-time, it causes some side effects as it did for Scott.
CHAPTER 6

6.3 THE CASE OF CATHERINE

Catherine is 23 years old. She took a Bachelor of Science degree in Combined Science (2:1). Her best subject was mathematics at A level, where she achieved a grade A. Catherine also took A/S and achieved a grade A in Further Maths.

Catherine is highly motivated and has had lots of relevant teaching experience. She enjoyed maths at university and combined it with psychology. She worked with a small group of children during her first year of A level. She helped a year seven maths class during the final year of her A level. She had worked as an ancillary teacher and as a private tutor to 6-14 year olds as well as helping with the Y7 mathematics class. She had also completed a six week primary classroom support course at the School of Education, Leicester University.

She worked as an ancillary teacher for three years and then applied for a PGCE course.

In the account which follows, data was obtained through observation, interview, Catherine’s own lesson evaluations and her own university assignments as for the other trainees.

As we will show, her course enabled her to become a reflective teacher (reflective practitioner), skilled at integrating her practice and learning from the evidence she gathered about teaching.

Catherine’s secondary school mathematics experience

Again, we focus on the topics of algebra and data handling. Catherine’s experience of algebra was very traditional. Algebra for Catherine was only letters, numbers and demonstrations, with no group work. Teaching was based on explaining and showing.

I can’t remember a particular topic being taught, but just explained in front of the class. I was given the work to get on with (interview).

Algebra was only letters and numbers and teachers just showed methods of solving equations (interview).

Catherine reported that her experience of traditional algebra teaching still exists, in the same school, with the same teachers. There was no group work, just board work and questioning pupil’s knowledge.

I think, it was pretty much the same as I did. It was what I have seen, how teachers teach with just a session on the board, asking questions and making sure they understood, but no group work. I don’t remember doing any group work in maths, perhaps we did. I don’t remember and then I was given work and told to get on with it (interview).
Catherine’s data handling teaching was in sharp contrast to her algebra teaching as a learner. She still remembers how they did data handling while she was at secondary school.

We were going and standing outside and watching cars go by to collect data. I can remember doing that, going into the car parks and counting the cars by colours. (interview).

From these extracts, it can be seen that Catherine’s experience of secondary mathematics teaching was, at least for algebra, mostly traditional-passive as a learner. On the other hand, the data handling teaching was very practical.

Her teacher didn’t realise her potential at mathematics until they conducted a test. According to Catherine, some students did not show their ability in the class, some of them were too shy to put their hands up and answer the teacher’s questions. It was a difficult job for teachers to discover the shy but more able students in the class.

My experience of the teachers I had included one teacher who thought I was not very bright and he didn’t realize until I had a test that I actually was. I used to sit there and not say anything. If he asked a question I didn’t answer, so he assumed that I didn’t know the answer. I just didn’t volunteer to put my hand up and he didn’t realize until we had this test. He told me this afterwards when I was in the A level group, where he treated me differently (interview).

This has influenced her own approach to teaching as she now tries to find out a pupil’s ability by using small group work and active involvement of individuals.

Being in a small group I had an opportunity to mark the students’ work as they were doing it. This helped me to get a picture of each students’ ability (EvaluationY8, 30 March 1998).

Although Catherine was shy, she was very good at mathematics. She doesn’t remember much about her GCSE and even A level mathematics teaching, apart from some practical work.

I can’t even remember my GCSE teacher, or my A level teacher. When doing A level, I did all the practical things you can do, but this wasn’t with algebra it was with Newton’s Laws ... (interview).

Catherine was very motivated to become a teacher and she took a few teachers as role models for herself. Catherine wanted to be confident, friendly and approachable. Catherine liked and admired her teachers, especially the Vice-principal and GCSE and A level maths teachers.

There was a teacher, working in the last year who was the Vice-principal and she was somebody whom I liked. As a role in a school I am not saying I wanted to be a Vice-principal but she was confident and a very friendly person and although she had a good position she was still very approachable. My A level maths teacher was a good teacher. I didn’t think so before in the GCSE, but he was a good teacher, he understood the work. (interview).
**Undergraduate teaching and learning**

Catherine found university education very hard, as learning depended on the students’ independent efforts. She also felt alone and nobody told her what to do. Lecturers just gave notes, jotted a few things on the board and students had to listen and understand.

You were more independent and you had to do a lot more yourself (interview).

It was hard work because you didn't know the people, you didn't know where to go for help. It is harder to go and find somebody as you can't just stop a teacher in the middle of the lecture or go over and say you can't understand. So you've got hard work, not only is the content hard, it's hard work because you've got to do a lot more yourself (interview).

When you are given the notes and you are not trying to scribble down and understand at the same time, you can listen and understand and perhaps watch and collect data if you have the notes given (interview).

You just copy from the board without understanding anything, it is not easy to go back (interview).

Thus, Catherine found a sharp contrast between straightforward, traditional mathematics teaching and independent university mathematics teaching. Therefore, from these extracts, it can be seen that Catherine's experiences of mathematics teaching, until the PGCE, were mostly traditional.

**Catherine’s motivation for teaching: her inspiration to become a teacher**

It is possible to see that in Catherine’s view, becoming a mathematics teacher was linked to her enjoying maths and liking school. She took as role models particularly her science and biology teachers but not the mathematics teachers. Liking these teachers had an effect on what to choose as her teaching career, as for other trainees.

I enjoyed maths so much that I wanted to teach it (interview).

I think I enjoyed being at school, I always wanted to be a teacher, it’s something I always wanted to do (interview).

I suppose I was affected by having good teachers. I consider that most teachers are role models to us. My form tutor who was also my science teacher influenced me so I did A level biology and my form tutor was my biology teacher (interview).

She liked the school and some teachers and these were the big influences on her. In addition, Catherine is highly motivated and has had lots of relevant teaching experience. Her psychology degree also reinforced her decision to be a teacher. Catherine insists on the fact that she always wanted to be a teacher, like Claire.

I don't think I ever had doubts about teaching. It’s always what I wanted to do. I never ever changed my mind about it. (interview).
For Catherine being an effective teacher means preparing the lessons with each pupil's needs in mind.

I think that being an effective teacher means changing the lesson to meet the needs of students (Evaluation Y11; 4 November 1997).

She took some role models such as other teachers and tutors. They all influenced both her decision to become a mathematics teacher and her teaching. She also emphasised that she picked up some ideas from other teachers and applied them in her teaching, during the PGCE year.

I was in the classroom and I was watching the teacher and picking up different ways of teaching and disciplining. I don’t think when I was at school I picked up anything on how to teach. I didn’t consciously think, that’s what Mr. So and So did and try that (interview).

One reason for her choosing the Leicester PGCE was geographical and secondly the reputation of the course, like other trainees. The course also allowed more practice during her training.

Because I live in Leicester, I didn't want to go anywhere else. I tried to go away to university to do a degree, but I ended up putting down Leicester as my first choice, so I stayed at home, now being more settled. I bought a house at the start of this course. I didn't want to be travelling anywhere else so that's the main reason (interview).

Two of my friends did it the previous year, so I knew what was going to be involved. I think it is good you get straight in there doing teaching, rather than how having lots of theory about you should do this and you should do that. The best way to do it is to learn and go and practice (interview).

**PGCE course influences**

Some PGCE course sessions made no difference to her prior experiences and she didn’t like these sessions and even called them boring.

Some of the professional course lectures were a bit boring. You sit and switch off and then there is nothing interesting, just giving you the sheet to read. I have more enthusiasm if I am actively involved and you learn in groups (interview).

She made a point about each lesson being made interesting for the students using different kinds of strategies. She found that PGCE sessions gave some advice, ideas about the topics and teaching methods and an opportunity to practise teaching. She compared her prior learning with her PGCE course learning. She discovered how to learn from her experiences. For Catherine, the PGCE course gave trainees advice and some learning materials and a chance to put their learning into practice.

People there give you advice. Students’ main way of learning is to get in there and practise and learn. (interview).
During my Mode A teaching practice, I gained experience of preparing and teaching lessons for students on solving simple equations (assignment II).

Part of the course is where we go over topics and get ideas and if I have already taught it I can say, well I did it like this. I taught this way, I didn't teach that way. If I have the idea first, I always use it. But, if I've been given the idea then I've gone away and tried that (interview).

**Lesson planning and evaluation**

Compared with Claire’s and Scott’s, Catherine’s school files were much more varied and thorough. They were analytical and detailed, and also more reflective.

Although she found it useful to prepare lesson plans and lesson evaluations at the beginning of the teaching, she later found them more of a burden. She claimed that lesson plans might be a way of checking if the lesson was right.

In the beginning, it is very useful. You are doing a lesson evaluation after the lesson and thinking about it because you think about what you were doing. But towards the end it gets a bit boring. Because you are just having to write the same things again and again (interview).

Catherine had some preparation difficulties with her lesson planning in the first term. By the end of the first term Catherine had begun to cope with the planning problem very easily.

The lesson went as planned (Evaluation Y11; 3 November 1997).

I think I am being over prepared but I would much rather plan too much than not enough (Evaluation Y11; 4 November 1997).

The students got through the activities I had planned quicker than I had planned (Evaluation Y11; 18 November 1997).

Again, I planned too much for one lesson. I am concerned that I do not make the mistake of not planning enough (Evaluation Y11; 5 December 1997).

By the last term, progression was seen in her writings and notes in school files.

I am not doing the same lesson plans. I have seen that I have no chance of completing them realistically. During the second attachment, after completing a couple of weeks you just go for a day without lesson plans or just use a minimum lesson plan without any prior discussion. It is very good practice to be able to put the minimum unit in place (interview).

According to Catherine, planning might consider the National Curriculum topics. It acts as a guideline on what to teach and how to teach.

It seems OK to me, It is telling you what to teach. (interview).

Although preparing plans is necessary, teachers do not always do so, or if they do, do not carry them out exactly.
Planning depends on the teachers. It also depends on the schools because some teachers just don't make lessons as good as they could be. They don't put in the effort and just get by on as little as they can (interview).

Catherine’s recording covered the main aims of the lesson, summary, recap, some questions, topics, assessment, feedback, what they learnt, how successful the lesson was, and planning the next lesson.

My lesson plans always stated clearly the aims of the lesson. The start of the lesson would usually consist of an explanation of ‘today’s lesson’. With practice I also incorporated into my lesson plan, a summary/recap of the lesson at the end of the lesson which often involved questioning the students to see what they learnt. I found this to be beneficial to myself as it helped to assess how successful the lesson had been and it also helped with my planning for the next lesson. I also tried where possible to connect one lesson to the next so that students did not see maths as lots of separate bits (assignment I).

I think ending the lesson by explaining what comes next or recapping on the lesson is a very good thing to do rather than at the end of the lesson saying, ‘OK pack away’ (Evaluation Y11; 21 November 1997).

Questioning

She emphasised that she needed to motivate pupils using interesting ways for them to learn. That’s why, according to her, she used interactive teaching of mathematics through questioning, as a feedback to the pupils and for her forward planning.

I am planning to do something a bit different next week. I want to try and motivate the students to be interested in what they are doing (Evaluation Y11; 5 December 1997).

I found questioning a very useful teaching tool as it provides more feedback from the students and the pace and direction of the lesson can then be determined (assignment I).

She also emphasised understanding as opposed to rote learning through questioning.

I am now confident and pleased with my questioning technique. I believe successful teaching involves questioning students to get them thinking about how and why rather than just telling them ‘this is what you do’ (assignment I).

I definitely think that successful teaching involves questioning the students to get them thinking about why rather than just saying “that is what you do” More understanding and learning takes place if the students can see why (interview).

I am pleased with the way my questioning is developing in a way which makes students think, rather than telling them the answer (Evaluation Y10; 24 November 1997).

Catherine used different techniques to solve equations. One of them was question and answer method, but she emphasised that pupils found this difficult.
I need to develop my question-answer technique more. I ask students to put their hands up to answer, but then I don't insist and students start shouting out. Students did not get as far as solving equations. Some students are finding this more difficult than anticipated. Another lesson is definitely needed (EvaluationY10, 30 April 1998).

At the start of the course, she was more advanced than the other trainees and Catherine's attitudes to planning are more like experienced teachers and more reflective in comparison with to Claire's and Scott's. This maybe because she is more confident or she had three years prior teaching experiences. Catherine generally adopted active learning elements in her teaching, for example in questioning and stimulating pupils' mental involvement.

More understanding and learning will take place if the students are more involved in their learning (assignment I).

According to Catherine, the questioning method aids successful teaching and also tells her if the students have understood and what they have learnt. It also encourages the pupils to think. Catherine emphasises pupils' thinking and understanding, to promote pupils' learning. Her approach is constructivist rather the traditional by inclination: guide the pupils and encourage them to think and find out the answers for themselves.

Subject knowledge

Catherine mentions that confidence changes at different times and in different ways. She reflects on the importance of confidence and responsibility.

This is something, due to lack of confidence in myself, I was afraid I wouldn't be able to do as well as I have. I was particularly apprehensive about being asked a question in A level mathematics. (assignment I).

This above extract illustrates how Catherine felt about her A level mathematics teaching. But, Catherine felt at ease answering pupils' questions at the end of the first term.

In summary, considering how I felt at the start of my teaching practice, about answering questions posed by students, I now feel totally at ease in this area (assignment I).

I am nervous about teaching the A level, but I can help myself by revising it (interview).

Catherine had enough subject knowledge and confidence to answer pupil's questions, because of the strength of her own mathematical subject knowledge.

I have no problems answering students’ questions (assignment I).

I had enough confidence to initiate revision of the whole book and confidently and successfully answered questions relating to problems with any part of the module (assignment I).
Classroom control

According to Catherine, her principal anxiety was over classroom control and dealing with her voice at the beginning of the first term, but she developed strategies to control these. She asserted that if you make a commitment to pupils and explain your rules beforehand, class control does not seem a problem.

The thing I am nervous about is class control. I think what you have to do is be there straight away and set your expectations (interview).

My fear before starting teaching was that I would be totally ignored by a class which would get louder and louder as I waited for quiet (assignment I).

I personally find non-verbal communication more effective in many classroom situations as my voice isn’t the loudest of voices (Evaluation8, 30 March 1998).

She developed a strategy to control the noise level by giving them exercises. Catherine also developed some classroom strategies to deal with the class: learning pupils’ names; giving them work and if they did not bring their work, giving them detention. In addition to this, circulating in the classroom is one solution to class control and is useful for checking pupils’ work and giving them feedback.

Names are useful tools when wishing to gain attention and or control behaviour (assignment I).

By being mobile and looking at their work whilst the students were working, I was able to pick up on any common errors and explain to the class straight away (assignment I).

If pupils were working on task, they were not disruptive and they concentrated on the lesson. She needed to keep them on-task. If pupils showed off task behaviour it caused increased noise levels.

The majority of pupils were on task for all of the lesson and no students were causing disruption. I was pleased with the positive responses I was getting when I explained the work. It made me feel I had control (Evaluation Y10; 2 December 1997).

The time of day has a great effect on teaching and learning, for both pupils and teachers. It also affects classroom control.

Early morning lessons are definitely nicer! The students are a lot easier to control (Evaluation Y10; 24 November 1997).

Writing lesson plans can be difficult when planning the time factor (Evaluation Y11; 4 November 1997).

For the last 3-4 minutes we played “Fizz-Buzz” as I felt there was not enough time to start a new exercise and had got through everything planned. The students seemed
to enjoy this. It is nice to have the opportunity to do “fun” things with students at Key Stage 3! (EvaluationY8, 30 March 1998).

Using games was another strategy to keep the class under control, organise teaching time and make mathematics more interesting using active learning elements.

**Considering individual differences in her teaching**

Throughout the interview, in which Catherine described her mathematics experiences, she often made reference to her teaching. She sees herself as approachable and being able to use different methods in teaching and taking account of individual learning differences as a mathematics teacher. Catherine appeared very confident.

> Hopefully I am a good teacher. I think, not only for teaching maths, you have got to get the right balance between approachability so students talk to you and authority. Showing them they are not gonna talk when you don't want them to, to enable them to learn and to think of different ways of teaching. With maths in particular, if a student doesn't understand something one way you try another way to explain. I go away and think how I can explain at their level (interview).

According to Catherine, if she knew the pupils, she prepared her lessons according to their needs and chose appropriate teaching methods and materials for them.

> As I got to know the students, I became more aware of what approach to take with each individual who required help (assignment I).

She realised that whatever ability level of pupil, whether low level, intermediate level or high level, she knew which teaching methods she wanted to use to solve equations.

> Intermediate students are expected to be able to solve quadratic equations and higher level students should be able to solve polynomials of higher degrees (assignment II).

According to Catherine, she realised that different sets illustrated different behaviour and ability. That’s why, she wanted to use different methods with different individuals. She focused mainly on individual differences in their learning. She seems to be a pupil-centered teacher.

> Doing the same lesson with a top set and set 2 has enabled me to observe a number of differences between the two groups in their behaviour and ability (Evaluation Y10; 9 December 1997).

> Different methods will suit different individuals and it is the role of the teacher to find a method that is most appropriate to each individual (assignment II).

Catherine also asserted that individual pupils had different learning strategies. This is reflected in her teaching as she gave attention to each individual pupil and concentrated on their learning and understanding. She looked for a reason as to why their learning changed
from one lesson to another. In addition to this, she gave each individual pupil's name and commented on their learning.

Stephen finished equations with x on both sides so I will begin the next lesson explaining, forming equations although I may not expect all students to start this straight away. Scott was not in today, but Stephen certainly worked a lot harder than the last lesson (Evaluation Y11; 26 November 1997).

Sherry was not in the mood for working today. It was clear that she could do the work as she was giving the answers when I explained the work to her friend Cara. Sherry can change from one lesson to the next. Sometimes she will work really well and other times she will be like she was today. There must be a reason for this. (Evaluation Y11; 3 November 1997).

I am finding that when Alison is present it affects the work of Becky, Tim, Pete and Liam (Evaluation Y10 21 November 1997).

She found each individual's learning strategies different from the others. For example:

Trina had struggled with the flow diagram method but seemed to get on much better with this method and indeed she said that she preferred this way (Evaluation Y8, 21 April 1998).

**Group work**

Catherine used group work in her teaching and she preferred random grouping rather than friendship grouping for pupils to communicate with each other, to encourage co-operative learning, to develop pupils' social skills and to help them get to know each other.

I've done some group work and some pair work (interview).

Group work was incorporated into some lessons and for some of these, random grouping rather than friendship grouping, was used to encourage students to work co-operatively with other members of the class as they will have to do in future employment (assignment I).

I believe that encouraging students to work in randomly selected groups develops their social skills and helps me to plan lessons in the future that continue to support the students' development in this area (assignment I).

The lesson was a bit more chaotic than usual as the students were doing an experiment which meant working in groups. I made the groups random. There were some groups of 5 and some of 6 and although they needed a partner for the first part of the experiment, the groups with an odd number worked around this with no problems. I think that random grouping is a good idea because, as well as splitting up students who do not work well together, it gives students the chance to work with and get to know other students whom they would not normally speak to (Evaluation Y11; 18 November 1997).

For Catherine, another aim of using group work was that different pupils worked together.

It was nice to see different students working together (Evaluation Y10; 18 November 1997).
Catherine found using random grouping helped her teaching. Catherine asserted that using random grouping with 5 or 6 pupils to a group was more effective than the other methods. She maintained that in the second term she was much more confident using this kind of grouping than in the first term. This is interesting and doesn’t follow a similar pattern with Claire and Scott. This is maybe because she is more experience or more confidence or more knowledgeable and reflections are much more detailed?

Besides the grouping activities, Catherine noted that using different seating arrangements affected pupils’ learning.

I am not 100% sure about the seating arrangement after looking at the quantity of work produced by some students, but I will give it until the end of this week (Evaluation 7a, 31 March 1998).

**Using mistakes**

She found it helpful if the pupils learnt by their own mistakes. They learned from them and they did not repeat them.

I found it useful to mark students’ work as I spent a minute or two with each student individually. This enabled me to assess and respond to any mistakes the students were making before they formed a ‘wrong rule’ and also so that they could learn from their mistakes (assignment II).

Mistakes could also affect the learning that took place after the correction. A teacher or pupil might make a mistake, but they could correct each other and this developed enthusiasm and trust. Pupils were shown that teachers can also make mistakes, that they are human beings. Catherine talked about her own mistakes, for example:

When I began this lesson by promoting ideas about other ways of solving simultaneous equations, I did not seem to be getting much class response even when the questions I used more or less gave away the answers. However, once I began using the method of substitution, I made some simple mistakes (not deliberately) on the board. I could hear students mumbling about what I had done wrong and asked them to point out the mistakes I made (e.g. using x instead of y or + instead of - ). These were pointed out confidently by some of the group. Had this been my first lesson with this group, I would have been very embarrassed at making mistakes but I enjoyed the responses I was getting from the group. It was clear that they had understood the work we had previously done with them on multiplying out brackets and solving equations because of the fact that my mistakes were being picked up (Evaluation Y11; 24 November 1997).

There are a number of ways in which simple equations can be solved and for each of these groups I used a different approach, as each method has its strengths and weaknesses which I feel are dependent on the ability of the students (assignment II).

In addition to this, Catherine used the flow charts for her algebra teaching to eliminate the pupils’ mistakes. She found that if pupils used flow chart method, they easily eradicated their own mistakes.
I introduced the flow of diagrams and reverse operations with the same types of simple equations before moving on to equations of the form $ax + b = c$. Having not used flow diagrams previously in solving equations, I have found it to be very successful and I feel that there are fewer opportunities for errors. I have yet to see how students cope with solving equations without the flow diagrams after being introduced to solving in this way (assignment II).

**Teaching for understanding**

To explore in greater depth the way in which Catherine’s teaching attempted to cope with her initial tensions and anxieties when facing the class, we looked in greater detail at her teaching in specific areas.

She planned her lessons and used methods with pupils according to their level.

Today, I planned to recap on the substitution method for solving simple equations and then at a relevant point in the lesson to introduce solving by elimination (Evaluation Y11; 27 November 1997).

She wanted to give pupils a grasp of simultaneous equations. She used different methods to help pupils understand the concept. That’s why she included graphical representations as part of her teaching.

I intervened to explain a quick method for drawing line graphs as this was not the concept I was teaching and so I did not feel it was productive for students to be spending more time drawing graphs than grasping the idea of simultaneous equations which was the concept I had introduced (assignment I).

I felt well prepared for this lesson and was happy with my explanation of simultaneous equations and how to solve them graphically (Evaluation Y11; 21 November 1997).

Catherine emphasised that she used her experience of solving equations and showed how pupils make mistakes in trying to solve equations.

Students were very successful at this although there was some confusion with equations involving negative numbers. ... For these reasons I created a number of my worksheets for this topic based on the methods used in the Longsdale worksheets (assignment II).

My personal preference when solving simple equations is to use ‘the change the side, change the sign rule’. A mistake that was fairly common here was that when equations were down to the form $ax = b$ where $x$ is the unknown, students would often conclude that $x = a/b$ rather than $b/a$ (assignment II).

By the time I asked them, all students had understood what happens when coordinates are reflected in the x-axis, y-axis and the line $y = x$. I was pleased about this (Evaluation y8, 12 May 1998).

I began with equations with the unknown on just one side and discussed what we would need to do to get the unknown on its own. I then moved on to equations with
the unknown on both sides. This is the point where mistakes were frequently made (assignment II).

Catherine realised that some pupils had difficulty multiplying the equations by -1.

I may also incorporate some formulas that involve needing to multiply by -1’ as students seemed to have difficulties with these types of equations (Evaluation7a, 2 April 1998).

She found that all pupils had difficulty solving equations and when she was a pupil she had made the same mistakes. Catherine’s experience of solving equations was by a mechanical method which she described as a ‘sign rule’. She gave pupils some drill questions to solve these questions using the sign rule.

Students quickly picked up the idea of how to solve simple equations and I instructed them to do the first 18 questions as I had planned (EvaluationY8, 30 March 1998).

But she also used some real examples to teach equation solving, such as using a balance scale. She wanted pupils to think and discover the right answers. Catherine thought this created a better understanding of the topic.

With my year 11, I introduced the topic by looking at problems involving making the scale balance. The first experiment that students were required to do was to simply find the value of the box or boxes on the scale. I then moved the students on to rewriting the scale as equations. I tried wherever possible to avoid telling the students and preferred to ask probing questions to make students think for themselves as I believe that this creates a better understanding (assignment II).

She was also aware of the recent literature about teaching methods of solving equations. She made a link between this literature and her teaching.

In an article on recent research in mathematics education, Askew & William (1995) reported that when teaching new procedures the most common approach, starting with simple examples and moving to more complex ones can be counter productive. Indeed, pupils who solve simple equations intuitively, without knowing how they solved them, cannot use such methods to solve more complex examples. With my year 8 students, I began by solving equations intuitively. The objective was for them to become familiarized with letters representing numbers, the idea of what an equation is and how to write down the solution (assignment II).

According to Catherine, there is no one right way to teach algebra. She found that there were several ways to teach algebra and she was very flexible in her teaching methods for algebra.

To conclude, I would suggest that there is no one right way to teach solving simple equations. There are several ways, all having their own merits and pitfalls. The method used, I believe, should depend on the ability of the students involved and even then, what is right for one student may not be right for all students. Hence the value of having more than one way to solve equations (assignment II).

She responded to individual differences in her planning of teaching methods. Using several methods to teach algebra gave pupils a deeper understanding of the topic. Pupils’
involvement and each individual’s learning style was different from other pupils’. At this point, she took account of several teaching methods in her algebra teaching and, according to her, these methods played a crucial role in her teaching.

