mathematics attainment in primary schools

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Introduction

In teaching young children mathematics, is it better to ***show and tell*** or encourage them to develop and apply the skills and strategies of ***finding out*** ...?

Since Cockcroft (1982) produced a list of six teaching styles, there has been much discussion concerning the teaching and learning of mathematics. The introduction of the National Curriculum has refocused this debate. The question of balance between teaching styles and approaches has become an important issue for all teachers. In primary school classrooms, teachers make professional judgements which help determine the quality and style of the teaching and learning experienced by a class of children. The preferred teaching strategies of classteachers may be rooted in their professional training, their continued professional development, or in established classroom practice which is perceived to be successful. The philosophy and educational approach of the school may also be influential, especially in creating professional networks which support teachers in differentiating mathematical content within a dynamic curriculum.

The opening question suggests that teachers have a simple choice between didactic and experiential styles of teaching. The evidence gathered from observations of mathematics teaching during this study suggests there is a variety of teaching practice, which is strongly influenced by contextual features. The level of debate within a school about teaching methods, curriculum innovation and pupil progress appears to underpin consistent levels of pupil attainment in mathematics. Current debate within schools needs to be seen in the light of new initiatives in teaching mathematics. The balance between whole-class teaching and groupwork is a controversial issue, with the experiment in Barking and Dagenham to the fore and a Government initiative, the National Numeracy Project, attempting to raise standards of performance with a structured approach.

This study reports on pupils' curricular experience and their levels of attainment in aspects of Number and Shape and Space and considers the context of teachers' decisions about curriculum style and organisation. Preliminary work began in 1992, and the investigation was completed during the academic year 1993–1994 using specially developed assessment tasks, administered on two occasions to establish measures of pupils' progress in both topics. A sample of Year 1 and Year 3 pupils from 18 schools, in nine LEAs, was structured to include pupils of higher-, middle- and lower-ability bands.

Visits to schools were made during the autumn and summer terms and information was gathered about the principles guiding the mathematics curriculum from a school's documentation, interviews with the headteacher and mathematics coordinator,

questionnaires completed by classteachers and observation of mathematics teaching. The assessment tasks were administered in a one-to-one situation and the pupils' mathematical attainment is reviewed in this report in relation to the mathematics curriculum of each school. A range of factors which appear to influence both the effectiveness and the quality of the mathematics curriculum observed in schools is also discussed. This approach invites the reader to reflect on the curricular and classroom management issues raised in this study and to relate these to their own views and experience of classroom practice. Discussion in the following chapters, of a variety of teacher strategies used in planning for continuity, progression, differentiation and monitoring within their school's mathematics teaching programme, encourages teachers to continue the process of review and development.

When children are engaged in learning mathematics, should the teacher intervene to explain, demonstrate a process, pose questions, seek information from the child, or stand back to observe pupils' interaction and the strategies used ...? Much of the teacher's skill in advancing a child's mathematical confidence and understanding centres