Contrast between algebra and data handling in Catherine’s teaching methods

For Catherine, data handling teaching included practical exercises, investigations and making posters.

They were all on task and working hard to find the ranges, medians and means from the information they collected in the last lesson (Evaluation Y10; 20 November 1997).

I think that maybe teaching students how to calculate the mean from un-grouped data is helpful and then there is only the extra step of finding the mid point when looking at estimating the mean (Evaluation Y10; 27 November 1997).

In contrast to her algebra teaching, not surprisingly, Catherine used more real life examples like her own secondary school experience in data handling. In algebra teaching, she had asked herself, ‘Why do we need to be able to solve linear equations?’ and she had found it a difficult question to answer!

Data handling is easier to refer to real life than algebra but it is important to try to do it with algebra and I ask myself when will I need this. The answers are different for algebra and data handling (interview)?

Topics such as arithmetic and geometry have direct relevance and application to the everyday world we live in. But with algebra, this is not so obvious.

She did find it easy to see a relationship between algebra and examples of everyday life. Pupils need to know how school learning, is used in our daily life and how to connect this learning to other things. Moreover, she found that using posters, showing how we use algebra in our real life, was very helpful in her teaching.

The Golden Ratio poster that I used with year 12 is also an example of connections that can be made with mathematics in real life (assignment I).

Students often ask what relevance a particular piece of mathematics will have in the ‘real world’, or if they will ever use the knowledge again (assignment I).

The selection of teaching methods depended on the topic and pupils’ ability and understanding. According to Catherine, algebra was more appropriate for flow diagrams on the board. Pair work was also suitable for low ability pupils. On the other hand for data handling, some practical activities and group work were needed.

I used to teach algebra using only the board. In the year 8 group of low ability pupils I would use pair work to work on flow diagrams and inverse operations (interview).
Teaching and learning aids

In the first term, Catherine’s main algebra teaching aid was the board. She used interactive board work to teach pupils. She often started lessons with board work. During her lessons she brought some pupils to the board and asked them to solve the equations. In the second term, she used a combination of board work and other materials and teaching methods.

Students found this work harder than I had expected. At the start of the lesson, I did some examples on the board (Evaluation Y11; 13 November 1997).

I put extra questions on the board as I had planned and 3 students got on to do these questions (Evaluation 8, 20 April 1998).

Catherine emphasised that boardwork was important for algebra. In addition to this, she wanted to use some cards, like a game, to teach how the signs are changed.

I decided next to show them without the flow diagram how to change one side to the other side. I prepared the cards taking one side and then physically moved them over to the other side to see what the equation then was. You turn the card over and I got them to do that in pairs and write down at each stage every time something happened (interview).

She found that some topics were easier to explain using the OHP, rather than the board. She wanted to use OHPs rather than write on the board.

I didn’t spend as long at the start of the lesson with examples. I think these kinds of examples using coordinates would be easier to explain using OHPs rather than drawing on the board (Evaluationy8, 13 May 1998).

In data handling, she reflected on ways in which she was taught, collecting data and working in a group, which she now uses in her own teaching.

...With the data handling I did some data collecting but the pupils didn't go out themselves. We did it in the class. Group work was just in data handling. (interview).

Catherine also used cards and games in data handling teaching. Using this technique, she made pupils work as a group.

I chose different ways. There was one activity that I did in the same way with the two groups: one group had cards with words like mean, mode, median, range. I then shuffled them up and gave them out and then all pupils had to arrange themselves to work together within the group (interview).

According to Catherine, worksheets were a beneficial and useful material for teaching different topics. Most teachers produced their own worksheet materials as she did. During her teaching practice, she used a blend of worksheets. She was keen to use worksheets as an additional teaching material. She found some of the questions in the text books were not original and most of them were identical. Some questions were not appropriate for each
individual pupil so that is why she wanted to use her own worksheets according to
individual differences.

I tried to produce worksheets that were not too laborious and repetitive rather than
ones which contained dozens of almost identical questions (assignment I).

During my teaching practice, I used a mixture of the school’s worksheets and books
along with my own worksheets where I felt they would be beneficial (assignment I).
I did selectively use exercises from the school worksheet especially for introducing
equations (assignment II).

I was pleased with the positive response from the students when I gave these out as
they obviously found them helpful (assignment I).

She asserted that worksheets must be appropriate for each individual’s right level of
understanding.

I think that the level of the worksheet I gave to the students today was too difficult
for some students. Other students got on well with it though (Evaluation 7a, 19 May
1998).

She realised that worksheets had an effect on her teaching. In addition to this, other
beneficial materials for her teaching were Overhead Projectors (OHP), computers and
books. Computers were mostly appropriate for teaching data handling.

Some topics, but not all were appropriate for using computers. I used them for data
handling (interview).

The year 10 group worked on computers with Microsoft Excel and this involved
students using general skills to follow instructions (assignment I).

She used books to retrieve some key concepts and relevant information.

In year 11, at both foundation and higher level, lessons on forming equations
involved picking out relevant information from sentences to form equations.
Similarly, year 12 chapter summaries involved students retrieving the key concepts
from their notes and unit book (assignment I).

According to Catherine, pupils need to receive homework but it must have a clear purpose.
She created her own homework materials.

…as long as it has got a purpose and not just setting it for the sake of it (interview).

I created homework sheets which involved students solving equations to find the
missing sentence (assignment II).

According to Catherine, every topic might be given as a homework, as long as it is related to
the lessons and it is at the right level for pupils’ understanding.

Every topic may be given as homework but I make sure that it follows on from the
lesson. It should summarize the last few lessons or introduce the next thing. And it
should be simple for them to be able to do by themselves. As long as it is not just
totally irrelevant to what they have been doing. (interview).
She found that if the homework was not appropriate to their level of understanding, they did not do it. At the end of the first term she faced this example in her teaching. She gave pupils some homework but they did not even attempt to do it.

A lot of students found the homework hard and some did not even attempt it. I felt that students were not working very hard, so I told them that since they were not using the time I had given them, we were going to move on to what I wanted to do. (Evaluation Y11; 1 December 1997).

OVERVIEW

Catherine was one of the intellectually stronger and more diligent students on the PGCE course. She had worked as an ancillary teacher and this partly motivated her to be a subject teacher in mathematics.

Catherine’s lesson evaluations and assignment were categorized and analysed in the same way as Claire’s and Scott’s. Table 6.5 illustrates that Catherine emphasised mostly teaching methods and materials in the first term of the lesson evaluations of her teaching practice. The second priority of her lesson evaluation was knowing pupils and learning. Catherine emphasised mostly teaching methods, materials and active learning elements throughout her lesson evaluations of her teaching practice. In the last term, she also concentrated on pupils’ learning and needs. This evidence illustrated that Catherine was a pupil-centered teacher by the last term of her teaching practice.

Table 6.5: Lesson Evaluation

<table>
<thead>
<tr>
<th>C</th>
<th>Lesson’s Evaluation (First Term)</th>
<th>Lesson’s Evaluation (Last Term)</th>
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<tbody>
<tr>
<td>A</td>
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<td></td>
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<tr>
<td>T</td>
<td>Freq.</td>
<td>%</td>
</tr>
<tr>
<td>H</td>
<td>Class, time, behv., man. contr.</td>
<td>3</td>
</tr>
<tr>
<td>E</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R</td>
<td>Pupil’s learning</td>
<td>3</td>
</tr>
<tr>
<td>I</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>Teaching methods</td>
<td>8</td>
</tr>
<tr>
<td>A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>K</td>
<td>Confidence</td>
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</tr>
<tr>
<td>N</td>
<td>Knowing pupils</td>
<td>3</td>
</tr>
<tr>
<td>P</td>
<td>Teaching materials</td>
<td>4</td>
</tr>
<tr>
<td>E</td>
<td>Active learning elements</td>
<td>2</td>
</tr>
<tr>
<td>N</td>
<td>Plan, preparation</td>
<td>-</td>
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<tr>
<td></td>
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</table>

Table 6.6 illustrates that Catherine emphasised mostly teaching methods and materials in the first assignment as in her first term lesson evaluations. Unlike Scott and Claire, she mentioned her planning and preparation as well as pupils’ learning difficulties. In her assignment she does not mention confidence. Both Catherine’s assignments mainly
emphasised teaching methods, materials and active learning elements. In the last assignment, she also concentrated on pupils’ learning and needs.

**Table 6.6: Assignment Evaluation**

<table>
<thead>
<tr>
<th>CATHERINE</th>
<th>Assignment I</th>
<th>Assignment II</th>
</tr>
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<td>Class, time, behv., man. contrl.</td>
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<td>Pupil’s learning</td>
</tr>
<tr>
<td>R</td>
<td>Pupil’s learning diff., needs</td>
<td>Pupil’s learning diff., needs</td>
</tr>
<tr>
<td>I</td>
<td>Teaching methods</td>
<td>Teaching methods</td>
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<tr>
<td>N</td>
<td>Confidence</td>
<td>Confidence</td>
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<tr>
<td>A</td>
<td>Knowing pupils</td>
<td>Knowing pupils</td>
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<tr>
<td>P</td>
<td>Teaching materials</td>
<td>Teaching materials</td>
</tr>
<tr>
<td>E</td>
<td>Active learning elements</td>
<td>Active learning elements</td>
</tr>
<tr>
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<td>Plan, preparation</td>
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<td>%</td>
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<td>Active learning elements</td>
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<td>18</td>
</tr>
<tr>
<td>Plan, preparation</td>
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<td>12</td>
</tr>
<tr>
<td>Total</td>
<td>77</td>
<td>100</td>
</tr>
</tbody>
</table>

behv.: behaviour  diff.: difficulties  man.: management
contrl.: control  Freq.: Frequencies

Her school file illustrates that she learnt to use a blend of teaching methods in her planning. As can be seen from Tables 6.5 and Table 6.6, she was not doing so at the beginning of the teaching stage when she used more traditional methods. But, by the end of the first teaching practice she seemed to be more confident in using active learning elements in her teaching. The majority of the lessons observed by the researcher also reflected the active learning values expressed in her interview and documentary evidence.

In summary, for Catherine, it seems the significance of what was to be learned and how it was to be learned were almost inseparable on the PGCE course. Contexts for her learning included secondary maths sessions, PDP sessions, teaching experiences, preparing lesson files, lesson notes, lesson evaluations and university assignments.

**Summary of Stage Theory and Catherine’s Progress**

The evidence, both quantitative and qualitative, illustrates her passing through the four stages of the Stage Theory. These extensive extracts offer an opportunity to view the shift in Catherine’s understanding of her teaching and her pupils’ learning and needs. Catherine has reflected on her background and experiences in such a way as to better understand the context of her pupils’ learning needs.

Broadly speaking, the common characteristics of most of Catherine’s lesson evaluations and assignments were a combination of teaching elements, teaching methods, teaching aids and active learning elements. This also showed how she moved from the second stage and passed through the other stages. Evidence of progression draws upon the qualitative and quantitative analysis of Catherine’s thinking and evaluation of teaching. It is notable that
she started the course ahead of the other students, because of her pre-teaching and work experience. Furthermore, the study of psychology in her undergraduate course may also have helped to shape her thinking about pupils and their learning. She was not in the beginning teaching stage when she started the PGCE course. Catherine had already passed the ‘beginning teaching stage’. Catherine’s started on the PGCE course at the ‘supervised teaching stage’. She developed some teaching methods and teaching competence and much better classroom control. In the ‘from teaching to learning stage’, she focused mainly on pupils’ learning and individual differences and needs. Catherine also mostly focused on teaching methods and materials. She wanted to make mathematics more understandable and interesting to motivate pupils to learn. She began to focus on pupils’ learning rather than her own teaching. Catherine developed a number of strategies to teach mathematics more effectively to pupils. This suggests that Catherine was still moving through the from teaching to learning stage at the end of the first teaching practice. In the ‘reflective teaching stage’, it is expected that she will develop as a reflective practitioner on the basis of critical evaluation. Catherine’s evidence shows that she was at the reflective stage by the third term. She reflects on her past and present experiences in relation to her teaching. She analyses these and is working towards a synthesis for her teaching. According to Catherine, effective mathematics teaching depends on enthusiasm and offering different ways for students to understand the concepts.

In considering these issues we note the greater confidence she showed in relation to the use of active learning methods which was facilitated by the training course. Overall, she was motivated to become a respected mathematics teacher. In particular, she was able to draw on all her experiences to develop her teaching methods. She took account of the uses of new teaching methods, organization, selection of materials and pupils’ needs and ideas. By the end of the first teaching practice, she was more confident with class control and using IT. Her lesson planning developed in flexibility and in the place of detailed written records.

Influences on Catherine’s Teaching

The major influences on her teaching may be summarised as follows. The first influence was her maths teachers and tutors with regard to classroom settings and choosing activities. The second influence was her major course tutor on the PGCE course, who reinforced and helped to develop her own thinking about teaching and the place of active learning. Teachers and tutors provided a role models for Catherine. The third influence was Catherine’s prior teaching experiences which made a great impact on her. In addition, this case study illustrates that her academic background (mathematics and psychology), strength
of mathematical knowledge, her motivation, pre-PGCE experience as well as the PGCE course itself all influenced her learning to teach mathematics. All these influenced her teaching style and her writings. She concentrated on individual pupil learning rather than her teaching but had a passive experience as a pupil while she was in secondary school. In what may be seen as a reaction to her experience as a pupil, she used whole-class-interactive teaching, questioning methods, emphasising understanding versus rote learning, active learning as opposed to passive learning, group work and use of pupil’s own mistakes. She showed flexibility in her teaching methods. She also developed a number of strategies for class control.

Catherine’s PGCE course mathematics session experiences and her experiences as a student teacher helped her to develop her personal beliefs about the characteristics of good mathematics teaching (Britzman, 1986). Catherine, however, relied less on her experience of secondary and university mathematics education and more on her own teaching when discussing her beliefs. In spite of her prior mathematics experiences (secondary and undergraduate) affecting her beliefs, her prior teaching experiences as an ancillary caused her to modify her beliefs. Catherine has already developed her strategies over a number of years.
CHAPTER 6

6.4. THE CASE OF LINDA

Linda is a 43-year-old and mature student like Scott. She has a physics degree from London University. Linda has an A Level in Applied Mathematics, a diploma in Industrial Studies (DIS) and a diploma from the Institute of Physics. Her route to teaching was school, work, university, work, Open University PGCE and Leicester PGCE. Linda aspires to teach from GCSE up to degree level.

Linda started on the Open University PGCE in February 1997 but was dissatisfied with distance learning. She already had substantial tutorial college teaching experiences. She has a strong academic background in Applied Maths and relevant work experience. Linda is thoughtful, confident and very well motivated for a PGCE.

Linda has 8 years part-time teaching experience in a private FE college in Leicester. She taught foundation, intermediate and higher GCSE, modules in mechanics (applied maths) at A level and expert maths GCSE course work. She taught year 9 pupils, mature students up to the age of 23 and also special needs students such as dyslexic and high ability pupils on foreign government scholarship schemes.

Linda has also worked as a part-time private tutor in physics and mathematics. She has taught different subjects. Her first year group of A level students all achieved very high grades. She gave private courses for GCSE, A level and B.Sc. Linda was also employed as a training manager. In the account which follows, the range of data sources used was the same as those used for the other three trainees.

Motivation for mathematics teaching and training on PGCE

Linda has a physics degree but she preferred to teach mathematics. The reasons for choosing maths were because she enjoyed maths and used more varied teaching methods in maths.

I did enjoy maths. I actually taught physics to start with and swapped to maths because I found there was a lot of factual material to hand out in physics, whereas maths involves more teaching methods. I like to explain the method, whereas in physics I just seemed to be feeding people facts. I was feeling my own way. Perhaps I did find I enjoyed teaching maths more than physics (interview).

Linda did not like the Open University PGCE. In that course, she felt isolated and not happy with the teaching practice school. What it offered was no different from her prior experience. Linda wanted to learn new teaching methods.
I was actually on an Open University PCGE about six months before this and I didn't like it because I felt very isolated. I also didn't like the school I was in, not because it was a bad school or that people were not particularly supportive, but I didn't feel I was learning anything from that school. It was just the same style of teaching as when I was at school. It was an independent grammar school and it just seemed pointless to me to continue. (interview)

According to her, the first reason for choosing Leicester PGCE was geographical and the second one was the reputation of the course. The third reason for choosing the Leicester course was dissatisfaction with the Open University course.

I live in Leicester, so for location reasons I chose here and I heard it was a good course. (interview).

I wanted to get on to a proper course, not the Open University course. So I am a bit exceptional, with an unusual background (interview).

Linda thinks of herself as an exception because she had already taught GCSE courses. Unlike the relative isolation of the Open University course, she enjoyed being at Leicester and having other trainees around her. According to Linda, this PGCE group is very small.

I am a bit exceptional. I taught all GCSE syllabus courses before, including course work and everything, only to small groups. So I found the course, very good, quite enjoyable. I liked just having other students around me (interview).

**Linda’s secondary mathematics experience as a pupil**

Unlike Claire, Scott and Catherine, Linda had a more traditional maths education in her single sex grammar school. She went to single sex school which was very selective. She was in the top set ability classes during her secondary school years. She found this education very appropriate, but low ability pupils were not considered.

Because I am mature I went through the selection, 11 plus and I passed into grammar school. There were 4 grammar schools in the town where I lived. They were single sex; 2 boys and 2 girls. I went to one of the girls' grammar schools. It was a very traditional style of education and teaching was also quite traditional. I believe, in my personal opinion, a lot of aspects were extremely good, extremely thorough. They didn’t deal with the low ability range (interview).

The school was a girls’ grammar school and class size would be around 30. Those classes were set by ability not by the subject. There were three classes per year group, each class was either top, middle or bottom. You stayed in the same classes for all subjects (interview).

**Linda’s beliefs and knowledge about teaching mathematics**

When Linda was in secondary schools, a typical algebra lesson for Linda was didactic and just consisted of how to handle equations.

The good features were it was very thorough in all aspects, particularly algebra. It was a little bit on the bad side, didactic. We were taught how to handle equations (interview).
It is noted that Linda is judging her own education in active learning terms. Linda emphasised that most of the passive students accepted what the teacher said and did not ask any questions, such as why and how? This type of education did not give pupils any chance to discover things. Linda asserted that those kinds of schools were not producing well-rounded persons.

We were taught +5 goes over to the other side and becomes a -5, x+5=11 become x=11-5. Nobody ever explained why and at the time it didn't bother me, but some of the passive students just accepted what was taught (interview).

I think pupils in those days, certainly in that type of school were expected to be very passive. It didn't develop me as a person. OK, I was good at maths and good at all subjects in fact, but I don't think I was very confident. It's only in the last few years with a bit of teaching, that I have had the confidence even to speak up with confidence. I think the school was lacking in terms of producing a well rounded person... (interview).

You didn't discover anything for yourself. You weren't encouraged to discover things for yourself even at A level (interview).

During her the secondary years, teachers were the driving force in the class, largely using exposition.

The teacher was very old fashioned. She was good and very thorough but she would talk for possibly half the lesson, which was lecturing to the children (interview).

The methods were strongly non-interactive: all silence, no question and answer and no discussions when she was in secondary school. Homework was given regularly and checked regularly. Linda's reason for this was the school's standards were very high and demanding. She makes a sharp contrast with active learning philosophy.

I don't remember many question and answer sessions. You would be set exercises which you did and some homework which was marked very rigorously. It would be handed in and handed back marked by the next lesson. I don't remember much discussion of the homework with the teacher. She would write comments on it and that was the end of it. Most maths lessons were not boring but quite pleasant anyway, because you knew what was expected of you. You went in and you were given the information, you practised it, you went away and did your homework, full stop. It didn't perhaps make many very verbal demands on you, mental demands, although because the standard was extremely high... , it was quite demanding mentally but there was not much verbal discussion needed. I mean that would be a typical maths lesson: in silence, no pupil discussion, no group work (interview).

Linda experienced whole class teaching but not whole-class-interactive-teaching. Her teacher did not use any group work or pair work or projects for mathematics lessons. All learning depended on each individual's effort.

I was talking about what I thought the style was: whole class teaching not really whole class interactive teaching. That was the methodology that was used in that era
and probably in all schools. Because I am quite mature, I go back a long way, where there was no project work, no coursework. I don't remember any group or pair work in maths. You worked individually and sat at individual desks; all your work was individual.

Linda only came across practical work and pair work in science lessons.

All subjects were pretty much thought of in the same fashion but perhaps some of the sciences involved more practical work and working in pairs (interview).

As will be shown in the analysis which follows of Linda's own teaching, she uses these experiences and uses mostly whole class teaching but also takes account of other methods and the extent of variation will be significant.

I think perhaps my teaching style may still reflect the way I was taught because it worked for me. I am very keen on whole class teaching perhaps because that was the way I was taught. That is not to say I am not going to use the other ways (interview).

Linda did not have any particular bad memories about mathematics teachers and mathematics teaching. But she emphasised that if you had a difficulty in understanding topics, you couldn't find anybody to help you, not even the teacher. Teachers were always busy and had not much time to explain things.

I was at the top end of the range. I don't remember having much difficulty understanding things. I think if you were having a problem, the negative side was that there wasn't much help for you. I don't think the teacher had much time. If you put your hand up and said 'Sorry, miss, I don't understand this', it was just hard luck. For me it was fine... for other people I am not convinced. (interview).

Her teachers mostly used textbooks alongside expositions. Linda emphasised that at that time, photocopier and computers were not used widely.

Textbooks, chalk-board, teacher exposition on the chalkboard, no worksheets or things like that and there wasn't even a photocopier widely available. I went to secondary school in 1966. The whole technology was different then. No computers, no photocopies—you worked from a standard class set of text books (interview).

Linda's reflection on her own teachers' teaching approach is very different from Scott and Claire. Claire and Scott associated such teaching with bad experiences of teachers, particularly in the case of relationships.

But Linda was not concerned about relationships with teachers. She just learned what she had to and could cope academically. She was positive about her teachers' performance but over a very limited range of methods which worked for her. But she also draws on her experience of teaching methods since then to raise question about such narrow methods and the missed learning opportunities, particularly in relation to active learning and quality of understanding.
Linda’s undergraduate education

Linda’s undergraduate education was also passive until her final year. She found that it was not different from school. In addition to this, she defined her undergraduate education as traditional teaching. Linda found herself alone, taking some notes and going to the library during her undergraduate education.

I didn't find it vastly different from school. It was a little bit more traditional in its style of teaching. We still largely went to lectures wrote notes down and did more work for ourselves. It was quite a shock to the system. You had to go to the library and work on your own- it was still quite a passive experience (interview).

According to Linda, an exception was in her final year, because she did a project and group exercises.

The final year, you had a project to do but this was done on your own. You didn't work much with other people. There were one or two group exercises but group work and collaborative work weren't high on the agenda in those days. It was still very much individual work. (interview).

For Linda, university education meant going to lectures, taking the lecture notes and passing the exams. University education was only exam focused like Linda’s own pre-PGCE teaching.

I took the lecture notes, I studied for the exams, passed the exams and found that at university you got the bare outline. You had to fill it in (interview).

You just went to lectures and took the notes and you learnt them. You also expanded the notes a little bit-that was that. You took exams at the end of the year and that was that (interview).

Linda’s own teaching for understanding

Linda wants to bring some meanings and links to mathematics. According to Linda, the reason for pupils not liking algebra was that algebra was only exam focused. They did not want to learn how to make a link between topics, even in private tuition. The following extracts show that she found a conflict between her own goals and pupils’ or parents’ goals.

I personally like to try to bring meaning into it, but I have found pupils don't like it. They just want to be taught how to do it and how to pass the exam. They do need very detailed explanation but I think it is nice to build in some other links to other subjects. Obviously, people who come to you for private tuition are quite exam focused. They want to pass the exam-that's why they pay for private tuition. Even though they might be low ability, their parents all still want to push them to learn how to solve equations. They aren't interested in the linkages to areas or fields or whatever with differences of two squares that sort of thing. (interview).

According to Linda, the response of pupils has made her deliberate on the benefits of trying to incorporate relational understanding into teaching. However, on deeper analysis, Selinger
(1994) notes that although the rewards of instrumental maths are more immediate and apparent, the benefits of relational understanding are that it is more adaptable to new tasks and easier to understand long term due to the conceptualization of connections. Selinger does, however, point out that relational understanding is problematic for pupils and teachers because greater effort is required to make connections than in instrumental understanding. These factors could account for the pupils' apparent dislike and impatience with this attempt at relational mathematics. Linda appears to take account of Selinger's point (1994) in her teaching. Her main aim was to teach mathematics that was understandable to pupils and she brings theory into practice.

Since my personal education in mathematics had been largely instrumental, I was quite keen to try some relational teaching. Hence, when teaching factorising of the form $a^2 - b^2$, i.e. the difference of two squares, I not only highlighted it as being useful to identify quickly, but also demonstrated and discussed it in a relational fashion by using cardboard and by passing the shapes around for the pupils to try for themselves (Assignment I).

Linda used squared paper to show how to represent the algebraic equations geometrically in her teaching.

I explained to the class this was a physical representation which would help them to make connections with another area of maths and thought that, this being a top set, the approach would appeal to and interest a large portion of pupils (Assignment I).

Linda used direct questioning to individual pupils to develop understanding. The aim was to encourage pupils' involvement and to help with class control. This shows how she reflected her co-tutor's teaching in her own practice.

I sometimes attempted to direct marginally easier questions to the slower pupils in order to maintain the flow of the lesson and to develop their confidence. I remain, however, unconvinced about the advisability of this technique with settled classes since it could appear patronizing and runs the risk of labeling certain pupils. I intend to keep this aspect under review and to assess it more fully on Mode B teaching (Assignment I).

Linda also used questioning which was appropriate for pupils' level of understanding. If the pupils were slow learners, the questions might be appropriate for their level. The aim of this was to give confidence to these pupils.

Linda's classroom was different from those of the other trainees in that she tended to stress the reasons why pupils who were engaged in certain tasks made particular mistakes. She thought that pupils knew their own mistakes either on the board or in their books and they looked and learnt from them and did not repeat them again.

Mistakes on the board due to changing the type of filled square (could have caused confusion with less able pupils) Evaluation Y10 11 May 1998).
They make systematic mistakes using what he refers to as ‘buggy algorithms’ i.e. procedures yielding consistent (but sometimes wrong)answers. (Assignment II).

Although Linda doesn’t like data handling for the likely reason that she didn’t meet the topic in her secondary school years, she believes that group work and computers are relevant in data handling teaching. According to her, pupils enjoy data handling but not algebra. Some everyday activities such as national games (lottery, horse racing) affect pupils and that is why pupils like data handling. Pupil’s do not link everyday life with algebra.

I think there is more opportunity in data handling for little projects and group work perhaps even getting out of the classroom or using computers because you could access information, you could pull in data from computers or data bases, something like that. There is not really so much opportunity with algebra. There is some software written for it but not the opportunity for group work. I think sometimes they enjoy data handling perhaps because it seems more relevant. I personally don’t like it because I think I did not do it when I was at school, but I think the children quite enjoy it because it has immediate relevancy. The algebra just doesn’t seem to have a lot of relevance for pupils. Pupils say to me, Why do I need to know about square root x or whatever? I agree you can’t see the relevance. But the national lottery or betting on horses they can probably see ... (interview).

Linda’s algebra teaching involved a blend of teaching methods and pupils’ active involvement. According to her, solving simultaneous equations depended on pupil’s active involvement.

The introduction of simultaneous equations to Year10 opened up an opportunity to deviate from the didactic and to allow pupils to take an active part in their learning (assignment I).

She started from a real problem for investigation e.g. 3 cups of coffee and 5 cups of tea cost so much (each time change the total). How much does tea and coffee cost per cup? She reflected these kinds of examples from the university course and a training video.

She summarised her teaching:

Upon reflection and analysis, I would use this approach (real problems for investigation ( again to introduce work on simultaneous equations as my co-tutor and I judged that it added depth and variety to what can otherwise appear to be a very procedural and prescriptive topic. Making the pupils more active in their learning, rather than just passive recipients of knowledge, was very satisfying. The different style of the lesson was well-received by pupils as was the element of self-discovery and discussion; this was in contrast to the work on the difference of two squares where perhaps the element of self discovery was lacking. However, for the future, I would hand out the sheets separately or, at least, tell pupils not to look at the second sheet until instructed; I would also introduce more structure into the first discussion, taking care to include a list of pupils’ contributions on the board concerning the possible price of the items. Exposition was necessary to establish the appropriate procedure for the method of algebraic elimination, but, in future, I would introduce some more challenging questions other than those on the first homework sheet for those pupils who had met the topic before and/or were more able (Assignment I).
In her second assignment, Linda considered Teubal and Nesher's (1995) points that other aspects of the text are also important for pupils in achieving a solution. What operation(s) (addition, subtraction etc.) are called for by the problem and the 'real life' situation described by the text? She was keen to use literature about using 'word problems' in everyday activities.

Despite the potential difficulties engendered by 'word problems', they are, or should be, motivational to the pupil since such problems represent a relevancy to real life situations and therefore give a context and purpose to the study of equations which should be apparent to the pupil. To conclude this section, quoting from Mathematics in NC (1995) KS3 and 4, Algebra: 'Pupils should be given opportunities to ...consider how algebra can be used to model real-life situations and solve problems' (Assignment II).

What is interesting here in her teaching is that whereas Scott's and Claire's approach is about relationships and pupils' active involvement, Linda's approach is about teaching strategies emphasising the subject and modes of presentation of difficult ideas: the emphasis here is on what Shulman calls "pedagogical subject knowledge".

Linda use some blend of methods to teach mathematics understandably for pupils. That's why she used graphical representations and some practice for pupils plus some exposition and explanation.

Pupils had difficulties understanding the squared inequalities e.g. $x^2 > 25$ and there was insufficient time to get on to the graphical representation of this. Perhaps I should have done this first rather than trying to explain in algebraic terms and let them get on with some practice (Evaluation Y10, 4 December 1997).

**Variety in Linda's teaching methods, including active learning elements:**

**Board work**

Linda's teaching involved board work and some expositions. She tried to gain class attention and motivate the pupils. She believes in the importance of board work to enable pupils to understand mathematical concepts.

However, they listened fairly well while I did some board work as I feel they have had enough of SATs preparations (Evaluation Y8. 31 March 1998).

Brackets work was quite challenging but pupils were well motivated during the whole class board work and enjoyed it (Evaluation Y9 27 April 1998).

Board work on formula needs going over, as many pupils had some difficulties with the worksheet 'circumference of a circle' (Evaluation Y10 20 April 1998).

Excellent attention during board work (Evaluation Y9 14 May 1998).
Co-operative work, including calculators and IT

Linda mainly preferred pair-work in her teaching. The reason for this was to involve pupils in a discussion.

The idea was that they would discuss the problem and begin to realize that it could not be solved with the information given on the first sheet (assignment I).

This strategy appeared to be successful in her teaching.

Overall, I did not find this lesson to be as successful as the previous one where pupils worked in pairs (Assignment I).

According to Linda, she is particularly open to the use of group or pair work with calculators and computers in her teaching. She finds graphical calculators very useful for algebra teaching.

The collaborative project carried out during Mode A serial practice provided the opportunity to use graphical calculators for the teaching of simultaneous equations, which therefore complemented the algebraic work done previously (Assignment II).

She gave pupils instructions on how to use graphical calculators to solve and draw simultaneous equations. She emphasised that using graphical calculators was beneficial for the teaching of simultaneous equations.

In conclusion, the use of graphical calculators for work such as the graphical solution of simultaneous equations is beneficial as it allows the learning to be pupil-led (Assignment II).

Instruction sheets were written for the pupils and these addressed three ways of solving simultaneous equations: firstly, a reminder of the algebraic method; secondly, use of the graphical calculator ‘equation mode’ which allowed pupils to self-check their answers to the algebraic method; thirdly, plotting the lines representing the simultaneous equations on the calculator and inspecting the point of intersection to obtain the solution (Assignment II).

She also used graphical calculators to motivate pupils and to calculate inverse functions.

Pupils appeared to be well motivated and to enjoy the change of emphasis in using graphical calculators (Assignment II).

The ability of each pupil might be a consideration in making a pair work effectively. If you did not consider each pupil’s ability, the more able pupils controlled the key board. She tended to use friendship groups when pupils worked co-operatively.

Pupils had paired up on a friendship basis which, in some cases, meant they were not matched in ability and the more able one was most likely to take control of the keyboard. However, there could have been resentment had they been paired off by ability, with the possibility that they would not have worked as co-operatively as they were observed to be doing in their friendship pairs (Assignment I).
Linda found that using computers made the lesson interesting and motivated the students. In pupil’s learning, pupil-pupil interaction might be considered.

I noticed that considerable on-task discussion took place and my personal opinion would be that the pupil-pupil interaction was beneficial for the learning taking place for both students (Assignment I).

She also observed that pupils work very quickly if they use the computers, sometimes getting ahead of their learning.

From observations of pupils working at the computers, I thought they had a tendency to move to the next level too quickly (Evaluation Y10, 24 November 1997).

**Practical work and investigation**

Linda combined some practical work, investigation and discussion with the group work. She felt she managed this well.

The practical feature of the investigation was useful and they were well involved with the work (Evaluation Y8 21 April 1998).

Linda used practical activities to aid control of the pupils’ behaviour. She felt all pupils enjoyed it.

The practical exercise was done well with accurate results and pupils enjoyed the activity. Even the trouble makers applied themselves (Evaluation Y10 20 April 1998).

The measuring task was a useful practical group exercise and so was discussion at the end of the lesson (Evaluation Y7 28April 1998).

She realises that practical work causes some problems e.g. noise, but can be very effective.

The practical work went well, but some were slow to reach a conclusion. They were noisy during practical work, but on task most of the time (Evaluation Y8 12 May 1998).

However, they listened well while I went over the previous day’s practical activities and worked well on the worksheet (Evaluation Y8 14 May 1998).

**Games**

She also used games in her teaching. The aim of this was intended to suggest to pupils what they should do in order to improve their learning.

Great improvement on yesterday’s lesson. Keep using the 3 strike system and keep relaxed as this approach improved matters. Possibly do a mathematical game if lesson is flagging, particularly in the last 10 /15 minutes (Evaluation Y10 13 May 1998).

Linda also used some games to teach algebra to the pupils.

The game required pupils to solve an equation in order to determine the number of places they could move a counter on the snakes and ladders board. Since these
pupils had not been taught other approaches to solving equations, they were largely using trial and improvement methods in groups to find the solution. It was interesting that no pupils seemed concerned about the use of letters to represent numbers (Assignment II).

**Using worksheets:**

According to Linda, worksheets were appropriate for algebra. She claimed that at the beginning of the lesson, some exposition was required.

Worksheet on algebraic expressions was appropriate- some students did not realize to substitute n, perhaps more initial explanation was needed (Evaluation Y9 20 April 1998).

Linda reported that worksheets helped to develop pupils' understanding and to provide some extension work.

Many pupils found the worksheet hard, but it was only intended as extension work (Evaluation Y10 29April 1998).

The worksheet worked well and many did most of second side, with some progressing to the extension work (Evaluation Y10 13 May 1998).

The worksheet worked well and some pupils had a good understanding even on the harder ones (Evaluation Y9 14 May 1998).

**Class and time management**

Linda's teaching and planning displayed some distinctive characteristics including a strong emphasis on control at the beginning of the first teaching practice. At the same time, she controlled classroom behaviour and she also controlled the task and time. During her teaching, she developed a strategy to keep disruptive pupils busy.

Strategies for keeping pupils' interest in lessons included:

Starting and stopping in the middle of sentences worked well (Evaluation Y8 . 31 March 1998).

She initially sees her main weakness as class management. But as she gained experience of class management in the first teaching practice it ceased as a problem.

That's my weakness-it's really the class management with no previous experiences (interview). Overall, I was pleased with my class management (Evaluation Y10, 12 December 1997).

Class control was overall good and OK. (interview) & (Evaluation Y9, 30 March 1998).

Linda also highlighted individual pupil's behaviour as opposed to their learning.

Behavior during the lesson was fine but they need keeping on top of Sayerl, Raj, Ozi, Aneena are problems (Evaluation Y7 28April 1998).

Nadeem was very loud and behaving in a silly manner-after several warnings he was given detention for Tuesday (Evaluation Y8 1 May 1998).
Linda had a few problems with timing of the lesson on the first teaching practice.

The lesson timing was difficult and I began to discuss a new topic at the lesson end (Evaluation Y10, 17 November 1997)

The major problem area of the lesson was that I mixed up the time of the lesson and dismissed the class at 9.45 instead of 9.50! (Evaluation Y10, 12 December 1997)

She emphasises that the weather was an important influence upon pupil’s behaviour. If the weather was too hot, pupils do not want to work and listen.

Very hot in the classroom, pupil restless and not wanting to work (Evaluation Y9 18 May 1998).

Besides the weather, she also emphasises that timing of the lesson was very important especially in mathematics. This also affects pupils’ learning.

This was an after dinner lesson, also the last lesson of the day on probably the hottest day of the year. Many students were restless because of the heat or didn’t want to work. (Evaluation Y10 19 May 1998).

OVERVIEW
As for the other trainees, the following tables capture the shifting emphases in Linda’s reflections.

Table 6.7: Lesson Evaluation

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<td>4</td>
<td>5</td>
<td>Pupil’s learning diff., needs</td>
<td>3</td>
</tr>
<tr>
<td>Teaching methods</td>
<td>33</td>
<td>38</td>
<td>Teaching methods</td>
<td>6</td>
</tr>
<tr>
<td>Confidence</td>
<td>1</td>
<td>1</td>
<td>Confidence</td>
<td>-</td>
</tr>
<tr>
<td>Knowing pupils</td>
<td>4</td>
<td>5</td>
<td>Knowing pupils</td>
<td>7</td>
</tr>
<tr>
<td>Teaching materials</td>
<td>15</td>
<td>17</td>
<td>Teaching materials</td>
<td>12</td>
</tr>
<tr>
<td>Active learning elements</td>
<td>17</td>
<td>20</td>
<td>Active learning elements</td>
<td>9</td>
</tr>
<tr>
<td>Plan, preparation</td>
<td>2</td>
<td>2</td>
<td>Plan, preparation</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>87</td>
<td>100</td>
<td></td>
<td>40</td>
</tr>
</tbody>
</table>

behv.: behaviour diff.: difficulties man.: management
contrl.: control Freq.: Frequencies

Linda had relatively few class management problems early on. The reason for this was that she had earlier teaching experience. First term lesson evaluations mostly referred to teaching methods, teaching materials and active learning elements. The references to teaching materials increased sharply in the last term’s lesson evaluations. She emphasised teaching methods from the first term.

Linda’s school file illustrates she learnt to use a blend of teaching methods in her planning. She used traditional methods at the beginning of her teaching practice, reflecting her prior beliefs, but by the end of the first teaching practice she seemed to be more confident in using a limited range of active learning elements in her teaching.

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### Table 6.8: Assignment Evaluation

<table>
<thead>
<tr>
<th>Linda</th>
<th>Class, time, behv., man. contrl.</th>
<th>Pupil's learning</th>
<th>Pupil's learning diff., needs</th>
<th>Teaching methods</th>
<th>Confidence</th>
<th>Knowing pupils</th>
<th>Teaching materials</th>
<th>Active learning elements</th>
<th>Plan, preparation</th>
<th>Freq.</th>
<th>%</th>
<th>Freq.</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assignment I</td>
<td>5</td>
<td>9</td>
<td>3</td>
<td>5</td>
<td>12</td>
<td>5</td>
<td>10</td>
<td>24</td>
<td>13</td>
<td>55</td>
<td>100</td>
<td>102</td>
<td>100</td>
</tr>
<tr>
<td>Assignment II</td>
<td>5</td>
<td>5</td>
<td>11</td>
<td>19</td>
<td>14</td>
<td>14</td>
<td>14</td>
<td>15</td>
<td>-</td>
<td>55</td>
<td>100</td>
<td>102</td>
<td>100</td>
</tr>
</tbody>
</table>

Linda also felt that preparing and writing the university assignments helped her develop reflections on her own practice, which she also linked to theoretical perspectives. Overall, in both assignments, Linda again concentrated on teaching methods, materials and active learning elements. Some shift in emphasis towards pupils’ learning and needs in her later writing is also detectable.

Observations of Linda in addition to the interview with her and examination of her school files about her teaching provide confirmation that she believed in the importance of knowledge of the subject as well as teaching methods. Her lessons which were observed by the researcher showed that her learning was reflected in her teaching. She had a good knowledge of mathematics especially algebra.

According to her open-ended questionnaire responses, she was keen to use problem solving, individual work and project work for algebra. She was keen to use practical simulations and real problem solving in her teaching. Linda liked to teach algebra, especially quadratic equations. She was keen to use practical simulations and problem solving in data handling, but she herself didn’t like data handling, because of lack of experience in her background. Although she was keen to try active learning components, she still preferred teacher-directed teaching. She preferred teacher exposition but gradually extended this to include interactive whole class teaching: cooperative work was largely driven by the stimulus of graphical calculators and computers.

**Influences on Linda’s Teaching**

She gained confidence for teaching using active learning during her training. Her attitudes and beliefs drove of her to use teacher-centered teaching methods. During her teaching practice, she had to use pair work in using graphical calculators or computer activities. She
took account of the uses of new teaching methods, organizations, selection of materials and pupils’ needs and ideas like the other trainees. Her written evidence showed that she had become more reflective in some respects but still her prior beliefs influenced her strongly.

Linda’s planning is more like experienced teachers and more reflective. Is this because she is more experienced, confident and knowledgeable about the subject? She recognised learning to teach maths as different from her previous learning but only gradually became open to using active learning elements, which she met on the PGCE course.

The major influences on her teaching may be summarised as follows.

Like other trainees, she was influenced by her former teachers, school tutors and university course tutor. Linda’s past teaching and learning experiences strongly influenced her teaching style and methods.

In addition to these human influences, her background and subject knowledge of mathematics influenced her learning to teach mathematics.

In spite of Linda’s prior mathematics experiences affecting her beliefs, her prior teaching experiences as a teacher and tutor caused her to change her beliefs. Linda retained and developed her strategies during the years. She felt more comfortable and more confident during her training. She has a very positive attitude towards teaching mathematics and especially algebra.

Summary of Stage Theory and Linda’s Progress

The evidence, both quantitative and qualitative, illustrates her passage through the stages of the Stage Theory like other trainees in the course. Like Catherine, it is noted that she started the course ahead of the other students because of her pre-teaching and knowledge. She had already taught a variety of subjects (e.g. maths and physics but just exam-focused) and pupils. Because of her knowledge and prior experience of teaching, she was not in the beginning teaching stage when she started the PGCE. Linda had already passed the ‘beginning teaching stage’ and was in the ‘supervised teaching stage’, during the first teaching practice.

After a few week of her teaching practice, she developed her teaching methods and teaching competence and much better classroom control. Unlike the other trainees, in the ‘from teaching to learning stage’, she did not focus on pupils’ learning and individual differences and needs. She did not shift to a pupil-centered rather than teacher-centered orientation. It is
difficult to find the elements of the ‘from teaching to learning stage’ such as pupil-centered attitudes in Linda’s reflections.

On the other hand, she showed elements of the ‘reflective teaching stage’ early on. She is more reflective and talks about teaching methods in her critical evaluations. She knows which teaching methods to adopt for which situations. Linda’s evidence showed that she had reached the reflective teaching stage during her teaching practice. She also reflected on her prior and present experiences of teaching.

In this case study, different kinds of influence on the ‘mathematics teacher-to-be’ were illustrated (pre and post PGCE). This study, like other three case studies, gives us a flavor of the trainees’ thinking, knowledge, beliefs and attitudes to teaching mathematics. But, in Linda’s case it is hard to assess the relative importance of the different sources of influence: prior experiences of school and work; academic ability; the PGCE course; and her varied teaching experiences. Furthermore, her powers of reflection are atypical and may be in part a function of her ability as a mathematician with good subject knowledge and her prior teaching experiences.

In relation to the stage theory model, she does not fit this model as a whole. It is difficult to put Linda in each category in the stage theory in sequence. This may be because her background was notably different to other trainees in the course. She talks about active learning but she uses traditional teaching rather than active learning. At the same time, she emphasises teaching for understanding. On the other hand, she is more reflective, and uses everyday examples in her teaching as an element of active learning (such as 3 cups of tea and 5 cups of coffee...). She also engaged in whole class interactive teaching and used pair work and individual work. This might be because of the resources. Using computers and graphical calculators forced her to use pair and individual work with ICT facilities. This case shows that there is a particular problem in the third stage. She shows fourth stage characteristics but not the third stage’s characteristics. This might be because she is more mature, with extensive prior teaching experience in a very narrow context (test-based teaching), and has more traditional schooling experiences.

There is a tension between her practice which is teacher centered and exam oriented and her awareness through the PGCE course experiences and reading a wide range of materials. It is quite an unusual case and it is uncomfortable to accommodate. In summary, the stage theory needs to be revised!
In the following section the four case studies are considered together in relation to the university tutor's view on learning to teach mathematics, the place of active learning and the stages through which trainees pass.
CHAPTER 6

DISCUSSION OF FOUR CASE STUDIES IN RELATION TO A UNIVERSITY TUTOR’S VIEWS

In these case studies, different kinds of influence on the pre-PGCE and post-PGCE ‘mathematics teacher to be’ were illustrated (Table 6.9) (Vallance, 1997; Wragg et al., 1993; Wubbel & Korthagen, 1990; Wubbel, Korthagen & Dolk, 1990; McIntyre, 1990; Bolluogh, 1990; Brown & Borko, 1992; Zeichner, Melnick and Gomez, 1996). These case studies revealed both differences and similarities in trainees’ thinking, beliefs and attitudes to teaching mathematics. How trainees use teaching methods and teaching materials are explored in the cases. The discussion which follows is set in the context of the university tutor’s view. The university tutor’s views were obtained using a structured interview schedule in an interview lasting about 1 hour which was conducted at the end of the PGCE year. The four case studies of trainees were also used to illustrate theoretical ideas and further discussion will be related to theories of active learning, stage theory and learning to teach which are offered by psychologists, philosophers, sociologists and educators and are expressed in the literature (Chapter 2.2, Chapter 2.3 and Chapter 2.1).

The present research, as part of the mainstream qualitative research in the sociology of education with its focus on natural settings, is concerned with perspectives and an understanding of trainees, with an emphasis on social processes and preliminary attempt to generate analysis. With this background, the researcher adopted a classic case-study approach (Yin, 1989, 1993a, b; Nisbet & Watt, 1978), with its associated strategies of observing and participating in, as already discussed in the Methodology Chapter 3. Of course, the results of such an approach are highly susceptible to specific factors, such as the nature of the sample case itself, the range and validity of the data which are collected and the analytical procedures which are employed to build an interpretation.

The data which the researcher collected from questionnaires, interviews and written documents provided useful and illuminative background information (Artiles et al., 1996), and the researcher used this information mainly to help to gain some understanding of the reasons why trainees had formed certain beliefs in learning to teach (Campione et al., 1989; Feiman-Nemser, 1983, 1990; Feiman-Nemser & Buckman, 1989; Carter, 1990; Aguirre et al., 1990; Weinstein, 1990; Brown et al., 1991; Thompson, 1992; Borko et al., 1990, 1992; Fullan, 1991; Benett, Turner-Bisset, 1993; McDiarmid, 1990, 1993; Borko & Mayfield, 1995; 191
<table>
<thead>
<tr>
<th>Table 6.9: Summary of Case Studies Matrix</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Claire -24yrs</strong></td>
</tr>
<tr>
<td>limited teaching experience &amp; limited subject knowledge</td>
</tr>
<tr>
<td>past experience as a pupil</td>
</tr>
<tr>
<td>I would prefer to be a teacher in a school rather than a lecturer at college</td>
</tr>
<tr>
<td>I actually got <strong>smacked</strong> in front of the classroom because I had forgotten something, or got it wrong which was embarrassing. I had a teacher who was very approachable, and he was very soft.</td>
</tr>
<tr>
<td><strong>Scott -32yrs</strong></td>
</tr>
<tr>
<td>limited teaching experience &amp; limited subject knowledge</td>
</tr>
<tr>
<td>One of the tutors we had, I found very unapproachable. So this was very scary for me. The other one was adaptable, and approachable</td>
</tr>
<tr>
<td><strong>Catherine -23yrs</strong></td>
</tr>
<tr>
<td>teaching experience &amp; strong subject knowledge</td>
</tr>
<tr>
<td>I had a teacher who was very approachable, and he was very soft. I had a teacher who was very approachable, and he was very soft.</td>
</tr>
<tr>
<td><strong>Linda -43yrs</strong></td>
</tr>
<tr>
<td>teaching experience &amp; strong subject knowledge</td>
</tr>
<tr>
<td>I found the course, very good, quite enjoyable.</td>
</tr>
<tr>
<td><strong>PGCE</strong></td>
</tr>
<tr>
<td>I enjoy it when you get to discuss, you get lots of ideas. I find them really helpful</td>
</tr>
<tr>
<td><strong>General teaching</strong></td>
</tr>
<tr>
<td>When I first went into teaching, I found that I did start teaching with blackboard and doing it like that. I actually taught pretty much the same way that I had been taught. I did similar things.</td>
</tr>
<tr>
<td><strong>Algebra and data handling teaching</strong></td>
</tr>
<tr>
<td>Data handling was a bit more practical. The pupils don’t particularly enjoy algebra. We did more algebra than data handling</td>
</tr>
<tr>
<td><strong>ACTIVE</strong></td>
</tr>
<tr>
<td>I worked with groups, worked in pairs as well as whole class: I used whole class work.</td>
</tr>
<tr>
<td><strong>LEARN</strong></td>
</tr>
<tr>
<td>If you can relate it to everyday life where you use it in practical situations you find that is probably the easiest way to learn maths. I’ve given quite a lot of investigative work and project work.</td>
</tr>
<tr>
<td><strong>ELEMENTS</strong></td>
</tr>
<tr>
<td>Books, questions, equations, blackboards I made up a worksheet with sample questions to go through. OHPs do help</td>
</tr>
<tr>
<td><strong>Scott -32yrs</strong></td>
</tr>
<tr>
<td>limited teaching experience &amp; limited subject knowledge</td>
</tr>
<tr>
<td>I wanted my lesson plans to be useful and at the same time easy to follow during the lesson and prepared a plan using a word processor. Teaching whole class through discussion, group work and obviously individual work. I do it a bit from books, I produce my own work sheets.</td>
</tr>
<tr>
<td><strong>Catherine -23yrs</strong></td>
</tr>
<tr>
<td>teaching experience &amp; strong subject knowledge</td>
</tr>
<tr>
<td>I had enough confidence to initiate revision of the whole book and confidently and successfully answered questions relating to problems with any part of the module. More understanding and learning will take place if the students are more involved in their learning.</td>
</tr>
<tr>
<td><strong>Linda -43yrs</strong></td>
</tr>
<tr>
<td>teaching experience &amp; strong subject knowledge</td>
</tr>
<tr>
<td>There is more opportunity in data handling for little projects group work perhaps even getting out the classroom or using computers because you could access information. There is not really so much opportunity with algebra.</td>
</tr>
<tr>
<td><strong>An example</strong></td>
</tr>
<tr>
<td><strong>Sets, questions, equations, blackboards</strong></td>
</tr>
<tr>
<td>OHPs do help</td>
</tr>
<tr>
<td>Different methods will suit different individuals and it is the role of the teacher to find a method that is most appropriate to each individual</td>
</tr>
</tbody>
</table>

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Feathersome, 1995; Capel et al., 1995, 1996; Fosnot, 1996; Richardson, 1996; Feathersome, Munby & Russell, 1997; Welsh & Jenlink, 1998). The literature base was discussed in Chapter 2.1. The researcher conducted four case studies to demonstrate trainees’ beliefs. The aim of the interview with the university tutor was to determine the goals of the secondary mathematics PGCE training course. He had given careful consideration to what he would cover during both terms and how he would implement the training curriculum. The mathematics course tutor intended to emphasise the conceptual aspects of teaching and learning mathematics (Lapointe, Mead & Askew, 1992), in particular using the active learning approach (Anthony, 1996). He gave information about each of the individual trainees, their backgrounds and their teaching and learning. The tutor emphasised that the trainees had different backgrounds and were of a wide age range. They also had had varied routes to the training course.

The discussion and conclusions which follow are based on sub-headings common to each of the case studies.

Motivation for teaching and training and inspiration to become a teacher
On the whole trainees’ reasons for wanting to teach were based on personal relationships with their teachers and tutors. On the other hand, some of the trainees turned to teaching as a second job opportunity. It would be easy to find a job because of the shortage of mathematics teachers (Gilbert & VanHeften, 1988). Their tutor asserted that ‘the job prospects are very good for mathematics teachers’ (Brown & Borko, 1992; Beynon & Tootey, 1995). Trainees’ shared goal was that they all wanted to be mathematics teachers (McQualter, 1986).

Choosing the Leicester PGCE
The trainees emphasised that the main reasons for choosing the Leicester PGCE were geographical and the good reputation of the course and Mike also made the same points.

For the majority of them it’s their local university. I think, last year, two thirds of maths students came from local universities onto the PGCE, two thirds is a very high proportion and geography is important. The other thing is they do get feedback about the courses in the career service and word gets around and the Leicester University course, for a whole lot of reasons, has a good reputation. We have relatively small numbers of people actually attracted to Leicester from a long way away. They are relatively local people (Mike).

The other reason for choosing Leicester University PGCE is that its links with local schools give trainees good experience and teaching facilities. Most of the time schools and university work closely together.
We have very strong links with local schools and also we have a wide range of schools with different ethnic groups represented (Mike).

**Influences: trainees' backgrounds**

The trainees have a degree in mathematics or an appropriate related subject, which gives them at least an adequate knowledge of mathematics to teach with confidence throughout the age range. The trainees' work and teaching experiences were also different from each other. The tutor, Mike, recommended to anyone who wanted to be a teacher, that they take one year out and gain some experience and then return to take a PGCE.

I would recommend people not to come straight from the undergraduate course onto the PGCE, but only two of them had some other kind of experience. If you take Catherine, she was very much committed to teaching when she left the undergraduate department but chose to do some other things first. I would recommend that to people (Mike).

The tutor also emphasised that trainees' prior experiences, both negative and positive, affect their teaching and learning. It also affects what kind of teacher they are going to be.

I think people's work experiences will affect the way people actually perform, also the kind of models they get of teaching from their own first hand experience is bound to be very important (Mike).

Mike emphasised that trainees' backgrounds were different and there were some individual differences among trainees.

It would be hard to describe a typical trainee because of the age range and work experiences. Some of them came straight from school to the University Department onto the PGCE course. But, somebody like Scott has worked his way up to get qualifications and is now good enough to be teaching mathematics (Mike).

**Influences: trainees' age**

In the PGCE course, there were mature and younger trainees. This study found that mature and younger trainees differed in their views of learning and teaching of mathematics leading to differences in practice which were compounded by mathematical background variables.

According to Mike, age and prior mathematics teaching experience were powerful influences in teaching.

Age is quite an important factor here because I think people's own education is a powerful influence on how they teach. When that education took place depends on the age of the person. You take somebody like Linda and the kind of schooling she had. That would be different from the schooling that Catherine had because of age (Mike).

Somebody like Claire has very vivid experiences, and not positive ones, from her own education. This actually determines the kind of teacher she is going to be. The way she is going to treat her pupils is not going to be the way that it was for her, so you can get that kind of reaction (Mike).
As a whole, trainees' age was an influence on learning to teach. Mature trainees' prior background only consisted of traditional teaching. In addition to this, they had just been introduced to some topics in the PGCE course such as data handling. They needed to support their subject knowledge (Stratuss et al., 1998; Wilson et al., 1987) and related teaching methods.

**Influences: secondary mathematics experiences and undergraduate education as a pupil, and relationships with teachers**

Trainees emphasised that their secondary and undergraduate teachers influenced them. They reported that their teachers and lecturers mostly used traditional teaching methods. On the other hand, Mike emphasised that some exceptional undergraduate lecturers used different teaching methods. All trainees stated that materials and resources for mathematics in their secondary school were mainly restricted to books. Trainees adopted an increasing range of resources for their own teaching during the PGCE year. As time went by, in spite of trainees prior mathematics experiences (secondary and undergraduate) affecting their beliefs, trainees' later experiences caused trainees to change their beliefs. All trainees had a very positive attitude towards teaching algebra despite some bad personal experiences of maths teachers, when trainees themselves were pupils. Claire and Scott retained and developed strategies during the course. Unlike Catherine and Linda, Claire and Scott had felt uncomfortable and lacking in confidence during the early part of their undergraduate education, but towards the end they became more confident with mathematics. Trainees' beliefs, prior knowledge and experience of mathematics as learners all affected their teaching as a student. They made some cross reference to their own prior experience as a learner and continued to work on similar lines.

Trainees had mostly passive experiences as a pupil while they were in secondary school and also university. In response, trainees did not completely reject traditional teaching but combined it with active learning elements and also used whole class interactive teaching. They were more flexible in their own teaching methods.

Once at university, however, the style of teaching was much more formal, like trainees' early experience of mathematics at school. During undergraduate education, some of the trainees, Claire and Scott, faced some personal problems, which involved their personal mathematics tutors at University. Their tutors were sometimes unresponsive. Some of the trainees' lecturers were insensitive and didn't understand the trainees' needs. Throughout their interviews, in which trainees described their own mathematics experiences, they
continually made reference to their teachers. Trainees’ views of teaching were very much
influenced by their personal experience of teachers. Trainees’ admired some of their
teachers and took them as role models.

Influences: PGCE course and teaching practice
The influences of PGCE course sessions -typically lectures and theoretic perspectives- were
discussed in the literature sections (Vallance, 1997; Wragg et al. 1993; Wubbel &
Korthagen, 1990; Wubbel, Korthagen&Dolk, 1990; McIntyre 1990). Mike identified some
other aspects of trainees’ learning to teach.

Learning might be collaborative and based on sharing experiences and on reflective
writings. Learning collaboratively is important and they also learn the system which
is based on individual initiative: reading and finding out, resource-based learning if
you like. I think some of them learn an awful lot, you know, through their own
efforts with the resources we provide, follow-up reading and projects and so on.
Although some of them do less than others on that front, the opportunities are there
for them to learn and a lot of individuals’ efforts are through reading. I encourage
them through assignments as well as written work for assessment (Mike).

According to Mike, school files were helpful and gave trainees some good habits for
learning to teach.

I think they are very important from early on, because of the need to actually
prepare very thoroughly and collect a range of ideas and resources and sort out the
way you are going to develop the topics and your lessons. Thinking very closely
about different stages in the lesson, kinds of questions to ask, all these things need
to be put down on paper. Breaking down the topic and planning for it and all the
record keeping and all the resources such as worksheets-we bring all these things
together and this is a good base for our teaching. I think the building up of good
materials and ideas and ways of working depends on these good habits (Mike).

Mike asserts that selection of co-tutors is very important to promote the use of active
learning methods. He believes that trainees learn to use these methods successfully if they
use them both in university and schools.

I choose to work with particular teachers because I know they use a range of
teaching methods and so do particular individuals in the departments (Mike).

Mike realises that secondary mathematics teachers do not prepare plans in the same way as
the trainees and this causes problems.

There is a problem where the school teacher is not the best role model and a school
tutor will support a way of preparing they don't actually adopt themselves. So I give
students examples of good planning and preparation. I would take examples from
school files of students and not from experienced teachers (Mike).

Tutor and co-tutor act as role models for trainees. Mike uses active learning methods in his
teaching as an example to his trainees. He believes that this method motivates and
encourages them to learn.
I obviously am very keen to develop these methods, but also as part of other systematic programmes and the curriculum. The quality of learning depends on things like motivation and active learning methods have a good potential for motivation so I encourage those methods. I do quite a lot on the course (Mike).

Co-tutors and their teaching methods influenced trainees learning to teach. According to Mike, trainees’ learning depends on trainees’ circumstances and chance in teaching practice (Benett&Carre, 1995).

It depends on lots of things-circumstances, chance and variation are major features of the situation, so someone like Catherine’s original co-tutor couldn’t exercise her role that year because of illness and, at very short notice, was replaced by quite a young teacher in the department who was absolutely superb as a school tutor. So, there is Catherine in a maths department which is quite outstandingly good for her. She has very rich opportunities to learn in that situation. But it’s chance. For Scott, it is very different. He finds himself with a co-tutor he does not get on with it. I actually think these are all chances and different circumstances which affect what they get on the course (Mike).

Trainees’ personal experiences also affected their learning. Trainees take teachers and course tutors as role models. They influence trainees’ learning to teach mathematics.

As I said, their own personal histories influence them so it is very difficult to know how we measure up to the strength of that. Trainees may learn to teach in certain kinds of ways and if those ways fit trainees’ own thinking it works well (Mike).

The influence of the role models and sharing some experiences with other trainees and tutor and co-tutor affected trainees’ learning to teach (Leikin&Zaslavsky, 1997). This is consistent with Vygotsky’s ZPD (Vygotsky, 1986).

They learn from each other a lot. I think learning to teach by sharing experiences from lots of different schools is useful. I would set the agenda and I would ask the questions but all through the year I would encourage the sharing of their experiences with others. To reflect on practice in different settings with different experiences and from different strengths (Mike).

The university tutor aimed to introduce new teaching ideas for trainees to use. That is, trainees should have realised that, in the case of algebra and data handling, key points and hints and different teaching methods were given by the tutor for the teaching of these subjects. Materials and resources and reading lists were introduced by the tutor. Trainees also met new role models in the teacher training course. Trainees made distinctions between the role model of the university tutor and the co-tutor. The tutor gave them an idealistic view; the co-tutor gave them a more realistic view about teaching and learning.

The major influences on their teaching may be summarised as follows. According to trainees responses, some sessions like PGCE secondary maths sessions, discussion with a university tutor and co-tutor, helped their learning to teach. From the interview data and written documents, the researcher identified a number of general categories which were subscribed
to by all of the trainees in the present study, in either a positive or a negative way. All of those categories discriminated between trainees. These categories include whether trainees were influenced by their own mathematics learning (Leder & Gunstone, 1990), subject knowledge (Leinhardt & Smith, 1985), their age, gender, class control and management, use of active learning elements and materials in their teaching (Pigge and Marso, 1997).

ACTIVE LEARNING

The present study illustrated that as trainees gain confidence, they start to use a variety of teaching methods and materials in their teaching. These include boardwork, books, cooperative work including calculators and ICT, practical work, individual work, games, worksheets, investigations, teaching and learning aids and well-established lesson planning routines (Borko et al. 1988; 1989; 1990; 1992). In addition to these, other written documents helped them in their learning to teach mathematics. Teaching and work experience gave them confidence about teaching and how to deal with some management and control problems during the lessons. The flexibility in teaching methods reflected trainees’ experience as well as their teaching competence. Knowing which kind of method or manner of teaching would suit which particular class situation, adopting various methods to meet each individual’s needs and right level of understanding, keeping pupils interested in topics, using different materials to make pupils mentally, emotionally and behaviourally active in their learning are all important.

The case studies illustrate the importance of both pedagogical knowledge and pedagogical content knowledge of mathematics. The present study illustrates trainees attempts to develop pupils’ understanding and motivation and how they concentrated on contexts and pupils’ misunderstandings. Trainees used a variety of strategies to check how well the pupils have understood the content of the lesson. These include checking the work of pupils while they are doing individual exercises, asking questions during the whole class sessions, or setting tests and getting the pupils to mark them and then asking for the results.

The present research illustrated that all trainees showed a combination of traditional and active learning elements in their teaching as a learner and as a teacher. This included whole class interactive teaching, a few group activities and pupils’ involvement and so on. They all wanted to use real life examples and they wanted to teach understandably to pupils. All trainees wanted to use different resources and techniques to make mathematics more interesting for pupils.
Trainees gained confidence in using effective seating arrangements, grouping activities and a variety of teaching methods in their teaching. Mike also explained how he preferred to use a mixture of teaching methods and materials in his teaching. He gave the trainees an opportunity to taste all kinds of approaches and methods for confident mathematics teaching.

I would use a mixture of ways of teaching so I would use some exposition, demonstration, use of audio visual aids and OHP. But I would also involve the students in group discussions, sometimes small groups, emphasise the arrangement of the furniture, its deliberate use to break them into groups. They are three groups of four and they are actually quite strong little sub-groups. They get on pretty well with each other so I encourage them to do lots of discussion and also practical work, using a variety of methods of teaching (Mike).

Trainees reported that the best way to teach and learn mathematics was to put it into a context for pupils and make it understandable. A similar point was made by the tutor. In addition to this, Mike also emphasised as did all the trainees, that graphical calculators, some software and spreadsheets on the computers were appropriate to use in algebra teaching.

Calculators, particularly graphical calculators, are a major advance and also link with using software such as spreadsheets. It was for algebra purposes, for stuff to do sequences, iterations etc. I think graphical calculators and spreadsheets are important and should be brought into algebra.

On the other hand, data handling was described as easily applied to daily life. This was a common point of view for all trainees and their tutor.

I think data handling is the strongest area of mathematics for applications which affect everybody, such as the national lottery and so on. Again I want to emphasise the usefulness of mathematical ideas and develop the skills in relevant contexts. I think that it can be developed in an experimental way (Mike).

Trainees found data handling was more suitable than algebra for ICT teaching. In the case studies, trainees used ICT in both subjects' teaching. They found ICT more helpful than other methods. All trainees had limited experience with computers but they started to use computers in algebra teaching. All trainees used OHP in their teaching as a teaching aid as well as helping with classroom management issues. During training, trainees met a variety of different teaching methods.

They also had an opportunity to use all kinds of grouping activities and teaching-learning methods and techniques which catered for pupils' needs in their teaching (Brandes & Ginnis, 1986). The researcher does not suggest that this should lead to attempts to change trainees' behaviour, but rather to a change of teaching methods to those which, by encouraging a more active involvement (Lave, 1988; Lave, 1990; Lave et al, 1988;
Lave & Wenger, 1991), will lead to the reduction of noise and disturbance. A second category was concerned with whether or not trainees gave up when pupils found mathematics difficult to understand. Not surprisingly, trainees found a solution to this was the use of active learning and the use of everyday activities in their teaching (Johnson, Johnson & Smith, 1991, Smith, 1996, MacKinnon & Grauna, 1994, MacKinnon, 1996).

The results arising from analysis of the trainees' questionnaire ratings of mathematical elements provided two specific findings. The first was that, in general, the trainees preferred algebra rather than data handling. This might be because of some lack of experience in trainees' backgrounds. In data handling they used mainly group work and also surveys. However, they believed data handling topics were more useful than algebra. As used here, the term 'maths topics' refers to any algebra and data handling topics in the NC. They all agreed that algebra is a difficult subject which is disliked by many pupils. From the trainees' perspective, mathematics is viewed as a puzzle and a challenge.

Influences: beliefs

The results of the case studies provide another way of considering beliefs about teaching mathematics (Good et al. 1990; Ernest, 1989a,b, 1994; Weinstein, 1990; Thompson, 1992; McDiarmid, 1990, 1993; Richardson, 1996). For many trainees, old habits need to be unlearned. This is a maxim: 'old beliefs die hard'. Trainees, like many other novice teachers (Livingstone & Borko, 1990), drew upon their own experiences as a student in the mathematics classroom, PGCE course mathematics session experiences and their experiences as a student teacher to develop their personal beliefs about the characteristics of good mathematics teaching (Britzman, 1986). These beliefs seemed to have their origins in trainees' own experience of secondary school mathematics (Loflin Smith, 1993). The findings of the case studies data indicated that the differences between pre-teaching practice and post-teaching practice described by the trainees, were mainly based on their attitudes and beliefs about teaching, including classroom management and control, pupils' individual needs and their effective learning. The findings also indicated that most trainees changed their former views, beliefs and attitudes about teaching mathematics mainly because of the conflict between their idealism and the reality they met in practice. It might be useful for a further study to find out the extent to which trainees' views, beliefs and attitudes changed during their first and second years of teaching (Villeme and Hall, 1980).

Different perceptions of mathematics teacher trainees have been highlighted through particular examples of their beliefs and how these beliefs affect their teaching. In spite of
trainees' prior mathematics experiences affecting their beliefs, especially prior experiences as a pupil the teacher training tutor tried to change trainees' beliefs.

It is widely recognised that there are significant barriers to learning to teach mathematics (Loughran, 1996). Attempts to alter a teacher's approach to teaching will be largely unsuccessful unless the underlying beliefs are tackled. Claire's and Scott's case studies illustrate that if they like the teacher and the subject then this promotes understanding and learning. Catherine's and Linda's cases illustrates different perspectives. For Scott and Claire relationships with their teachers were very important and influential.

Trainees' descriptions of learning to teach mathematics (Moon et al., 1993; Moreno-Armella & Waldegg, 1993; Munby & Russel, 1994) through observation, imitation and practice as well as through feedback and discussion correspond well with the processes of learning in active learning (Chapter 2.2). Trainees made mistakes and found out for themselves in an inevitable process of trial and improvement as can be seen in the case studies.

Mike believed the best way to use a progressive approach in trainees' learning to teach mathematics was to learn while in the job. Trainees were responsible for their learning. University sessions gave them the theory and teaching practice allowed them to put it into practice. The best system was coordination between school and university.

Actually the training process is alongside the classroom practice, practitioners being trained on a day to day basis. It is very important that this should be a substantial part of the course. So, I agree with learning to teach on the job in ways in which you are supported and which are progressive. You gradually have responsibility and then learn more. I think we have changed the course a lot from ten years ago. At that time you got theory at the university with no relation to practice in the school and then jumped in at the deep end. Now, they learn gradually with school contact all the way through the year (Mike).

There are a number of limitations in sets of beliefs which are grounded in trainees' prior experiences of education. Firstly, we do not always remember as well as we think we do—especially when recalling childhood memories. From these case study extracts, it can be seen that all trainees' main experience of secondary mathematics teaching was largely one in which topics were taught, examples were practised and pupils were tested. Thus most of the trainees' memories of secondary school and university were associated with traditional mathematics teaching such as 'chalk-talk'. All trainees were in shock when they met university education. Secondly, each one of us has only limited access to the mind of a pupil and no access to the minds of the teachers who taught us, therefore, it is difficult to generalise. Thirdly, the new teacher was probably a successful pupil and is therefore unrepresentative of the schools' pupil population. Fourthly, the teaching methods one
experienced may be limited in their wider application. Finally, how one believes one learned maths will be influenced by the view one has of the nature of maths itself. 'Learning from our own experience' is a seductive phrase.

Summary of 'Stage Theory' and trainees’ progress
During the PGCE course, the evidence, both quantitative and qualitative, illustrates trainees going through the four stages of the Stage Theory which was discussed in Chapter 2.2.

In the 'beginning teaching stage', all trainees illustrate characteristics of this stage as mentioned in the literature review in Chapter 2.2. For example, they struggled to solve the complexities of the classroom; they were experimenting with class control issues and were developing a new persona. Trainees calls this time 'highly stressful'. Class control, teaching and planning were main concerns for them (Marso&Pigge, 1989). Scott and Claire did not want to prepare detailed lesson plans. This stage revealed individual differences. If the trainees had teaching experience, like Catherine and Linda, they adapted more comfortably. Catherine and Linda had already passed this first stage, because of their teaching experience. The majority of the lessons observed by the researcher reflected the active learning values of their interview and documentary evidence. Eventually, the common characteristics of most of the trainees’ lesson evaluations and assignments were a combination of managerial elements and some teaching elements, such as teaching methods, materials and active learning elements (McLaughlin, 1994; Goodchild, 1992; Rosental, 1995).

All trainees illustrate characteristics of the ‘supervised teaching stage’ which is explained in Chapter 2.2. For example, they started to develop some varied teaching methods and to reflect the influence of the PGCE course. They learnt how to be flexible in their choice of teaching methods. They had some difficulty in choosing appropriate materials and methods according to the topics, but found some interesting computer-based materials. Trainees developed an awareness of using active learning materials in their own teaching, such as calculators, practical apparatus and computers. Catherine and Linda were different from Claire and Scott. They developed teaching competence and better classroom control. Catherine was well advanced into this stage. Claire and Scott reported that they had some tensions and anxieties in their teaching during the first semester and this was reflected in their written documents and interview.

In relation to the ‘from teaching to learning stage’, trainees also illustrate this stage’s characteristics which were explained in Chapter 2.2. On the other hand, there were
significant individual differences in their progress. For example, trainees focused mostly on pupils’ learning and individual differences, but they also focused on teaching methods. Claire and Scott had a rapid growth in self confidence in teaching mathematics and in using a variety of teaching methods, strategies and organisation. In the second term, Claire and Scott became more confident and relaxed about teaching mathematics. Scott and Claire had little problem with class control and organising time but they were keen to use different methods, materials and organisation and made some significant breakthroughs in their learning to teach. For Linda and Catherine class management and control were not a major problem. At the end of teaching practice, Claire and Scott seemed more confident with class control and using IT. In summary, all case study trainees found PGCE sessions helpful for their learning to teach mathematics. They recognised learning to teach maths as different from previous learning. They were open to the use of active learning elements which they met in the PGCE course. Apart from Linda, they focused on pupils’ learning needs and individual pupil differences. They used more open questions and wh- questions. At this point, it is difficult to locate Linda in this stage, but apart from the pupils’ needs and question types, she does try to use active learning elements such as pair work with computers in algebra and with graphical calculators. She mostly emphasises effective teaching and not the pupils’ learning. She mostly uses whole class teaching including interactive teaching which is influenced by the PGCE course. She also illustrates the fourth stage’s characteristics. Linda’s case is conflicting in relation to progression through the four stages in their normal sequence. This one case raises questions about the general validity of the stages model in its entirety (Vleaminke, 1995, 1996; Furlong et al, 1994; Furlong & Maynard, 1995).

As regards the fourth stage of the stage theory trainees should be focused on pupils’ learning rather than their own teaching-developing more effective teaching strategies. Evidence has shown that Claire and Scott were at the beginning of this stage by the end of their second teaching practice. At the end of the last term, trainees had reached the reflective teaching stage but some of them earlier (Linda and Catherine) and some of them later (Scott and Claire). Linda and Catherine were concentrated on effective teaching to pupils. They were using active learning elements. At this stage, class management and control were not a problem. Trainees were more reflective and more critical of their teaching (Adler, 1991). Their evaluations of teaching in algebra and data handling illustrate the extent to which they have become critical evaluators. At this stage, it was expected that they will have developed into reflective practitioners and critical self-evaluators. At the end of the course all were
reflective practitioners. The present study showed that reflection plays a vital role in teacher education.

In the passage through the stages, subject knowledge and teaching experience were found to be very influential. Some of the trainees (Claire and Scott) felt insecure and lacking in confidence in their teaching during the first and second term teaching practice. The reason for this was trainees’ subject knowledge. It has been suggested that pedagogical subject knowledge should be more emphasised in university courses. Claire’s and Scott’s experience provided reasons for questioning that priority as opposed to subject knowledge. The increasing number of academic courses required for certification would not guarantee that trainees acquired the subject knowledge they needed for teaching. Ball & McDiarmid (1990b) suggested that trainees in mathematics courses could fulfill the requirements without developing a conceptual understanding of pedagogical subject knowledge. ITT needs to consider the content, process and context of cognition in order to understand the school based learning of trainees (Stoddart & Floden, 1989; Stoddart et al., 1992; Stones, 1994; Booth, 1993; Avalos, 1998). The university courses should be more focused on the conceptual development of National Curriculum topics, such as algebra and data handling in all Key Stages.

Summary
The present study found that in the PGCE course, trainees gave attention to the pupils’ motivation, individual pupils’ needs, pupils’ understanding and teaching methods in relation to pupils’ learning. Claire and Scott had some problems with planning and classroom control but they overcame them. The PGCE sessions helped with this. All these trainees mentioned that they were keen to use active learning elements in their teaching in spite of their prior mathematics teachers’ limited teaching and their attitudes to them while they were in secondary school. They all reported that using active learning elements which they met in the PGCE course helped them learn to teach mathematics.

During the training, each trainee developed his/her own teaching style and strategies to teach each different subject and topic in the subject. The PGCE course was a very good example of how to use different methods and materials according to the topics, pupils and classes.

They developed their responsibility as a teacher during their training coping with time control, voice control, management of the class, planning and so on. They all emphasised how important pedagogical subject knowledge was and the choice of teaching materials.
During their training Claire and Scott developed pedagogical knowledge alongside mathematical subject knowledge. Teachers trainees’ prior beliefs initially had a big effect on their teaching but beliefs became modified through school practice and the influence of the PGCE course.

These case studies show how the training course help trainees to gain confidence to teach, and to develop pedagogical subject knowledge. The course also help them reflect their learning into their teaching as well as their writings (Ormrod and Cole, 1996). At the end of the course trainees have reached the reflective teaching stage of the stage theory. From the start of their teaching practice, trainees were aware of classroom management and control (Pigge and Marso, 1997) and of the importance of using time effectively.

According to the case studies, if trainees learn how to use active learning methods in their teaching then they start to address class management and control issues (Pigge and Marso, 1997). Claire and Scott use active learning as a means of classroom control.

On the other hand, Catherine and Linda used active learning as a challenge. Trainees showed that in the beginning of the first teaching practice they feared using different methods in their teaching; they largely used chalk-talk and worksheets. Trainees emphasised that some of the pupils need some traditional teaching such as ‘chalk-talk’. This reflected their own mathematics backgrounds. Representations of teaching and learning to teach held by maths teacher trainees may reflect their mathematical background and knowledge rather than their position as a teacher trainee in general. This present study showed that the method course and tutor were a very positive influence on trainees learning to teach mathematics. In this course trainees developed their own subject knowledge and pedagogical subject knowledge.

All trainees in the case study illustrated that they did learn how to manage the class and how to choose the teaching methods and materials according to the topic and aim of the lesson. These trainees claim that mathematics needs to be understandable, meaningful and useful for everyday life for the learners. They emphasised that prior mathematics experiences of traditional rote learning were not appropriate for mathematics teaching. In this context, active learning teaching in the methods course would seem relevant with its emphasis on understandable mathematics.
In the final chapter, the findings from these case studies will be discussed alongside the other evidence, conclusions will be drawn, and implications for Turkish teacher education will be discussed.
CHAPTER 7

DISCUSSION, CONCLUSION AND RECOMMENDATION

Introduction

The purpose of this study is, as explained in Chapter 1, to examine the secondary mathematics teacher training programme and to investigate learning to teach using the 'active learning approach' in England, and, as appropriate, to use the findings to make recommendations for improvements in the Turkish secondary teacher training system. The following chapter interprets the main findings reported in Chapters 4, 5 and 6, using ideas from the theories of learning to teach, stage theory and the place of active learning. In Chapter 6, four case studies are also used for in-depth study to answer the research questions. This chapter comprises a review of the study and brings together the findings of the survey and case studies. The findings are compared for the two countries, England and Turkey. The objectives of the study are addressed within themes which consider the role of initial teacher training in the context of the active learning concepts. From the findings of the study and the literature on learning to teach, a theoretical framework is developed for the role of initial teacher training. The study addressed two fundamental aspects:

- The role of using active learning in initial teacher training;
- The need for an appropriate conceptual framework within which the initial teacher training institutions operate.

Review of the Research Methodology

In this study, the survey and multiple case studies were conducted as a combination of methodological triangulation described in Chapter 3 (Cohen & Manion, 1994). The pilot studies were beneficial for predicting how the research instruments would work. In the main study, the response rate was 100%, and the questionnaires returned showed no evidence of ambiguity in the questions in both countries. All these issues were discussed in methodology chapter, in Chapter 3.

In the present comparative study, in Turkey, trainees were asked to respond to the translated version of the instruments. Some items in the questionnaire were identified and translated in more than two words. Notwithstanding translation, the instrument was employed to validate the authenticity of the original and both versions of the instruments may have slightly different meanings. Some items do not give the same meaning, for example, for whole class teaching, group work and active learning.

It should be noted that instruments may not measure the same thing in different cultures. The use of instruments in cross-cultural comparisons and research has the
recognised limitation that items may have different meanings in different cultures. That is why some differences in language, interpretation, religion, social life, culture and tradition were expected in both cultures. It should be noted that the questionnaire used in the Turkish study was adapted to investigate the above mentioned differences. The major difficulty with the case studies was bringing all the data sources together and reaching a conclusion. The main research burden was that interviews, transcribing, coding and re-coding and drafting and re-drafting were all time-consuming, but all this evidence gave richer data to the study. In the event, the cases studied covered a range of different perspectives on trainees' learning to teach mathematics and provided a great deal of useful data. There were a number of issues which were repeated in the case studies, thereby adding to the confidence in the findings in relation to those issues. It was disappointing that active learning did not play a greater part in the literature on learning to teach. The case study findings show a weakness of the questionnaires, which did not illustrate the influences on trainees' learning to teach mathematics. One of the other findings of the case studies was that the training course and prior experience influences the trainee's teaching methods and their learning to teach. It would have been useful to have these influences on trainees included in the questionnaire. Unlike the questionnaire, the case studies were found to add some rich data on key issues for teacher training programmes such as trainees' classroom management and control, and using time effectively. The case studies also showed how the trainees used their subject knowledge to boost their confidence in teaching and how trainees used active learning methods in their teaching to get pupils' attention and promote a variety of teaching methods and materials.

Each research method has limitations and strengths. That is why the researcher used more than one method and supplied alternative methods to eliminate the limitations of particular research methods which were discussed in Chapter 3. Time limitation, gaining access and sampling were major factors in conducting the research in both countries. The school tutor was not used as a data source because access to the school tutors could not be obtained by the researcher. In further research on this subject, school tutors' views should be considered. As mentioned in Chapter 3, if the researcher had an opportunity to conduct this research in Turkey again, the methodology of the present study that has been undertaken in England would be adopted and team research might be considered. Ethical considerations would also be taken into account.

Overall, the research strategy and methodology provided a satisfactory means of acquiring data necessary to address the aim of the study.
Comparing Two Programmes and Sampling

For the study, Leicester in England and Balikesir in Turkey were selected. These institutions may not be representative of all trainees in both countries. The sample number from each institution was 12 in Leicester and 57 in Balikesir. It is clear that numbers of trainees in the present study might affect the results. To be able to obtain valid and reliable results while investigating cultural or national differences, one of the most important aspects of cross-cultural methodology is to ensure that both subjects are valid representatives of their culture. This might be an issue to consider before making any decisions on training programmes. The aim in contrasting two secondary mathematics teacher training programmes was to find similarities and differences between two different cohorts and between the ways in which trainees learn to teach in different institutions in different countries which are summarised in Table 7.1.

Trainees’ age and experience were different in both institutions. Nearly all Turkish trainees were recent graduates with no teaching experience. By contrast, in the English sample, 1/3 of them were mature and the rest were recent graduates, and a number had work or prior teaching experience. Therefore, it was not possible to match and compare both samples of trainees. The present study found that age did not have much effect on the desire to learn to teach. But trainees’ subject interests were different.

In the two institutions, the procedure for selecting trainees for the teaching programmes was different (See Appendix 12 and Appendix 13 for details of the Turkish educational system and the main characteristics of two programmes). A sharp contrast was found between the Balikesir Teacher Training Programme and the Leicester Teacher Training Programme. In Turkey, higher education after secondary school is provided by the government. In Turkey, many universities offer graduate programmes in various fields, including teacher education. All BEd. training courses run for four years (YOK, 1991; 1997). Teacher trainees on courses have to be inducted into the theory of classroom teaching, class management, teaching methods and techniques. A teacher is required to be aware of all this and be able to recognize the issues for learning and teaching.

At Balikesir, in the last year of their course, teacher trainees spend two days each week in school and 56 days in schools in the last year of their course, Leicester teacher trainees spend around 121 days in school during their training course. A trainee has to spend 2/3 of their time in schools, according to Circular 4/98. The Leicester course includes a collaborative project in schools but the Balikesir training course does not. The Leicester teacher trainees gain experience of both primary and secondary schools; the Balikesir teacher trainees gain experience of upper-primary schools or secondary schools. In Turkey, teaching practice takes place in schools near the training establishment. The Balikesir
teacher education programme provides a sharp contrast with the Leicester teacher education programme. The Leicester PGCE has a long tradition of partnership with local schools, based on notions of equality and the principle that ITT should be beneficial to the professional development of all trainees, tutors, co-tutors and pupils.

Table 7.1: Main Characteristics of two programmes

<table>
<thead>
<tr>
<th>The Characteristics of Turkish BEd’s Programme</th>
<th>The Characteristics of English PGCE Programme</th>
</tr>
</thead>
<tbody>
<tr>
<td>had traditional background</td>
<td>had traditional background</td>
</tr>
<tr>
<td>no working and teaching experiences</td>
<td>working and teaching experiences</td>
</tr>
<tr>
<td>no mature trainees</td>
<td>mature trainees</td>
</tr>
<tr>
<td>mostly male</td>
<td>1/3 male, 2/3 female</td>
</tr>
<tr>
<td>want to be a teacher</td>
<td>really want to be a teacher, but sees as a second job opportunity</td>
</tr>
<tr>
<td>adequate subject knowledge</td>
<td>adequate subject knowledge</td>
</tr>
<tr>
<td>limited pedagogical subject knowledge</td>
<td>adequate pedagogical subject knowledge</td>
</tr>
<tr>
<td>no transfer subject knowledge to pedagogical subject knowledge</td>
<td>transfer subject knowledge to pedagogical subject knowledge</td>
</tr>
<tr>
<td>not learn how to use teaching methods according to lesson’s aims, pupils’ readiness and individual needs, meet ICT, and other teaching materials</td>
<td>learn how to use teaching methods according to lesson’s aims, pupils’ readiness and individual needs, meet ICT, and other teaching materials</td>
</tr>
<tr>
<td>limited teaching practice</td>
<td>adequate teaching practice</td>
</tr>
<tr>
<td>limited writings, planning, no assignments</td>
<td>reflection in trainees’ writings, planning</td>
</tr>
<tr>
<td>enough mathematics teachers</td>
<td>shortages in mathematics teachers</td>
</tr>
<tr>
<td>use traditional teaching methods</td>
<td>use traditional teaching methods and active learning methods with everyday activities</td>
</tr>
<tr>
<td>whole class teaching</td>
<td>whole class teaching (mostly whole-class-interactive)</td>
</tr>
<tr>
<td>no group and pair work</td>
<td>group and pair work</td>
</tr>
<tr>
<td>no individual work</td>
<td>individual work</td>
</tr>
<tr>
<td>no investigation</td>
<td>investigation</td>
</tr>
<tr>
<td>homework</td>
<td>limited homework</td>
</tr>
<tr>
<td>no everyday activities</td>
<td>everyday activities</td>
</tr>
<tr>
<td>no OHP, computers, posters</td>
<td>OHP, computers, posters</td>
</tr>
<tr>
<td>(memorising and drill)</td>
<td></td>
</tr>
<tr>
<td>seating in row</td>
<td>seating in groups</td>
</tr>
<tr>
<td>teacher-centered</td>
<td>pupil-centered</td>
</tr>
<tr>
<td>mostly theory based and limited practice</td>
<td>good balance of theory and practice</td>
</tr>
<tr>
<td>want to be approachable, friendly, caring teacher</td>
<td>want to be approachable, friendly, caring teacher</td>
</tr>
</tbody>
</table>

210
Another issue is the shortage of mathematics teachers in England (Gilbert & Van Haeften, 1988). Recent research results indicate that the number of students choosing mathematics as a profession has decreased in recent years. This is why many candidates see mathematics teaching as a second job opportunity. On the other hand, in Turkey, there is a good supply of mathematics teachers.

Trainees' Prior Experience

According to both the qualitative and quantitative data, most trainee teachers were used to traditional methods of teaching mathematics in both countries. The content of the different categories of evidence here came from the comparisons made by mathematics teacher trainees between traditional teaching and active learning teaching.

To understand how and what knowledge develops within teacher training, it is first necessary to understand the conceptions brought to the training. According to Zeichner et al. (1987) trainees’ attitudes and beliefs towards teaching are not transformed through training, and a range of factors such as social and personal beliefs, pre-conceptions, prior beliefs and attitudes influence trainees’ learning to teach mathematics (Kagan, 1992; Wideen, 1998).

In the Turkish educational system, both teachers and trainees used the same methods and techniques for teaching algebra and data handling. In teacher training, newly qualified teachers might be encouraged to use different teaching methods apart from traditional exposition. A few Turkish teachers used a few new techniques but this was exceptional. Not only the teachers and tutors but also the government, the Ministry of Education and teacher training programmes were responsible for limiting the range of methods.

A Theoretical Model for Initial Teacher Training for Turkey

In seeking to develop a theoretical model or conceptual framework for learning to teach mathematics and the place of active learning for initial teacher training for Turkey, there are a number of approaches in the literature which offer useful starting points (Table 7.2). The literature review and findings of the present research suggest that any model for teacher training must recognise the difficulties of implementing lasting changes in an educational system. This suggested model explores the requirement of school-based teacher education in relation to trainees’ beliefs, knowledge, experiences and practices using the active learning methods in learning to teach in an English setting. The components from Table 7.2 are here considered in turn.

- **Selection of trainees:** This is a very important component in this model. The Turkish training programme accepted trainees after competitive selection. Trainees need to take an interview and then suitable candidates are accepted.
Selection of Trainees

Influences
- cultural
- economical
- political
  (ITT policy, inspection, NC)

Teacher trainees' belief

Role Models (prior and present)

PGCE University Course

Trainee's pedagogical content knowledge

Teaching practice
- Mode A
- Mode B

Knowledge of teaching, e.g. active learning, whole class teaching, ... resources and materials

How to teach mathematics using active learning approach

Knowledge of planning (short, medium, long term), written assignments, lesson evaluations

Regular feedback from tutor and co-tutor

Graduated as NQT

Table 7.2. Theoretical Model for the Initial Teacher Training: Learning to Teach

*Influences:* There are internal and external influences on teacher training programmes. There are two types of influences: on the system and individuals. Influences on the system are cultural, economic and related to the ITT policy, the national curriculum and inspection of the ITT course. Trainees' work and prior teaching experiences had some influence on trainees' learning to teach mathematics in this study which are discussed in Chapter 6. Trainees' own experiences as a pupil were also an important influence on trainees' learning to teach. Teaching practice in school had a strong influence on learning to teach.
• **Role Models:** Trainees' prior and present teachers including PGCE course tutors, co-tutors, other teachers and colleagues influence trainees’ learning to teach, which was discussed in Chapter 6.

• **Teacher trainees' beliefs:** Sets of beliefs (including subject knowledge) and pedagogical subject knowledge were very influential (Askew et al. 1997; Aubrey, 1993; Shulman, 1987). These have already been discussed in detail in Chapter 2.1. Trainees' beliefs were modified during the teaching practice. The present study illustrated that if a trainee's subject knowledge is limited then trainees need to develop these skills in the training course and to monitor and record their progress. Trainees’ subject knowledge was also closely related to the trainees’ mathematical qualifications. It was easy to see this relation in trainees' algebra and data handling knowledge. Pedagogical subject knowledge covers mathematics knowledge and knowledge of how pupils’ learn mathematics effectively, and knowledge of mathematics teaching approaches. This study illustrated that pedagogical subject knowledge was more significant than subject knowledge. Trainees’ mathematical knowledge must support pedagogical mathematical knowledge. But the case studies implied that mathematical content knowledge was important in teaching practice in Mode A attachment and helped with early levels of confidence, but that afterwards it did not seem to have much effect. Looking at the whole of the teaching practice, mathematical content knowledge was important in the first weeks of teaching practice but, later, beliefs and pedagogical content knowledge (including in particular, teaching methods and the active learning approach) were more important for the teacher trainee.

The present research illustrated that increased confidence and competence in subject knowledge and pedagogical subject knowledge is closely bound up with the ability to apply that knowledge. Nickerson (1988) asserted that knowing and applying are not linear, they are periodic.

The literature review in Chapters 2.1, 2.2 and 2.3 illustrates that common points in learning to teach are trainees’ subject knowledge and pedagogical subject knowledge. On the other hand, there is a disagreement about whether trainees’ pedagogical content knowledge changes or remains static. This raises questions such as how do trainees learn to teach; how does this develop during the training; how do their prior and present influences affect this? However, in Turkey, pedagogical subject knowledge is very limited (YOK, 1997).

Teacher education institutions may serve at least two important functions: to provide practice in the use of certain tools for teaching certain topics more effectively (using the active learning method) and to generate enthusiasm for pursuing further study in the pedagogical subject knowledge trainees are teaching. As stated before, old beliefs die hard.
This view is shared by a considerable number of mathematics teacher trainees but trainees’ beliefs were modified during their training. Trainees’ concerns appear to link with a number of specific beliefs.

- **PGCE University Course:** Trainees’ beliefs also had an effect on the course, because trainees brought them to the course. The school-based teacher education allowed trainees to experience the full range of teaching methods and techniques and roles and to gain access to all secondary school mathematics attainment targets. In the PGCE course, trainees experience could become the subject of mathematics study via episodes, as in the Leicester Secondary Mathematics PGCE. In this programme, trainees’ experience and learning were important. On the PGCE course, trainees focus on mathematics teaching. Trainees need to be able to transfer their subject knowledge to pedagogical content knowledge. The research on the link between trainees’ knowledge, experiences, practices, beliefs and so on suggests that a mix of teaching methods to engage trainees, as well as teachers’ knowledge and understanding, backed up by classroom observation to examine actual practices, is required. Trainees need to learn new approaches to develop their own repertoire, and also to make pupils more interested in the lessons. The use of a variety of methods is determined by the trainees’ beliefs. Tutorial and feedback influenced trainees’ progression in learning to teach. Tutor and co-tutor will need to work collaboratively to share their own ideas about trainees learning to teach. It needs effective mentoring during the training.

- **Teaching Practice:** This is a major factor influencing trainees’ learning to teach. Trainees also learn how to reflect their learning to teach in their classroom teaching. University courses need to have a good balance between theory and practice. Lesson evaluation was also influential in learning to teach. During teaching practice trainees met a very wide range of new experiences which they brought back to the university. Some of the trainees had idealistic views before and at the beginning their teaching practice, but after trainees started to teach in the classroom much of the initial idealism about teaching quickly faded! Trainees’ views changed between the end of the first teaching practice and the end of the final teaching practice. It seemed that trainees recognised and were reconciling the differences between idealism and real school life. This also requires following up in a further study of the trainees over the next two years. At the beginning of the teaching practice, trainees had survival concerns about management issues rather than priorities about teaching and learning activities and pupil’s learning and differences. The present research also found that the beginning of teaching practice is a difficult time for trainees. During the PGCE course, trainees developed a new persona ‘me as a teacher’. Gradually the trainees’ focus shifted from how to manage the classroom, to how to use
teaching methods consistent with the active learning approach. Trainees learned how to focus on pupils' learning, individual differences, pupils' right level of understanding and how to respond as a teacher. They emphasised pupils' learning rather than their own teaching. At this point, using active learning helps trainees. If trainees gain the confidence, then they are capable of promoting active learning and being a reflective practitioner. The research found generally that practical work with an active involvement and real life examples was an important component in trainees' developing practice. All trainees' beliefs and pedagogical content knowledge shaped trainees' teaching.

Active Learning

What is the role of active learning in teacher training programmes? The role of active learning, recognised by all participants in the case studies, reflected the definitions of active learning in the literature as given only in relation to pupils' learning. But the present study penetrated active learning as a teaching and learning approach in teacher education. At this point active learning acquires a different meaning which has been neglected in the literature. In the case studies, all participants agreed with aspects of active learning. Trainees need to learn a flexible range of teaching and learning methods; to encourage active involvement, ownership and control; and to use appropriate grouping activities and seating arrangements including whole class interactive teaching, which was discussed in the Chapter 2.3.

Active Learning, Stage Theory and Trainees' Reflection

In the literature, learning to teach studies adopted different perspectives. The two key questions were raised:

1. Does active learning (university and classroom-based experiences) promote reflection by trainees?
2. Where does active learning fit in stage theories?

The present research preferred to use 'active learning' alongside 'Stage Theory' from which Furlong et. al's Stage Theory is developed as explained in Chapter2.2. This research has confirmed that, in learning to teach, the trainees go through a number of stages of development as given Table2.3 and discussed in Chapter2.2 and Chapter6. It is noted that these stages are cumulative rather than discrete. This classification was applied to all four case studies drawing on written evidence, questionnaires, observations and interview. Categories in Table6.9 were developed on the basis of these case-study-trainees' and questionnaire responses. There are problems with staged models of teacher education which were discussed in Chapter6. Firstly, in the literature, there are alternative models in stages
from which to choose (Kagan, 1992). Secondly, it is sometimes difficult to put trainees into one category as there is no definite line between the stages; there may also be problems in the sequences of stages e.g. the case of Linda. Thirdly, the stages may reflect the researcher's own view and judgments rather than represent trainees' experience of learning to teach. Fourthly, it is also difficult to make any generalization about teacher trainees' progression in learning to teach from four case studies. Finally, all trainees' cases are unique. Although trainees take the same training course, their experiences and their development differ.

Active Learning in Training

Planning, preparation and sharing information all contribute to an effective evaluative partnership between trainee, tutor and co-tutor. It seems that written planning is essential for trainees' learning to teach (Kyriacou&Stephens, 1999). In addition to this, university tutors encourage the trainees to reflect on their experiences in schools in a structured way, a process described by Schon (1983). During the training course, trainees develop into reflective practitioners who observe, analyse and evaluate teaching and learning and develop critical thinking (Galton, 1990; Alexander, 1984; Pollard&Tann, 1987).

In the model developed from the case exemplars, mathematics teacher trainees passed in different ways through the stages using an active learning approach. Using an active learning approach in both training and in the classroom helped trainees to accelerate through the first two stages and to reach the reflective teaching stage. Notwithstanding trainees' prior knowledge, pedagogical content knowledge and stage theory are important to the professional development of trainees' learning. Finally, different approaches to learning to teach are likely to have significantly different effects, given adoption of active learning methods.

Conclusions and Major Recommendations for the Turkish Educational System:

Introduction and dissemination of active learning methods in teacher education would be an innovation in the case of Turkey. The social, economic and political conditions of the country and the cultural characteristics of the training institutions and schools should be taken into consideration. Integration of active learning methods into training programmes and into trainees' and teachers' own teaching of not only maths, but all other subjects might be an important aspect of reform in Turkish teacher education programmes and schools. Turkey needs well-trained educators, teachers and mentors who apply active learning methods to real teaching. In addition to this, new materials and ICT facilities are needed. Teachers and technical support are also needed so that these materials and equipment can be
effectively used. The Ministry of Education and YOK (The Higher Education Institution) need to work together to solve Turkish educational problems such as Government, universities and schools working collaboratively in the planning and putting into action of educational changes. The main element is the careful planning of education, which is planned for every five years, including teacher training programmes and the needs of schools and pupils. We need to ask what kind of future we want. What kind of people do we want as teachers? All new developments and changes need to be piloted before being applied to all other institutions.

The Leicester PGCE training course is a very good example for other teacher training programmes applying the requirements of the National Curriculum to initial teacher training programmes, especially for Turkey's initial teacher training. Under the new arrangements in Turkey, what professional knowledge develops in the training course? The National Numeracy Project has set up a series of changes in primary schools in England. This is also a very good example of using active learning in primary schools. Turkey also needs similar projects for the primary and secondary phase in all Turkish schools. Initial teacher training programmes and secondary schools also need to adopt similar projects for secondary mathematics teaching both in England and Turkey.

Further Challenges for Implementation

1. In-service training should be given to tutors, co-tutors, inspectors, head teachers and teachers. In these in-service training education programmes items such as pedagogical subject knowledge, psychology of education, measurement and evaluation, technology of education, guiding and counselling might be included. This programme might be applied throughout the whole country.

2. The teaching practice period might be extended to give trainees the opportunity to adapt their learning to practice and to encourage trainees and also teachers to develop and implement new teaching methods.

3. Trainees must also be given the opportunity in mathematics sessions to strengthen their pedagogical subject knowledge in Turkey. Both mathematics sessions and teaching experiences should complement and support each other, both in pedagogical knowledge and pedagogical content knowledge.

4. The teacher training curriculum should focus more deeply on the school curriculum topics in mathematics and on teaching methods in mathematics in the teacher training programme using active learning.
5. The teacher trainee must be prepared to teach in all kinds of schools and classes according to school culture, class size, room layout and topic of the lesson and the ability of pupils in the class.

6. Trainees need to share their own experiences with other trainees and tutors in tutorial time and sessions in Turkey.

7. Teacher education programmes, educators, tutors, teachers and, in addition to this, schools, need to reform: changing the conception of pedagogy, reflecting the influence of active learning including ICT. Tutors and teachers as role models need to be trained how to use active learning elements in teaching. Trainees need to meet active learning elements throughout the university course. Training programmes should take into account each individual trainees’ needs and beliefs, and design training programmes accordingly. Tutors also should consider individual trainees’ differences in learning to teach. Trainees need to be actively involved in the process of change.

8. Activities used with trainees such as those adopted at Leicester in England might be adapted for training programmes in Turkey.

9. If we train our teachers appropriately, to have knowledge, a good repertoire of teaching methods and materials, to be friendly, approachable and caring, trainees will be a better model for our future children. K. Ataturk, who was the first Turkish President, said, ‘The future is in your (teachers) hands!’.

**Future Research**

This present study provides only a small-scale comparison between English and Turkish trainees and indicates the need for more research with other samples and groups. Further research is needed about learning to teach mathematics and the place of active learning in Turkish education and its wider use in England. For future work, all case study trainees might be followed up at least two or three years later to find out how trainees have developed and what kind of changes have occurred: how trainees choose and reflect teaching and learning strategies in their teaching and how trainees move from the novice to expert teacher stages. Do trainees continue to apply active learning or not? Further work is also needed to ascertain the extent to which these findings are specific to maths teaching and how the gender variable -for trainees, tutors and co-tutors- affects trainees’ learning to teach. The examination of learning to teach mathematics by considering the research questions concerning active learning approaches in teacher training programmes generally, both in relation to primary and secondary schools, will be worthy of further study.
CONCLUSIONS

What marks this study as unique is the way in which it examines trainees learning to teach using active learning and the stages through which trainees pass during their training. The conclusions drawn from the study rely both on comparison between two different teacher training programmes and on an in-depth case study of one English programme.

1. This is an unusual comparative study of learning to teach mathematics and the place of active learning. It not only helps to clarify the role of active learning in learning to teach in relation to teacher training programmes, but also suggests new research topics and questions. The examination of learning to teach using active learning and the stage theory considered both internal (trainees, and teachers) and external (organisational and environmental) factors in the teacher training programmes.

2. Active learning is identified as a potentially powerful approach to teaching mathematics to both trainees and pupils.

3. If trainees use active learning in their teaching then this shifts their foci to pupils’ learning, learning difficulties and individual learning differences.

4. Teacher training programmes, in Turkey, have not included the active learning approach. This approach has potential to support effective teaching and learning in the following ways: trainees take responsibility and active involvement in their own learning; trainees have a sense of ownership and control; and trainees adopt active learning elements in their own teaching.

5. The main difference between Turkish and English trainees is seen in their training for method courses in the training programmes during their initial teacher training.

6. Feeling confident in mathematical subject knowledge, having support, from the tutor and co-tutor, colleagues and partners in the training course, trainees’ own perceptions about using active learning as a teacher, their beliefs and attitudes all emerged as influential elements in developing learning to teach in the teacher training programmes.

7. Policy makers should consider planning guidance for both trainees and teachers in teaching mathematics in Turkey.

8. The present study investigated how trainees’ age, prior backgrounds, work experiences, their secondary and university backgrounds, PGCE course and teaching practice all influenced their learning to teach mathematics in both Turkish and English teacher training programmes. In this study, mathematics teacher trainees reflected on their backgrounds and knowledge. This study found that these factors were all influential to some extent.

9. Training courses must find ways to offer a programme which is responsive to each trainees’ beliefs about teaching, learning and learning to teach mathematics.
POST SCRIPT

In Turkey, by the end of the BEd course all of the trainees in the present study had obtained a job as mathematics teacher from Ministry of Education in different region of Turkey.

In England, by the end of the Leicester PGCE courses all secondary mathematics trainees in the present study has obtained jobs as mathematics teachers. The destination of all case study trainees are outlined briefly below.

Claire O’Neill appointed a full-time post teaching mathematics at Sir Jonathan North Community College, 11-16.

Scott Holligan appointed as mathematics teacher in Bushloe High School 10-14 school.

Catherine Penn obtained a full-time, permanent job as mathematics teacher at Lutterworth Grammar School 14-18.

Linda Hackett appointed full-time mathematics teacher in King Edward VII Melton 14-18 School.
BIBLIOGRAPHY


APPENDIX 1: DfEE (1998) NATIONAL NUMERACY STRATEGY

There is support for this in the research literature, which also identifies the quality of the teaching as the key factor. Teaching the whole class does not mean that the teacher simply ‘lectures’ the class.

Good direct teaching with the whole class is characterized by genuine communication about mathematics. Teachers give pupils the opportunity not only to show what they know, but to explain the reasons behind it, and suggest creative ways of tackling new problems. This gives teachers important feedback about where pupils may be uncertain, and where they are not making connections between old and new knowledge. There is also evidence that the level and type of teachers’ question is important. Teachers need to be sensitive to pupils’ different levels of attainment when targeting individuals, and may need to give pupils time to think or to discuss their answers in pairs, before answering. There is positive benefit from asking questions that challenge pupils to think about the mathematics before giving an answer. Such ‘open’ questions invite pupils to explain their reasoning, for example by making new connections in their knowledge, or solving problems in a real life context. Closed questions, which demand a single correct answer, are useful for practising recall of multiplication tables or steps in a procedure, but if these are the only sort of questions asked, whole class teaching is unlikely to realize its real potential (DfEE, 1998, pp. 19-20).

Group work

Most mathematicians agree that the best way to learn mathematics is by actively doing mathematics; by discussing it with others; by synthesizing major ideas. Students are better able to learn and retain concepts when they are actively involved; students can learn from each other, and can learn from teaching each other; students get practice working and communicating with each other (Rosenthal, 1995).

Group work is a way of increasing interaction with a teacher further. The teacher may teach each group for a period, whilst other groups get on with other work, with pupils helping each other when they have problems. Working in a group, with or without the teacher, encourages pupils to communicate amongst themselves, forcing them to justify to each other their own approach. One purpose of group work is to allow a manageable degree of differentiation around a common theme. Groups can be organised by attainment, while the main body of the class works on the set task can be set a more challenging task for those who would benefit from this. Another purpose of group work is to encourage pupils to collaborate in solving a problem. This needs careful handling if a few children are not to dominate, but research suggests that it gives particularly good results where groups are mixed in attainment. In every case, it is important that the activity is clearly planned, and that communication between pupils is about mathematics (DfEE, 1998, p20).

Treisman, (1992) assert that students are better able to learn retain and concepts when they are actively involved; students can learn from each other, and can learn from teaching each other, students can get practice working and communicating with others and students sense a warmer, more welcoming and more caring atmosphere.
Paired work

Working in pairs on appropriate tasks, e.g. number games, guessing the rule that the other pupil is thinking of, can produce a high level of involvement, thinking and communication. This kind of activity has been carried out with the whole class, to ensure that all pupils understand what to do (DfEE, 1998, p20).

Individual work

It is important that pupils have some opportunities to work individually, either to practice a method, or to apply to different contexts something they have partly learned, in order to consolidate the ideas and methods. Pupils also need experience of sorting out an unfamiliar problem on their own without depending on others. Individual work of this sort may sometimes happen before pupils share their ideas in a group. When pupils have to practise a quick method on their own, it may be appropriate to confine this to a short period with a fast pace. At other times, children will need time to reflect individually on what they are learning, and to tackle more complex questions (DfEE, 1998, p21).

Homework

Regular homework can give pupils the opportunity to play an active part in their own learning. Homework is an important way of extending pupil’s ‘opportunity to learn’. If time in class is used to maximize the extent of direct interaction with the teacher, then homework opportunities should be used to extend the time spent practising in varied ways what has been done in class. It can also be a preparation for what is to be done next in class. It is important for pupils to learn to work independently (DfEE, 1998, p21).

The National Numeracy Project (NNP) was set up by the English Government in 1996 with the overall aim of raising standards of numeracy, in line with national expectations, in participating primary schools. The project has established twelve local centers with teams of consultants whose main role is to provide in-school support and out-of-school training in the planning, teaching and assessment of numeracy. The consultants also support the management of numeracy by headteachers and mathematics coordinators. The concept of numeracy includes: the approach; the lesson; organising the class for a numeracy lesson; the layout of the lesson (timing, resources, vocabulary, introduction of lesson, main activities in the lesson), plenary session, and further activities.

The National Numeracy Project’s view of teaching and learning incorporates active learning elements but the term ‘active learning’ is not used. This project covers only primary education, and, arguably, secondary education needs a similar initiative to raise standards.

Good direct teaching with the whole class is characterized by genuine communication about mathematics. Teachers give pupils the opportunity not only to show what they know, but to explain the reasons behind it, and suggest creative ways of tackling new problems. This gives teachers important feedback about where pupils may be uncertain, and where they are not making connections between old and new knowledge. There is also evidence that the level and type of teachers’ question is important. Teachers need to be sensitive to pupils’ different levels of attainment when targeting individuals, and may need to give pupils time to think or to discuss their answers in pairs, before answering. There is positive benefit from
asking questions that challenge pupils to think about the mathematics before giving an answer. Such 'open' questions invite pupils to explain their reasoning, for example by making new connections in their knowledge, or solving problems in a real life context. Closed questions, which demand a single correct answer, are useful for practising recall of multiplication tables or steps in a procedure, but if these are the only sort of questions asked, whole class teaching is unlikely to realize its real potential (DfEE, 1998, pp. 19-20).

Group work is a way of increasing interaction with a teacher further. The teacher

The right blend of teaching methods

The Cockcroft Report (DES, 1982) included investigational work as one of six elements which should be included in mathematics teaching at all levels. (paragraph 243.) An official report such as NCTM (1980) *Agenda for Action*, and The Cockcroft Report (1982), DfEE (1998) recommended the adoption of a problem-solving approach to the teaching of mathematics. Such reforms depend to a large extent on institutional reform: changes in the overall mathematics curriculum. They depend even more essentially on individual teachers changing their approaches to the teaching of mathematics. However, the required changes are unlike those of a skilled machine operative, who can be trained to upgrade to a more advanced lathe, for example. Ernest (1994) asserts that a shift to a problem-solving approach in teaching requires deeper changes. It depends fundamentally on the teacher's system of beliefs, and in particular on the teacher's conception of the nature of mathematics and mental models of teaching and learning mathematics.

DfEE (1998) advises that the teacher must ensure that the teaching methods chosen support the particular learning activities according to the lesson's aim, and pupils' level of understanding, and readiness. Some forms of organization are more effective for particular purposes than others in teaching mathematics. 'There are many advantages in having a whole class of pupils of different abilities working together, but it will sometimes be appropriate to have groups of pupils working on different tasks, according to what they have already learned, with the teacher able to focus on teaching one particular group of pupils' (DfEE, 1998, p. 21). In using whole class interactive teaching, lessons finish with a review with the whole class, when tutors, trainees and teachers discuss what the important points of the lesson were, and trainees and pupils share what they have been doing and what they have learned. When they finish training they embark on their teaching careers using a high proportion of whole class teaching. They have gradually become more confident about choosing for themselves which form of classroom organization to use at a particular time' (DfEE, 1998, p. 21).
If tutors, trainee or teacher used active learning activities such as whole class interactive teaching, desired outcomes are as follows:

- Teachers know how to illustrate, demonstrate and explain mathematical concepts, offering models and contexts from which the key ideas can be extracted.
- Teachers establish appropriate links between different topics in maths and between mathematics and other cross curricular subjects.
- More time is devoted to interaction between teachers and pupils about mathematics, especially in interactions with the whole class, and also in groups.
- Less time is spent working and trouble-shooting with individuals, and in using questions that do not challenge pupils to think.
- Teachers are knowledgeable about the forms of classroom organization that are most effective in improving standards in mathematics, and know when it is appropriate to use each particular form.
- Teachers provide appropriately demanding work for pupils, with limited differentiation around work common to all pupils in one class.

(DfEE, 1998, p.22)

**Resources in the classroom**

Resources are essential for active learning, and have to be used properly for effective teaching and learning. The classroom needs to be organized in a way that will maximize their benefit. All tutors and teachers have access to key resources (blackboard, OHP, computers, data bases, spread-sheets, software packages, CD-Roms, duplicated sheets, worksheets, calculators and so on.) for the classroom and individual pupils, and many use them to teach mathematics. The potential of new technology also depends on each tutor’s and teacher’s competence and confidence in using ICT (Information and Communication Technologies) as a resource for teaching and learning, and the initial teacher training national curriculum for primary and secondary mathematics includes this element for all trainees.
APPENDIX 2: Requirements in Secondary Mathematics PGCE

Requirements in Secondary Mathematics PGCE were as follows:

In addition to general requirements of initial teacher training, secondary initial training requirements are as follows:

- The Secretary of State requires that institutions satisfy themselves that the content of entrants' initial degrees are appropriate to the secondary school curriculum.

- Applicants for secondary courses should be prepared to demonstrate the relevance of their degree to the curriculum subject they wish to teach. Those whose degree titles do not obviously relate to the National Curriculum or other secondary school subjects in which a postgraduate course exists, will need to unpick their degrees and identify the subject content that is relevant.

- The Secretary of State has decreed that all applicants should take English Language and Mathematics exams and be interviewed. Institutions are not permitted to waive this requirement (GTTR, 1997; DfEEb, 1998: Circular 4/98 degree requirements).
Date: 11/12/1997

Dear Colleague,

I am currently an EdD student in the School of Education at Leicester University. My major area of study is teacher trainees' attitudes to teaching and learning mathematics, in particular algebra and data handling, in Turkey and in England.

This questionnaire is to ask about your perceptions of different teaching methods in algebra and data handling at secondary level.

To answer the questions, please indicate your choice of response by ticking the appropriate words or box. Space has been left for extra comments after some responses.

Please feel free to add comments which you consider might help. Please answer (*: from your point of view) as honestly as you can. All information will be treated in the strictest confidence.

To this end I would appreciate your assistance if you would take a maximum of 20* minutes to complete this anonymous questionnaire. Please return (*: unfinished if you need more time than this) to me via the Postgraduate Research Students pigeonhole (bottom right) in the Building A.

Thank you very much, in advance, for taking the time to complete this questionnaire.

Yours sincerely

Hulya Gur
Leicester University
School of Education
Leicester
LE2 7RH
Tel: 0-116-2525711
**Instruction to participant:** As you read through the statements below please indicate the extent to which you agree or disagree with each statement by *ticking* in the appropriate box. Tick one box only for each statement. Only use the neutral box if you are really undecided. There are no *right* or *wrong* answers.

If you would like to comment on any particular item please feel free to write overleaf.

---

**SECTION ONE**

**BACKGROUND**

I am ... □ Male □ Female

My age group is?

□ 18-20 □ 21-25 □ 26-30 □ 31-35

□ 36-40 □ 41-45 □ 46-50 □ over 50

My degree subjects are .................................................

Before starting to PGCE course, I was working/ studying* as ........................................................

* delete as a appropriate

In my first years at secondary (for mathematics) I was in the

□ set ability or □ mixed ability group class

If you have any previous teaching or mathematics teaching experiences give details briefly.

..................................................................................................................}

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**SECTION TWO**

**ME AND MATHEMATICS**

<table>
<thead>
<tr>
<th>Statement</th>
<th>strongly agree</th>
<th>agree</th>
<th>neutral</th>
<th>disagree</th>
<th>strongly disagree</th>
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</thead>
<tbody>
<tr>
<td>1 I find mathematics topics fun to do.</td>
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<td>2 I like arithmetic.</td>
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<tr>
<td>3 I like doing quadratic equations.</td>
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<tr>
<td>4 I like data handling.</td>
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</tbody>
</table>
5 I think mathematics is a challenge. □ □ □ □ □ □

6 I think data handling is useful. □ □ □ □ □ □

SECTION THREE
ME AND MATHEMATICS TEACHING

strongly agree neutral disagree strongly agree disagree

7 I enjoy teaching algebra. □ □ □ □ □ □

8 I enjoy teaching data handling. □ □ □ □ □ □

9 In your teaching practice this year have you taught algebra?
   □ yes □ no

   When teaching or intending to teach algebra, how important are the followings:

   practical simulations □ □ □ □ □ □
   problem solving □ □ □ □ □ □
   structured individual work □ □ □ □ □ □
   mathematical projects based on □ □ □ □ □ □
   extended work?

10 What topic did you use or what would you suggest for algebra project work

11 The area of mathematics I would most enjoy teaching is

12 In your teaching practice this year did you teach data handling?
   □ yes □ no
When teaching or intending to teach data handling, how important are the followings:

<table>
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<tr>
<th></th>
<th>not important</th>
<th>quite important</th>
<th>important</th>
<th>very important</th>
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<tr>
<td>use practical simulations</td>
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<tr>
<td>set problem solving task</td>
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<tr>
<td>use structured individual work</td>
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<tr>
<td>use mathematical project based on</td>
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<tr>
<td>an extended piece of work?</td>
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</table>

13 What topic did you use or what would you suggest for data handling project work

<table>
<thead>
<tr>
<th></th>
<th>strongly agree</th>
<th>neutral</th>
<th>disagree</th>
<th>strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>14 I have adopted a new approach to teaching mathematics recently.</td>
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<td>15 I think mathematics needs to be taught in a different way to other subjects.</td>
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<td>16 I have my own ways to teach</td>
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<tr>
<td>17 I feel happy in my mathematics lessons</td>
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</tbody>
</table>

18 How much of your spare time in a week do you spend engaged in any kind of mathematical activity (e.g. data handling, lottery, doing accounts, ...)

<table>
<thead>
<tr>
<th></th>
<th>no time</th>
<th>up to 1 hour</th>
<th>1 to 2 hour</th>
<th>2 to 3 hour</th>
<th>more than 3 hour</th>
</tr>
</thead>
<tbody>
<tr>
<td>19 In mathematics lessons how often have/ would you use the following forms of organization (<em>please delete as appropriate)</em> (5 = usually, 4 = sometimes, 3 = occasionally, 2 = rarely, 1 = never)</td>
<td></td>
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<tr>
<td>a group work</td>
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<td>b individual work</td>
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<td>c pair work</td>
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<td>d whole class</td>
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<tr>
<td>e if you use other strategies, please specify ..........................................................</td>
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</tbody>
</table>
20 Below please rank in order how often the frequencies with which you use published materials in mathematics lesson. (5 = usually, 4 = sometimes, 3 = occasional, 2 = least, 1 = never)
   a books □
   b library sources □
   c cinema or video □
   d computer software □
   e home made materials

   □ duplicated sheets
   □ lectures notes
   □ pupils notes
   □ exercises
   □ OHP
   □ other apparatus

SECTION FOUR
ME AND MY MATHEMATICS STUDENTS

<table>
<thead>
<tr>
<th></th>
<th>strongly agree</th>
<th>agree</th>
<th>neutral</th>
<th>disagree</th>
<th>strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>21 I think most of the students in my classes enjoy studying mathematics.</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>22 If students work hard they will be good at maths</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>23 My lessons have almost the same form or structure for each lesson.</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>24 My students have lots of opportunities to use maths in other lessons (e.g. science,..)</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>25 Pupils find algebra difficult</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
</tbody>
</table>
26 If my students are struggling with their mathematics, then: I would

(please tick most appropriate column)

<table>
<thead>
<tr>
<th></th>
<th>strongly agree</th>
<th>agree</th>
<th>neutral</th>
<th>disagree</th>
<th>strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>be more sympathetic</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b</td>
<td>suggest that they ask their parents for help</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c</td>
<td>not be concerned about it</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d</td>
<td>use different way to help them understand</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e</td>
<td>think learning depends on their own efforts</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>f</td>
<td>encourage them to use diagrams</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>g</td>
<td>encourage them to use computer</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>h</td>
<td>encourage them to use books/textbook</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

27 I have learned little new about mathematics during teacher training.

28 My understanding of mathematical ideas has changed in the process of teaching mathematics.

29 I think my view of mathematics teaching has changed.

If so, how has it changed?

30 I believe effective teaching of mathematics depends on:

1. 
2. 
3. 

Please add any additional comments below

Hulya Gur
**APPENDIX 4**

**MATHEMATIK STA杰LERI ICIN ÅNKET**

**BIRINCI BOLUM**

**ÖZGECMISIM**

Cinsiyetim  □  Bay  □  Bayan

Yasım;

□ 18-20  □ 21-25  □ 26-30  □ 31-35  
□ 36-40  □ 41-45  □ 46-50  □ over 50

Fakultede devam ettiginim / bitirdigim bolum..............................................................

Formasyon kursuna baslamadan once;yaptigim is ..............................................................

Lisede bitirdigim bolum ........................................................................................................

Daha once hic ogretmenlik deneyiminiz oldu mu? aciklayıniz ..............................................

**IKINCI BOLUM**

**BEN VE MATEMATIK**

<table>
<thead>
<tr>
<th></th>
<th>kesinlikle</th>
<th>katiliyorum</th>
<th>kararsız</th>
<th>katilmiyorum</th>
<th>kesinlikle</th>
<th>katiliyorum</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Matematikle ugrasmaktan hoslanirim</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>2</td>
<td>Aritmetigi severim.</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>3</td>
<td>Denklemleri, özellikle ikinci dereceden denklemleri cozmekten hoslanirim.</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>4</td>
<td>Olasiliği severim.</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>5</td>
<td>Matematikte zor olanı basarmayı severim</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>6</td>
<td>Olasiligin yada istatistiksel bilgileri degerlendirmenin yararli olacagini sanirim.</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
</tbody>
</table>
UCUNCU BOLUM

BEN VE MATHEMATIK OGRETIMI/OGRETMENLIGI

kesinlikle katilıyorum katılıyorum kararsız katılmıyorum kesinlikle katılıyorum

7 Aritmetik, sayilar, semboller, denklemleri,...

ogretmekten hoslanirim. □ □ □ □ □ □

8 Istatistiksel bilgileri ogretmekten hoslanirim. □ □ □ □ □ □

9 Stajda hic algebra ogrettiniz mi?

□ evet □ hayir

Stajda ogrettiginizde yada ogretmeye baslayacaginiiza asagidakiler sizin ne kadar onemlidir:

hie biraz onemli cok

onemli biraz onemli onemlidir

onemlidir biraz onemli

teorinin pratige uygulanmasi □ □ □ □ □ □

problem cozme □ □ □ □ □ □

verilen taslak uzerinde bireysel calisma □ □ □ □ □ □

genis uygulama alanlarina yonelik matematik projeleri □ □ □ □ □ □

10 Algebra projesi icin hangi konulari kullandiniz yada kullanmayi dusunuyorsunuz?

11 Matematik konulari icinde en cok ogretmekten hoslandigim konu ........................................

12 Stajda hic istatistik, olasilik yada bunlarla iliskili herhangi birsey ogrettiniz mi?

□ evet □ hayir

Stajda ogrettiginizde yada ogretmeye baslayacaginiiza asagidakiler sizin ne kadar onemlidir:

pratik uygulamalar □ □ □ □ □ □

problem cozme □ □ □ □ □ □

yapilandirilmis bireysel calisma □ □ □ □ □ □

mathematisel projects yapimi □ □ □ □ □ □

13 Olasilik yada istatikle ilgili proje icin hangi konulari kullandiniz yada kullanmayi dusunuyorsunuz?
14 Matematik dersinde yeni metod
uygulamaya basladım

15 Matematik diger derslerden farklı bir
metodla/ yontemle öğretilmelidir

16 Kendime ait öğretim yöntemlerim var

17 Matematik dersinde kendimi daha rahat
hissederim

18 Matematique haftada kaç saatinizi ayırabilirsiniz? (alışveris, yatırım kararları: faiz, repo, kar-
zarar, enflasyon hesabı, toto, loto,...)

19 Matematik dersinde aşağıdakilerden hangisini daha sık kullandığınızı derecelendiriniz (5 =
coğunlukla, 4 = bazen, 3 = nadiren, 2 = çok az, çok nadir, 1 = asla)
a group calismasi
b bireysel calisma
c ikili calisma
d tum sinif
e diğer (lutfen açıklayınız) ........................................................

20 Matematik dersinde aşağıdaki materyalleri hangi sıklıkla kullandiğiniz derecelendiriniz
(5 = cüğunlukla, 4 = bazen, 3 = nadiren, 2 = çok az, çok nadir, 1 = asla)
a kitaplar
b kutuphane
c sinema / video
d bilgisayar programları
e sizin hazırladığınız öğretim materyalleri aşağıdaki derslerden hangisine giriyor?

   □ teksir yada fotokopi edilmiş materyaller
   □ kendi ders notlarım
   □ iyi not tutsun öğrencilerin defterleri, notları
   □ birçok kaynaklardan toplanan seçme alistirmalar
   □ transparant, tepegoz
   □ diğer materyaller
DÖRDUNCÜ BOLUM
BEN VE ÖĞRENCİLERİM

21. Öğrencilerimin coğu matematikten hoşlanır □ □ □ □ □ □

22. Öğrencilerim çalışırsa matematiği basarırlar □ □ □ □ □ □

23. Derslerimin işleniş tarzı hemen hemen aynıdır □ □ □ □ □ □

24. Öğrencilerim öğrettiklerimden diğer derslerde yararlanırlar (fen bilgisi, fizik, kimya,) □ □ □ □ □ □

25. Öğrenciler aritmetiği, sayıları, onları sembollerle ifade edip denklem çözmeyi zor zannederler □ □ □ □ □ □

26. Öğrencilerim matematik dersinde ya da bir çözüm ugrasırken zorlukla karsılasırsa o zaman;

(uygun olan kolona tick atınız)

kesinlikle katılıyorum yorumsz katılmıyorum kesinlikle katılmıyorum

a. daha yardımcı, hoşgörülü olurum ........ ........ ........ ........ ........ ........

b. ailelerinden yardımcı gormelerini öneririm ........ ........ ........ ........ ........ ........

c. çok ilgilenmem ........ ........ ........ ........ ........ ........

d. onların anlamalarına yardımcı olmak için degisik yollar, teknikler kullanırım ........ ........ ........ ........ ........ ........

e. öğrenme öğrencinin kendi cabasına baglidir ........ ........ ........ ........ ........ ........

f. daha iyi anlamaları için diagram ve şekillerle yardımcı olmaya calisirim ........ ........ ........ ........ ........ ........

g. bilgisayardan yararlanmalarını öneririm ........ ........ ........ ........ ........ ........

h. diğer kaynak kitaplara, ve malzemelere bakmalarını öneririm ........ ........ ........ ........ ........ ........

(uygun olan kolona tick atınız)
Kurs sırasında;

27 matematik öğretimi ile ilgili yeteri kadar öğrenmedim □ □ □ □ □
28 matematik öğretimine ait yeni fikir ve yollar öğrendim □ □ □ □ □
29 matematik öğretimine bakış açıım değişti □ □ □ □ □

nasıl bir değişiklik oldu?

30 Matematik öğretimi şekili sunlara bağlıdır:
1. 
2. 
3. 

Lütfen varsa ilave etmek istediğiniz yorumlarınızı çekinmeden lütfen aşağı yazınız.

Hulya Gur
APPENDIX 5: INTERVIEW PROTOCOL

Autobiographical Interview for Trainees

INTERVIEW PROTOCOL

AIMS:

To obtain supplementary information (to questionnaire background section an GTTR form) about reason for choosing PGCE, teaching and type of schooling.

To explore intellectual history, mathematical knowledge, secondary under graduate education, work experience (teaching or other), other situations, first hand experience.

To ascertain teaching aspirations and expectations of training.

To explore interviewer's and referee's impressions.

ADVANCE ORGANIZER:

The important point is that what students bring to training, how this effect and the need to take account of this. The purpose of this interview is to explore aspects of your background which may be important influences on how you aspects of your background which may be important influences on how you think about teaching and why you have decided to train as a mathematics teacher.

1. ROUTE INTO TEACHING: Mathematics teacher trainee arrive at training program via various routes, such as; school ⇒ university ⇒ PGCE. Could you briefly outline your route please?

2. SCHOOLING: Secondary school years experiences of teaching and learning as a school pupil are influenced on how we think about teaching. This section explores the ways in which this is true for you. It would be helpful if you could start by describing your secondary schooling such as; school type, class size, ability group, special features, good and bad maths learning ) and I will ask you about particular experiences in that time.

2.1.a experiences of being thought maths.

Was there a typical maths lesson that you can describe?

(If not?) Could you outline the different types of maths lesson?

[ PROBE for: good and bad or positive and negative experiences of being thought maths]

2.1.b Implications

Now what implications do these experiences carry for you?

2.2.a Experiences of learning maths

Were there particular ways of learning maths?
[PROBE for: preferred styles of learning, what type of organization used your teacher according to you which one is the best]

2.2. b Implications
Now, what implications does your school learning have for you?

2.3 Other experiences of teaching and learning.
Are there any other important school experiences of teaching and or learning? (maths, science, ...)

2.4 Experiences of algebra in secondary school
2.4.1 How did your secondary school teacher teach algebra? Were there any particular strategy to teach?
2.4.2 What kind of organization did s/he used to teach algebra?
2.4.3 What kind of material did s/he used to teach algebra?
2.4.a Implications
Now, did it influence your teaching algebra? How?

2.5.1 How did your secondary school teacher teach data handling? Were there any particular strategy to teach?
2.5.2 What kind of organization did s/he used to teach data handling?
2.5.3 What kind of material did s/he used to teach data handling?
2.5.a Implications
Now, did it influence your teaching data handling? How?

3. UNDERGRADUATE EDUCATION
University undergraduate education experiences are different from school for many students. Students find out every problem's answer themselves.

3.a Differences in teaching
What ways did teaching at university differ from the school?
And did you use to that.

3.b Differences in learning
Are your learning style changed? If changed how did your style of learning change?

3.c Reaction to differences
What was your reaction about this differences?

3.d Implications
Now, what implications do these experiences carry for you?
4. OTHER INFLUENTIAL EXPERIENCES

4.a Experiences
   Are there any other experiences, which have been influential? such as professional,
   personal, formal, informal experiences...

4.b Consequences
   What were the consequences of these experiences?

5. MOTIVATION

   You may have mixed reactions to decide become a teacher

5.1.a Reason for teaching
   What was your reason to chose teaching mathematics?

5.1.b Anxieties
   What is /was your own anxieties?

5.2.a Reason for particular PGCE course
   What are the main reasons for choosing to train at Leicester University? Why did you
   consider other possibilities?

5.2.b Expectations of training
   What do you expect training at Leicester University to provide or, gain?

6. SELF PERCEPTION

Finally, how you see yourself is likely to influence your development as a mathematics teacher.

6.1.a Teaching aspiration
   How do you see yourself as a mathematics teacher? What type of teacher do you see
   yourself becoming?
   [ PROBE for: images, preferred model of teaching, aspirations]

6.1.b Strengths
   What are the major strengths qualities you bring to teaching?

6.1.c Weakness
   What is your weakness area to do you need help?

6.2 Self as Learner of Teaching

Finally, how do you see yourself as a learner of teaching mathematics? What sort of
learning will be involved? Are you planning to use newly learned teaching method?

Is there anything else that you would like to mention?
7. EXPLORING SOME OF QUESTIONNAIRE ITEMS

7.1.a mathematics need to be taught in a different way to other subjects?
7.1.b Mathematics is a challenge?
7.1.c Mathematics is fun to do? What do you think that remark?
7.1.d Are you using any classroom organization such as whole class work, pair work, small group work?
7.1.e How can you decide to choose these organizations?
7.1.f Which materials help to teach algebra and data handling, are there any certain line between them?
7.1.g Are the OHP, books and computer helps to your teaching?
7.1.h What kind of homework do you prefer to give them? Solving equations, problem solving, project work, pair work, individual work, ... ? and why?

Thank you very much for your help.
APPENDIX 6.1: OBSERVATION IN BALIKESIR

An example of the researcher's field notes in mathematics lesson in secondary school in Turkey.

Table 1: Typical Turkish Classroom Plan:

<table>
<thead>
<tr>
<th>class list</th>
<th>black board</th>
<th>door</th>
</tr>
</thead>
<tbody>
<tr>
<td>teacher's table</td>
<td></td>
<td></td>
</tr>
<tr>
<td>desk</td>
<td>desk</td>
<td>desk</td>
</tr>
<tr>
<td>desk</td>
<td>desk</td>
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<tr>
<td>desk</td>
<td>desk</td>
<td>desk</td>
</tr>
</tbody>
</table>

'Observation II (second lesson, 9.20-10.05, morning period, male mathematics teacher, year 7 pupils, 43 pupils, state school, subject: algebra (reversibility).

He enters the classroom, all pupils stand up until he lets them sit down. It is a usual thing for Turkish classrooms. On the board, date, lesson's name, three numbers were written. He started with registration, and revision of the past lesson. He checked pupils' homework which is copied into their notebooks or not. Four pupils had not done their homework; he warned them, 'If you do not this next lesson, I will give you a low mark in your report'. After, he went to the board and started to introduce a new topic and solve related problems in front of the blackboard, and mainly speak to the blackboard. He does not realize what are the pupils doing. Whole class teaching mainly exposition are his teaching methods. He jumped to solving some different types of exercises from the college textbooks, and science college exam's exercises. He asks pupils three times: 'Do you understand?' If you want to ask something, ask now not later! He wrote two questions on the board and he wants them to solve these exercises in their notebooks in a maximum 5 minutes, During that time he walked around and checked a few pupils' writings. Pupils are mainly seated according to their mathematics ability. Each row has two pupils, who are mainly good at mathematics and are seated in the first two desks. In the back row, pupils are not interested in mathematics, some of them are talking with friends, or doing other lesson's homework.

He asked the class who wants to do this problems' solving on the board. A few hands are raised-just front rows. He summarized the topic, and gave the pupils some rules to solve this problem quickly. He asked a few questions like: Do you know how we can solve this
quickly, or in a different way? But some of them said yes, some of them said no. He mentioned to pupils you just need to know this formulae, and rules are enough to solve that kind of problem.

There is not any kind of group activity or other teaching methods; just exposition, demonstration, drills, and whole class teaching. Materials are only chalk-talk, book, duplicated sheets, notebooks. Not any application to real life examples.

After the lesson, he told the researcher: ‘I felt I was inspected!’ And the researcher asked him some questions: ‘Have you prepared a lesson plan?’ ‘What kind of plan have you prepared and why?’, ‘What do you think about the National Curriculum?’ ‘Why do you just solve exercises?’, ‘What kind of homework do you give the pupils?’, so on.

And he replied with some interesting answers as follows:

‘It might be remarked on that there are no applications of theoretical mathematics knowledge to real life. This may have been why pupils lost interest in mathematics’.
APPENDIX 6.2

OBSERVATION IN PGCE AND SECONDARY SCHOOLS IN LEICESTER

The reasons for doing observation of tutor’s sessions and trainee’s teaching sessions in PGCE and secondary classrooms were to provide real, shared events as a focus for discussion; to find out the trainee’s learning and their interpretations of learning to teach, and perceived influences on learning. The other aims were as follows:

• To obtain evidence of the trainee’s practical procedures for learning with particular emphasis on the operationalisation and usage of active learning (as embedded in the targets, individual needs identified);

• Explain that, before, the observation provides a shared experience for the discussion of learning to teach mathematics - specially algebra and data handling. Obtain copy of documentation for the session;

• Ask for a brief outline of the session to be observed, i.e. intention and justifications. Observe lesson, noting incident, especially those which seem illustrative of the trainee working on stated needs and targets.

After the observed lesson, a short discussion was made with the trainees and tutor, and a number of questions were asked to find out their beliefs and attitudes. These were ‘can you tell me about any incidents in this lesson which you feel were important?’ The next WH- questions were asked, such as: What led up to ...?; What were you thinking ...?; Where did the idea come from ...?; Why did you decide / say / do ...?

Operationalisation of active learning in the mathematics lessons:

The researcher need to know ‘How does this lesson relate to your individual needs, targets? And how does the active learning relate to your individual needs, targets?’. Here trainee is working on collaborative project, practical work, individual work, pair working, small group discussion, collaborative problem solving, project work’... ‘How pupil involvement, what is the pupil’s interests, ...’ and ‘How has the lesson contributed to your learning? (i.e. What are you acquiring, developing, taking away as a result?)’.

Perception of learning from training

How has the lesson been influenced by any interaction with pupil / teacher / other teachers / other lessons / texts and resources, environment? The observations were focused on interpretations of learning/ origins of learning knowledge acquired and its use in practice and relationship of views of learning to knowledge acquired / used.
Observation of the mathematics sessions, algebra and data handling sessions, in University

From the university tutor's standpoint, teacher trainees should have been able to recognize the conceptual shift that was made when they moved away from the use of manipulatives to obtain a solution to the division of fractions problem, and toward the algebra and data handling. That is, they should have realize the following, in the episodes of algebra and data handling:

- the key points and hints were given for teaching algebra and data handling by tutor but tutor was not within the knowledge constraint of pupils.
- Materials and resources and reading list were introduced by the tutor.
- However, the tutor has seemed a role model for trainees but trainees have difficulty in meeting the class teacher in teaching practice. Trainees believe there is a distinction between the role model of a university tutor and the co-tutor. Although the tutor gives them an idealistic view, the co-tutor gives them a realistic view of teaching and learning.

Trainees' typical classroom observation in schools

The researchers' field notes follow during the observations, such as; Classroom plan:

<table>
<thead>
<tr>
<th>white board</th>
<th>teacher's table</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>d</td>
</tr>
<tr>
<td>I</td>
<td>I   _</td>
</tr>
<tr>
<td>I</td>
<td>_ _ I</td>
</tr>
<tr>
<td>I</td>
<td>_   _ I r</td>
</tr>
</tbody>
</table>

Lesson start time 11.45, Y8 pupils, 30 pupils in the class, Moat College, seat two pairs in each desk. She started to the lesson with all pupils sitting down for a registration. She did a quick recap of the last lesson, and wanted the pupils to make an investigation to the number sequence: 11, 13, 17, ..., 29, 32, ?.

<table>
<thead>
<tr>
<th>Number of term</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>term</td>
<td>11</td>
<td>14</td>
<td>17</td>
<td>20</td>
<td>23</td>
<td>26</td>
<td>29</td>
<td>32</td>
</tr>
</tbody>
</table>

She asked 'How can we work out the formulae?' to the class, and she waited for them to work it out for themselves, then five minutes later she wrote down the formulae on the board. She spent most of the time dealing with the class management problems, walking around the desks, trying to answers pupil’s questions. She was active in the classroom, using demonstration,
exposition, and worksheets, and checking pupil's answers. She told the pupils: 'if you don't make mistakes you're not extending yourself'. Pupils copied the board. The pupils seemed interested in the number patterns, and investigation. A few pupils who were very good at maths, were finished very early, and after that they appeared bored. Some of the pupils seemed to be daydreaming, looking at football player's cards, or chatting. The teacher wanted to gain their attention by saying: 'Can I stop you a second?'. After that she checked the answers and solved them on the board, showing them step by step:

\[ 2x - 16 = 0 \]

\[ 2x = 16 \text{ and you have to divide 2 both sides.} \]

The other examples she did:

\[ \frac{1}{2}x = 5, \text{ what do we gonne do? Multiple, divide by 2?} \]

'Yees, multiple by 2 both sides of the equation'. \[ x = 10. \]

She asked to the class, 'Who doesn't understand ± part?' She summarized again. She asked: 'If we had a -7 to make at 0 what we add?’, ‘+7 might be add and make 0’. Pupil went back to the exercises on their books which was Key Maths 8³, and they worked out the inverse formulae. If pupils did not finish exercises during the lesson, she told them they had to finish at the beginning of the next lesson. She did not finish the lesson on time, and apply the lesson plan properly.

**Master class video observation on PGCE course:**

Part of the trainees' collaborative project, more able pupils who were in secondary schools, came to the university to take part in tutor's and trainees' learning to teach study. The tutor, Mike, explained why they were in the university, and then divided into six different groups, each group held by two trainees. They then applied all active learning requirements in their groups. These sessions were video recorded. After the recording, this taped session was assessed on the following criterias: What are the negative aspects and positive aspects of this video: What's going on negative / positive? What can be improved, which strength? How? What would happen if......., What were the active learning elements, requirements? According to these observations, mathematics teacher trainees still needed to 'learn how to teach'. Also all teacher trainees had problems with classroom control. They may start to see the potential motivational advantages of active learning but, in future, this possibility will be constrained by the National Curriculum targets. The observation results found a systematic relationship between the perceptions and approaches.
APPENDIX 7: PHOTOGRAPHS IN TURKISH SECONDARY CLASSROOMS
APPENDIX 7: PHOTOGRAPHS IN TURKISH SECONDARY CLASSROOMS
Assignments in Leicester PGCE course:

In examining how trainees learn to teach and what influences can be identified, trainees’ writing for University Assignments I and II and their School Files were analysed. University Assignment I was in the form of a report of not more than 2500 words completed by Thursday 23 January, and University Assignment II was in the form of an essay of not more than 2500 words completed by Thursday 20 March and prepared by the all secondary mathematics teacher trainees.

University Assignments I and II required the trainees to respond to questions related to concepts. University Assignment I is subjective and included how to manage and control the classroom; University Assignment II is more theoretical and academic, and included teaching certain topics such as algebra or data handling, analysing difficulties in teaching and preparation for teaching.

- University Assignment I

Self-evaluation Report Based on the Mode A Block Attachment

This assignment is a self evaluation report based on the Mode A Block Attachment. This report requires trainees to analyse and reflect upon selected aspects of their developing experience, achievement and learning on their first block attachment. Taking into account the opportunities available for their own teaching and learning in the Mode A Mathematics Department, they should choose to focus on between two and four of the following aspects illustrating competence. The numbers refer to the corresponding competence statements to encourage depth of analysis and evaluation with some opportunity for breadth in the focus. (University of Leicester, 1998a, pp17-21):

- **Ab** justifies decisions taken about the approach/ materials used in relation to the National Curriculum;
- **Ag** responds appropriately to pupil questions;
- **Ai** takes appropriate steps in planning and teaching to deal with pupils’ subject difficulties;
- **Bb** prepares appropriate and effective lesson plans... and plans a sequence of lessons which take account of the school scheme of work;
- **Bc** adjusts plans in the light of assessment of learners’ work;
- **Bg** judges the necessary level of attention in the class and takes the necessary action; actively monitors the behaviour in the class;
- **Bh** maintains an orderly framework for learning;
- **Bk** matches the approaches used to the subject matter and pupils being taught; questions effectively, matching the pace and direction of the lesson, and ensures that all pupils take part; selects and makes good use of textbooks, IT and other learning resources which enable teaching objectives to be met;
- **Ca** adjusts plans and lessons in the light of assessment of learners’ work;
Cb sets appropriate tasks;
Cc assesses systematically the work of an individual.

Preparing for the Report

The trainees should seek the advice of their co-tutor regarding the choice of relevant aspects upon which to focus throughout their block attachment. In the report, trainees produce self-evaluations and individual action plans.

Collecting evidence

The bulk of evidence upon which trainees need to draw in writing the report comes from the school file: forward plans, lesson plans, materials and resources used, lesson evaluations, records of individual pupil's progress, and written feedback from teachers, and co-tutors. Trainees also get feedback orally from discussion with teachers, use departmental resources, and their own observations of class teachers at school. Assignment I does not expect a literature review but it needs to cover sufficient analysis of experience, achievement and professional learning in each aspect. All judgment needs to be supported by appropriate evidence.

- University Assignment II

Critical Essay on the Teaching of a Specific Mathematical Topic within Key Stage 3 and 4.

This assignment shows a trainee's development in Standards Area A- Subject knowledge and understanding - with particular reference to the following aspects applied to one mathematical topic (University of Leicester, 1998a, b, pp. 17-21):

Aa secure knowledge and understanding
Ab detailed knowledge and understanding of the National Curriculum Programmes of Study and Level Descriptions
Ac familiarity with KS4 examination syllabus and courses
Ae familiarity with progression from the KS2 Programmes of Study
AgAi consideration of pupils' questions, misconceptions and mistakes and appropriate teaching responses
Ah consideration of relevant literature on pupils' learning and performance and the implications for teaching.

For assignment II, trainees should choose a topic which they will have an opportunity to teach during their Mode A block or serial attachment. They will be able to draw on first-hand practical experience in writing University Assignment II. Practical experience of the topic covers Mode A experience; trainee's own learning of the topic; primary attachment; small-group work in Leicester schools; KS3/4 (KS3 for pupils age 11-14, year-groups 7, 8, 9; KS4 for pupils age 14-16, year groups 10-11, peer group brainstorms
Trainees should draw on a range of relevant background reading to inform their essay. Trainees use such sources as: National Curriculum and assessment documents; books and reports; articles and periodicals; Mode A departmental materials; published teaching materials; test and examination materials. The trainee should consider the following aspects of teaching: reason for teaching the topic; the topic's place in the National Curriculum and assessment arrangements; historical and cultural background; progression in knowledge, skills and concepts; language and communication skills; applications and context; studies about pupil learning of the topic; teaching ideas and resources; ways of assessing pupils' learning.

Trainees also include their first hand experience: practical experience, background reading, and their reflections.

- **School files in Leicester PGCE course:**

  The school file is often contained within a ring binder and is used to contain all of the documents, all the plans (short, medium, and long term) and records required for trainees' time in school. The opening page contains essential information, namely the trainee's name, Mode A or B attachment, school's name, the name of the class teacher and co-tutor in the attachment schools and the co-ordinator. **Short term planning** is likely to be in the form of individual lesson plans. These need to take account of more than just the mathematical content of the lesson. **Medium term planning** is normally forward planning for the teaching of a topic over a series of lessons. This planning should reflect the development of a topic, the prerequisites for learning the topic and ideas for teaching and presenting the material. **Long term planning** is likely to be in the form of departmental schemes of work for a Key Stage, broken down into yearly and termly plans. (NCC, 1989, Section B; Vlaeminke, 1996, p.97). Every lesson follows some sequence, either by design or default. Trainees who give careful thought to a lesson's likely pattern (introduction, distribution of resources, settling, time-on-task, conclusion and so on) in the early part of their teaching, normally discover that it becomes less necessary to be as precise as the weeks go by. If trainees are very inexperienced, it pays to write down some approximate timings alongside the different parts of the lesson: introduction 3 min., question-answer 5 min., and so on.
# APPENDIX 9: PLANNING

<table>
<thead>
<tr>
<th>teacher trainee's name:</th>
<th>code:</th>
<th>school:</th>
<th>year group:</th>
<th>date:</th>
<th>ACTIVE LEARNING ELEMENTS</th>
<th>RESOURCES</th>
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<td></td>
<td></td>
<td>1. Exposition&amp; practice</td>
<td>1. Surveys</td>
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<td>2. ques-ans.</td>
<td>11. field work</td>
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<td></td>
<td>3. bring up pupil to board</td>
<td>12. DARTs (directed activities related to texts)</td>
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<td>4. individual</td>
<td>13. comp. assisted learning</td>
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<td></td>
<td>5. teacher demonstration</td>
<td>14. CD rom</td>
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<td>6. pupil demonstration</td>
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<td>7. group problem solving</td>
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<td>8. small group discussion</td>
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<td>9. formal presentation to peers</td>
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</tbody>
</table>

## TOPIC 1

## OUTLINE PLANNING

## DETAILED PLANNING

**COMPANY NAME**

---

**PLANNING**

**NC LINK & AIMS OF LESSON**

**EXPERIENCE OF LESSONS** (where can we use this topic in real life)

**TEACHER ACTIVITIES**

1. take register

**PUPIL ACTIVITIES**

**ACTIVE LEARNING ELEMENTS**

1. Exposition& practice
2. ques-ans.
3. bring up pupil to board
4. individual
5. teacher demonstration
6. pupil demonstration
7. group problem solving
8. small group discussion
9. formal presentation to peers
10. surveys
11. field work
12. DARTs (directed activities related to texts)
13. comp. assisted learning
14. CD rom
# APPENDIX 9: PLANNING

## LONG TERM PLANS

(> 1 lesson) (whole topics)

<table>
<thead>
<tr>
<th>teacher trainee's name:</th>
<th>code:</th>
<th>school:</th>
<th>date:</th>
<th>year group:</th>
<th>date &amp; year grp</th>
<th>TOPICS &amp; NC LINKS</th>
<th>PLANNING FOR ASSESSMENT</th>
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</tbody>
</table>

**ANTICIPATING PUPIL RESPONSES**
1. whole class
2. sub group (pair, team)
3. individual

**QUALITY OF LONG TERM PLANNING**
1. workspace
2. text books
3. blackboard
4. 
5. 
6. 

**RESOURCES AND MATERIALS**
1. worksheets
2. text books
3. blackboard

**ACTIVE LEARNING ELEMENTS**
1. Exposition & practice
2. ques-ans.
3. bringing up pupil to board
4. individual
5. teacher demonstration
6. pupil demonstration
7. group problem solving
8. small group discussion
9. formal presentation to peers
10. surveys
11. field work
12. DARTs (directed activities related to texts)
13. comp. assisted learning
14. CD rom
### APPENDIX 10: LESSON EVALUATIONS

<table>
<thead>
<tr>
<th>teacher trainee's name:</th>
<th>code:</th>
<th>school:</th>
<th>year group:</th>
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</tbody>
</table>

#### TOPICS:
- **MY ROLES AS A TEACHER**
  - 1. maths
  - 2. management
    - 2.1 timing
    - 2.2 class control
    - 2.3 behaviour, control
  - 3. staffing things
    - 3.1 sole charge
    - 3.2 joint teacher
- **PUPIL RESPONSES**
  - 1. whole class
  - 2. subgroup (pair, team)
  - 3. individual
- **ACTIVE LEARNING ELEMENTS**
  - 1. Exposition & practice
  - 2. ques-ans.
  - 3. bringing up pupil to board
  - 4. individual
  - 5. teacher demonstration
  - 6. pupil demonstration
  - 7. group problem solving
  - 8. small group discussion
  - 9. formal presentation to peers
  - 10. surveys
  - 11. field work
  - 12. DARTs (directed activities related to texts)
  - 13. comp. assisted learning
  - 14. CD rom
- **RESOURCES AND MATERIALS**
  - 1. worksheets, examples
  - 2. text books
  - 3. blackboard
  - 4. collect hw
  - 5. 
  - 6. 
  - 7. 

#### PLANING AND MOVING ON THE NEXT LESSON

2. topic time:
   length:
   year group:
APPENDIX 11: CIRCULAR 4/98 (DfEE) for ITT IN SECONDARY MATHEMATICS

A. Pedagogical knowledge and understanding required by trainees to secure pupils’ progress in mathematics (pp.105-115):

1. Progression in pupils’ mathematical understanding
   a. All courses must ensure that trainees are taught that pupils’ progression in mathematics depends upon teaching which emphasises that mathematics:
      • is a powerful tool in other subjects, adult life and employment;
      • is intriguing and intellectually exciting and can be appreciated by pupils of a wide range of ability as an activity in itself;
      • requires the use of logical reasoning and a developing ability to understand and use concepts;
      • provides a concise means of communication;
      • involves the study of relationships and inter-related ideas within the subject.
   b. Trainees must be taught how to analyse the underlying progression in pupils’ understanding of mathematics and the implications of this for their teaching. Such analysis should take account of progression within each session on the Programme of Study of the pupils’ National Curriculum and of connection between the different aspects of mathematics.
   c. So that trainees develop high expectations of their pupils and to aid them in planning, trainees must be taught the importance of ensuring that pupils aged 11-16 progress.
   d. Trainees on 11-18 and 14-19 courses must be taught how pupils’ progression post-16 builds upon the progression identified above.

2. Trainees must be taught that pupils’ progress in mathematics depends upon them teaching their pupils.

3. In order to secure progress in pupils’ knowledge, skills and understanding of mathematical ideas and the relationship between them. Trainees must be taught:
   • to recognise the factors which may contribute to low levels of numeracy;
   • the importance of structuring learning in mathematics.

4. As part of all courses, trainees must be taught the importance of engaging all pupils’ interest in mathematics.

B. Effective teaching and assessment methods

6. Trainees should be taught how to teach mathematics contained in the pupils’ National Curriculum for mathematics, in particular:
   • how to teach number;
   • how to build on pupils’ understanding of number in teaching algebra, through:
i. understanding the nature of algebra in the pupils’ National Curriculum and knowing how to give sufficient emphasis to each of its three main components in their teaching:

• representing and generalising- generating algebraic expressions and equations, e.g. equations which represent quantitative problems; expressions of generality from geometric problems or numerical sequences; expressions of the rules governing situations;

• manipulating and transforming- maintaining equivalence and equality, e.g. simplifying algebraic equations; transforming between graphical and algebraic representations;

• modelling and proving using properties and structures, e.g. identifying constraints of a problem; anticipating and working backwards;

ii. helping pupils to progress from arithmetical approaches to algebraic approaches in solving problems, e.g. expressing relationships graphically and as functions;

iii. teaching and building upon, the foundations for early algebra, including:

• expressing relationships involving more than one operation; recognising symbols as a succinct way of expressing the rules;

• working with arithmetical operations and their inverses; manipulating formulae expressed in words;

• focusing on language as a means of expressing relationships precisely

iv. teaching the rules of algebraic notation and the manipulation of symbols and ensuring that pupils receive feedback on the way they use algebraic language through extensive class discussion and written work over time;

v. selecting contexts for solving algebraic problems which enable pupils to focus on the algebraic activity and not be distracted by the surrounding context;

vi. giving high priority to work on algebraic equivalence, so that pupils recognise equivalent statements;

vii. preparing pupils who have not covered the full KS4 programme of study post-14, for the algebra within A-level mathematics;

c. how to develop effective strategies for improving skills in numeracy for those pupils who achieve below the standard of mathematics expected for their age;

7. Trainees should be taught to plan mathematics teaching, identifying the knowledge, skills and understanding which pupils are to acquire and build on and, where appropriate, relating them to other areas of mathematics, including:

i. giving sufficient attention to oral and mental work;
ii. making effective use of purposeful enquiry within mathematics;
iii. consolidating and practising knowledge and skills on a regular basis;
iv. using mathematical resources effectively including:
   • how to use text books and individualised schemes;
   • how to apply criteria in order to determine whether or not a particular
     resource will support the achievement of identified teaching objectives;
   • knowledge of the mathematical resources available and their potential
     usefulness in achieving specific teaching objectives;
v. ensuring pupils solve a wide range of familiar and unfamiliar problems;
vi. ensuring pupils apply well-founded mathematical knowledge and
   understanding to new and real contexts and problems.

8. Trainees should be taught methods of teaching which secure pupils’ understanding and
   progress in mathematics, in particular how to:
a. teach whole classes, groups and individuals, by:
i. introducing lessons to capture pupils’ attention, outlining objectives and where
   appropriate, reviewing and drawing upon previous work;
ii. providing pace and variety and ensuring that the lesson follows well from one
   section to the next;
iii. making appropriate decisions about when and how to intervene constructively,
   e.g. to monitor progress; to inject pace and challenge into a lesson; to focus or
   develop mathematical thinking, as well as when pupils ask for help;
iv. working with pupils to draw together, organise and analyse their ideas and relate
   them to other mathematical ideas and methods;
v. ensuring that pupils consolidate and extend their understanding, e.g. by providing
   opportunities to practise new skills or to apply mathematical concepts in
   different contexts;
vi. summarizing and reviewing with pupils, during and towards the end of lessons,
   the mathematics that has been taught and that pupils should have learnt;
vii. using homework and revision constructively in mathematics for diagnosis,
    learning and consolidation, including giving study support, e.g. in after-school
    settings.
b. using effective interactive methods involving:
i. clear exposition, including:
   • giving clear instruction, e.g. how to construct a geometric figure; how to
     set out a formal proof;
• providing clear explanations, e.g. when teaching to resolve pupils’ errors and misconceptions; when explaining how to factorise an expression;

• demonstrating and illustrating mathematics using appropriate resources and visual displays, e.g. demonstrating random behaviour using a computer or tossing a coin; illustrating the effects of m in \( y = mx + c \) using a graphical calculator;

**ii** oral work with whole classes and groups which:

• secures the involvement of the whole class and enables pupils to contribute actively to mathematical discussion, allowing pupils to think an answer through before a response is demanded;

• requires pupils to provide clear mathematical explanations to teacher and to other pupils, as well as giving answers and encourages them to pose new questions and make conjectures;

• provides clear feedback, correcting mathematical mistakes and errors and enabling pupils’ mathematical progress to be monitored;

• includes skillfully framed open and closed, oral and written questions to:
  ■ foster pupils’ thinking and elicit answers from which pupils’ mathematical understanding can be judged, giving clear feedback to take pupils’ learning forward;
  ■ require pupils to clarify, justify and develop their mathematical ideas;

c. teaching pupils to think mathematically when solving a problem, through:

  i. interpreting the problem and formulating it in mathematical terms;

  ii. devising overall strategies for working towards a solution;

  iii. breaking the problem down into simpler stages and using suitable resources to make representations, e.g. graphs, diagrams, mental images, ICT statistical packages, geometrical models;

  iv. checking chains of reasoning and the reasonableness of solutions in the context of the original problem.

d. using information and communications technology effectively to support the teaching of mathematics.


10. Opportunities to practise: Trainees must be given opportunities to practise, through taught sessions or in the classroom, those methods and skills described above.

C. Trainees’ knowledge and understanding of mathematics
11. All trainees enter a course of initial training for secondary mathematics with:

- (for post graduate courses) a UK degree or equivalent and an educational background which provide the necessary foundation for work as a teacher of mathematics in the secondary phase.

Although all trainees will have had a substantial amount of mathematics in their previous education and those on postgraduate routes as part of their degree, different trainees will have covered different areas to different extents. For example, some trainees may have pursued studies which emphasised pure mathematics, while others may have academic backgrounds where the mathematics content was largely applied, e.g. engineering. For some, the narrowness of their background knowledge means that they may not feel confident about and competent in, the mathematics which they are required to teach, nor about the links which exist between different areas of mathematics. All trainees need to be aware of the strengths and weaknesses in their own subject knowledge, to analyse it against the pupils’ National Curriculum and examination syllabuses and to be aware of the gaps that they will need to fill during their training. Trainees need to be alert to the differences between having a secure knowledge of the subject and knowing how to teach it effectively.

12 Audit

13. Teaching mathematics post-16.
APPENDIX 12

System of Education in Turkey

General Background

Turkey lies at the junction of Europe and Asia and is situated at the northeast of the Mediterranean. The total area of Turkey is 815,000 square kilometers, of which 97 percent lies in Asia, and the rest in Europe. The boarders with neighboring countries are 2753 kilometers long and the total length of the coastline is 8333 kilometers. The coastal regions consist of the Black Sea, the Sea of Marmara, the Aegean, and the Mediterranean, while the inland regions consist of central, eastern, and southeastern Anatolia (Karakaya, 1995).

The Turkish Republic has a parliamentary system. With the proclamation of the Republic of Turkey in 1923, the first president, Kemal Ataturk, led the country in building a politically and economically independent, secular, and western social state. In 1924, religious schools were closed, the Latin alphabet was adopted, and all schools were placed under the control of the Ministry of National Education.

The population growth rate was 2.5 percent in 1994. Information is also available at http://gov.tr. about Turkey. Over the years, there have been structural changes in the composition of the society. Between 1935 and 1960 over three-fourths of Turkey's population was rural. Turkey's population is a young one. In urban areas approximately one-third and, in rural areas, two-fifths of the population is under 15. The high population growth rate is regarded as one of the most important factors negatively affecting schooling rates and the quality of education (Baykul, 1995). There has been a continuing population flow from rural areas to commercial centres such as Istanbul, Adana, Izmir, as well as to Ankara, the capital of Turkey. This has resulted in squatter areas around big cities. The population flow is heaviest from eastern and southeastern Anatolia to Western Anatolia. Centres which receive these migrants are being challenged by increasing problems of providing sufficient infrastructure, education, and health services. Cities where urbanization rates are high are faced with educational problems such as large classrooms and double shifts schools, and need more teachers.

The Turkish Latin Alphabet was adopted in 1928 to transcribe the Turkish Language. This system, where the correspondence between letters and sounds is very high, has contributed to increasing literacy rates. Although regional and gender differences exist, literacy rates have continued to rise. According to the official statistics (Census), by 1990, Turkey had achieved a 90% literacy rate in the 14-44 year old age group. A series of interventions, including the literacy campaign of 1982, helped increase the literacy rate from 72% in 1981 to 90% in 1990. Literacy rates are higher for men (96%) than for women (84%).
and higher in developed regions than in less-developed regions. The more developed a region, the less the gap between male and female literacy rates.

The Turkish Republic which had taken over the economic inheritance of the Ottoman Empire reflected a very different economic structure in 1923 than the beginning of the 1990s. The economy was agriculture based, the per capita income was low, and the labour force lacked sufficient education. Between 1923 and 1950 the main economic policy was statistic. This policy may best be characterized by a reluctance to accept foreign investment and keeping a highly protected domestic industry. Since 1950, however, a liberal economic policy became increasingly dominant. The policies for the 1990s reflect efforts to strengthen a competitive economy, encourage private sector investments, and support, and provide education for the social and economic well-being of the people.

Especially in the 1980s, the economy was marked by a high growth in agriculture, industry, and services. The structure of the labor force also changed considerably. The economy experienced an increase in the proportion of the population reported in industry and services. Thus, economic changes have created an increasing demand for vocational and technical education.

Employment rates vary according to educational level, gender, and geographical location. The highest rate of unemployment is found among secondary school graduates for both males and females. Non formal education which is designed to provide new skills and knowledge has been regarded as one of the possible solutions for unemployment, especially in less-developed regions.

4.2. Politics and the goals of the education system:

The Ministry of National Education has been responsible for the performance, supervision, and control of all educational services on behalf of the state since 1924. This constituted a major step in achieving unity in education. In 1973 the Fundamental Principles of National Education went into force. The general aims of the Principles are:

- to bring up citizens in the spirit of Turkish nationalism with Ataturk’s reforms and principles which are dedicated to preserving and developing the national, moral, human, and cultural values of the Turkish nation;
- to develop interest, ability, and talent in citizens by supplying the required knowledge;
- raising Turkish citizens who support social and cultural development in national unity.
The principles used for achieving these general goals are:

1. equality in education,
2. meeting individual and societal needs,
3. orientation,
4. continuity,
5. Ataturk's reforms,
6. secularism,
7. scientific norms in education,
8. coeducation,
9. planning,
10. cooperation between schools and family,
11. widespread education(Karakaya, 1995).

The year 1983 marked the beginning of a series of reorganization efforts within the education system. Such reorganization affected the structure of the education system as well as the organization of the Ministry of National Education.

4.3. The formal system of secondary and higher education

Secondary education covers general, vocational, and technical education institutions. The aim of secondary education is to prepare students for either higher education or for a vocation. Most institutions of secondary education are government schools which are free of charge while a small percentage are privately owned. The majority of secondary education institutions are coeducational. The school year in secondary education is 175 days, and the school day consist of 5 hours of instruction in general high schools and 6 hours of instruction in technical schools(Sanemoglu, 1991).

Higher education covers all educational institutions which provide at least two years of education over and above secondary education. These institutions consist of universities, higher schools, conservatories, and higher vocational schools. Only around 23% of students graduating from secondary education institutions are able to pursue higher education. Entrance to higher education institutions is governed by the centralized University Entrance Examination. In 1989, 824000 students sat the University Entrance Examination and only 193000 gained a place in an institution of higher education. Many students attend private courses which prepare students for the entrance examination.
Higher education is provided by the government. A small tuition fee is levied. Scholarships are provided for academically successful, but economically disadvantages students. Many universities offer graduate programs in various fields as well.

4.4. Administrative and supervisory structure and operation

The Ministry of National Education is responsible for planning, carrying out, following up, and supervising all educational services on behalf of the state.

The Ministry of National Education opens or grants permission to open all institutions of formal or informal education. Since 1984, the Ministry of National Education has transferred the appointment of teachers and their promotion to provincial governments.

The inspectorate is also under the control of the Ministry of National Education. In fact, the inspectorate is one way of ensuring that government supervision over education is continued. In 1990, there were 365 ministerial inspectors and 1763 primary education inspectors working under the ministry of National Education (Karakaya, 1995, Sanemoglu, 1991, Piskin, 1996).

The Board of Higher Education was established in 1981 as part of a reform movement in higher education. The planning, coordination, and control of higher education is the responsibility of the Council of Higher Education, which was also established under the Higher Education Law of 1981 (Karakaya, 1995, Sanemoglu, 1991, Piskin, 1996).

4.5. Supplying personnel for the education system

Efforts are being made to increase the number of teachers. Teacher education is performed by three types of institutions (Sanemoglu, 1991):

1. higher schools of education which prepare primary education teachers;
2. faculties of education preparing secondary education teachers;
3. faculties of science and literature offering programs in basic and social sciences.

As of 1990-91, the higher schools of education which used to offer a two-year undergraduate program now provide a four-year program. Thus, teacher training now requires a minimum of four-years of higher education.

All training courses run for four years. Teacher training programmes consist of (Sanemoglu, 1991):

- 62.5% subject matter knowledge;
- 12.5% general culture;
- 25% pedagogical matters.

The practice training takes place in schools near the training establishment. Upon completing their courses, new teachers are assigned to schools by the Ministry of National Education. They are on probation for one or two years depending on the results they
obtained at the end of their training. In-service training courses are offered by the In-service Training Department of the Ministry of National Education.

In 1989-1990 there were 6734 preschools, 224382 primary, 47239 secondary, and 105700 high school teachers working full-time in Turkey. In 1995 there were 532093 teachers in all levels of education, of which 9622 teachers were in pre-primary level, 22979 in primary schools, 69533 in general high schools, 70158 in vocational and technical education, 36778 in non formal education and 47267 in higher education(Karakaya,1995, Sanemoglu,1991, Piskin,1996).

Low teacher salaries have meant that the attractiveness of teaching as a career has declined. Salaries at all levels of education decreased between 1980 and 1988. A parallel decrease can also be observed in secondary education teacher salaries. The declining attractiveness of teaching as a career is reflected by the academic standards of students entering schools of education in 1986, none had grade-point averages above 80 over 100.

As the qualification requirements for teaching have increased over the years, in-service training programs and degree-completion programs have been offered. Furthermore, other in-service training programs offer training in computer skills, foreign languages, or other selected areas in order to upgrade the knowledge and skills of teachers at all levels.

4.6. Curriculum development and teaching methodology

There is a set curriculum used across the country. At the primary and secondary education level all students follow basically the same curriculum. There are also very few elective classes in secondary education. There are efforts underway to increase the flexibility of the curriculum and provide students with a choice of classes, based on their interests and abilities. However, such changes have not yet been implemented.

Textbooks that are used at all levels of education are either prepared or approved by the Ministry of National Education. Schools are required to choose books from the list of books approved by the Ministry.

Foreign languages are taught in secondary education and the intensity of training depends on the type of the school. Some schools place a higher emphasis on foreign language learning and the language of instruction is primarily the foreign language(specially English, French and German).

4.7. Major Reforms in the 1980s and 1990s

Many changes occurred in the education system in the 1980s. The most striking change was the extension of compulsory education from five to eight years. By 1991, this change was still in a transitional phase and eight-year primary education was only being
provided in some experimental classrooms. The whole system will switch to eight years' compulsory education only when facilities have been provided and teacher training completed.

At the higher education level the establishment of the Board of Higher Education (YOK) in 1981 marked one of the most important changes in the higher education system. This board was criticized for its efforts to standardize the higher education system in the country by centralizing all major academic decisions including faculty appointments. The fact that two-thirds of the board’s members were appointed by the Ministry of Education and by the president, and only one-third was elected by the universities produced outcries from the universities of political meddling. Nevertheless, the Board had some success in increasing the quality of education in some new universities founded in smaller cities in the country, and it generally increased the number of much-needed faculty members.

4.8. Major problems for the year 2000

The major obstacle for the education system in Turkey has been the steady population growth which has led to social demands which have not always been successfully met because of the increasing student population in the system. Thus, double-shift education, crowded classrooms, insufficient physical capacity, limitations of educational programs and educational materials, and most importantly, an insufficient number of teachers have become major problems facing the system of education in Turkey. Obviously, limited resources set aside for education constitute the common obstacle for all of these problems.

A further problem has been the growing tendency toward regional inequalities in education. Although providing equal educational opportunities for all is one of the important goals of national education, success rates for students from different geographical regions suggest that there have been diversions from this goal. Gender disparities in schooling rates also need to be addressed. It is in the interest of the whole society to meet the education demands of both boys and girls.

Restructuring of the education system in accordance to the social and economic demands of the community is needed and the Ministry of National Education has been showing some signs for these long-needed reforms.

The Entrance for ITT Courses in Turkey

In Turkey, the entrance for Turkish initial teacher education follows a completely different procedure from England. Teacher education is part of university education in Turkey. Teacher Education institutions, in common with departments, admit their students through university entrance examinations. The central examination for higher education
consists of two parts. The first is a selective test of general knowledge and abilities, the second is linked to the placements and is related to the study area. Both apply the multiple-choice method. The questions are closely pitched at a very demanding level (Sanemoglu, 1991, p296).

Last year the YOK changed the university entrance examination: this is now just one step. Apart from the entrance examination, there are no particular criteria or requirements for entry to initial teacher education. Candidates for the courses of teacher education can be accepted by universities on the basis of the scores which have been gained in the university entrance examination (Sanemoglu, 1991). Sanemoglu stated that the institutions of teacher education are responsible for course development. On the other hand, the YOK and the Ministry of Education now have responsibility for new changes in the teacher education system in Turkey. The YOK sends a set programme for teacher education to each institutions. Institutions are not given any responsibility to select their students for BEd. Course. On the other hand, the institutions have an opportunity to select their own students for PGCE course under the new regulations. This started in the 1998-1999 education year.

Routes to becoming a mathematics teacher in Turkey

There are two routes to becoming a mathematics teacher in Turkey: BEd. graduate maths subject degree or the one year course similar to the Post Graduate Certificate of Education (PGCE) course. Teacher trainees in course have to be inducted into the theory of classroom teaching, class management, teaching methods and techniques, made aware of all that is required of a classroom teacher, and enabled to recognize the issues for learning and teaching. Furthermore, they have to adapt their knowledge and perspective on mathematics and its teaching from that of recipient to that of provider.

All successful candidates on completing the course must apply to the Ministry of Education. The newly qualified teachers are appointed to teach in schools under the regulations of Ministry according to the vacancies that exist (Sanemoglu, 1991).

Turkey's general view of education

The Turkish educational system depends on the Ministry of Education's Law of 1739 and number 222 (Demirel, 1994). Primary and secondary education are compulsory and free of charge in public schools. These schools are under state control. There are 180 school days a year and five hours of instruction per day. There is a national curriculum. National programs are prepared by special expert committees appointed by the Ministry of National Education. The committee comprises subject matter experts and teachers from both
universities and schools. The draft curricula are reviewed by the Ministry and when approved, textbooks are written and introduced to the schools on an experimental basis to begin with. The textbooks used at all levels are either produced or approved by the Ministry. Parents representatives on governing bodies are elected annually. The governing bodies meet three times a year. They make some decisions such as: what kind of activity they have this year to raise money for the school. They have no power and have no influence over the National Curriculum.

Main Problems in Turkish Education

Unfortunately, Turkish schools face serious and real problems. Indeed, many of these problems are worse today than they were in earlier years, and many are more serious here than they are in other western countries. It is surprising that the Turkish Ministry of Education copes as well as it does in the face of myriad barriers and manages to educate so many students, and to such a high standards! But a national curriculum must be adapted to allow for different regional and cultural settings.

But saying this is one thing, and understanding the real problems faced by Turkish schools is something else. Unless they have the knowledge, well intentioned Turkish will be confused about what their schools can and cannot accomplish, and they may embrace ineffective or even inappropriate nostrums for improving education. But once they have able to design and support curriculum and programs that can truly improve schools, the real problems that Turkish Education faces still remain, for example social problems, income and wealth inequality, growth and stagnation of the economy, racial, ethnic, religious diversity, suburbs, ghettos and city centres, violence, the aging of the population(uncontrollable population growth, not enough school, physical capacity, teacher), money, and the restructuring of work(Duman,1991). Effective reforms must begin by taking these problems seriously. In addition, schools need to develop their own mechanism for support and development of the curriculum.

Turkey needs new curriculum planning and an opportunity to use new teaching methods. According to M.E.B.(1991; 1992), since all subjects are theoretical, most learning is not related to real life. Theory without application causes pupils to lose interest in school subjects particularly mathematics and science.

The existing political parties and the pressure groups have the greatest control of the curriculum in Turkey. Educational decisions are not made on a stable basis because every government has it own educational policy. For example the secondary maths curriculum is quite often changed in Turkey. Logic and Boolean algebra were taken out of the National
Curriculum by the new Ministry of Education four years ago (T.C. M.E.B. Tebligler Dergisi, 1995) but put it back in 1997.

Turkey needs stable, up-to-date educational reform and curriculum. But the YOK and Ministry of Education have started a new nation-wide project to improve the Turkish educational system in all areas including teacher development, and equipment.

It is necessary to distinguish between five decision making levels in Turkey:

- **regional**: National guidelines and syllabus by Ministry of Education and assessed by regional standards by inspectors from the Ministry. The Turkish inspector observes each teacher in the class. In Turkey, appraisal is on-going over the teacher's career. Every two years inspectors write reports appraising teachers on a numerical scale on five aspects: professional qualifications, organizational and administrative abilities, efficiency, social relationship, participation and conduct in out of school activities. They take into account a report written by an inspector about the teacher and headteacher. Inspectors use this report to improve teaching quality.
- **institutional(school)**: The whole curriculum worked out by the academic board (heads of board) of the school.
- **departmental**: Syllabus agreed by all teachers in departments and applied exactly, assessed at the end of the year (just on the examination paper).
- **individual(teacher in the class)**: Class teacher has to apply all the syllabus but in fact s/he is free to decide on lessons and appropriate teaching methods.

Control and guidance only are provided by Ministry of Education. Every 3-4 years, all schools and teachers are inspected. Since they just look at and evaluate visible evidence, curriculum evaluation is not considered, but formative and summative evaluation can be seen in the schools.
APPENDIX 13

MAIN CHARACTERISTICS OF THE TWO PROGRAMMES:

Institutions:

Teacher trainees have to be inducted into the theory of classroom teaching, class management, teaching methods and techniques, made aware of all that is required of a classroom teacher and enabled to recognize the issues for learning and teaching. Furthermore, they have to adapt their knowledge and perspective on mathematics and its teaching from that of recipient to that of provider.

The University of Leicester in England and The University of Balikesir in Turkey were chosen as a sample of teacher training institutions to find out how mathematics teacher trainees learn to teach in both countries.

The Leicester secondary mathematics teacher training course is 36 weeks. During the first two weeks, they go to the primary schools for preliminary school attachment for the two days of the 5th and 7th, and the 9th -10th weeks of the course, they go to the Mode A schools. From the 8th - 14th weeks of the course, they start to teach in these Mode A secondary schools. During the 15th -24th week of their course they go to the same secondary schools for two days a week and take courses at the University. After the Easter vacation, they go for 6 weeks to Mode B schools. During the 34th -35th and two days of the 36th weeks, they go back to Mode A schools(PGCE Secondary Course Mathematics Subject Handbook(1997/98). The University subject work in mathematics covers National Curriculum topics, teaching skills, assessment and examinations, departmental schemes, and developing forward plans; brainstorming over maths topics, lesson planning and evaluation, classroom observation and evaluation, producing teaching materials, communication with pupils, assessing and record keeping of pupils' progress, cross-curricular concerns including IT and dissemination of teaching ideas. In addition to tutor-led sessions, the University PGCE sessions include practical workshops, using video in the classroom, work with small pupil groups(11-16 city schools during weeks 3-4), and trainee-led sessions. The work on planning and evaluation is supported by material which is reproduced in the Course Handbook( Vlaeminke et al.1996, Price & Richardson 1995, 1996). During 15-24th, 33-36th weeks, trainees prepare forward planning for teaching specific mathematics topics, including the 16-19 age range(with trainee-led sessions). They also study equal opportunities, special needs, gender, culture; mathematics education: history and politics; cross-curricular themes and skills and the contribution of mathematics to education. During 33-36th weeks, they meet more ideas and resources for mathematics.
In Turkey, the teaching practice takes place in schools near the training establishment. Upon completing their courses, new teachers are assigned to schools by the Ministry of National Education. They are on probation for one or two years depending on the results they obtained at the end of their training.

At Balikesir, teacher trainees spend two days in school each week in their last year of the course. The training practice takes place in schools near the training establishment. However, Balikesir teacher trainees spend around 56 days in schools in their last year of the course, but Leicester teacher trainees spent only around 121 days in school during the PGCE course. The Leicester course includes a collaborative project in schools but the Balikesir training course does not. The Leicester teacher trainees gain experience of both primary and secondary schools. The Balikesir teacher trainees gain upper-primary or secondary school experience. Thus, there was a sufficient contrast between the two teacher training programmes for the research requirements.

A sharp contrast with the Balikesir Teacher training programme was sought and found in the Leicester Teacher Training Programme. The Leicester teacher education programme had a long tradition of partnership with local schools, based on notions of equality and the principle that ITT should be beneficial to the professional development of all trainees, tutors, co-tutors and pupils. The trainee has to spend 2/3 of time in schools according to Circular 4/98.

In Turkey, many universities in addition offer graduate programmes in various fields in teacher education. All BEd. training courses run for four years. Teacher training programmes consist of: 62.5% subject matter knowledge; 12.5% general culture; 25% pedagogical matters. Teacher trainees on courses have to be inducted into the theory of classroom teaching, class management, teaching methods and techniques, made aware of all that is required of a classroom teacher, and enabled to recognize the issues for learning and teaching. Furthermore, they have to adapt their knowledge and perspective on mathematics and its teaching from that of recipient to that of provider.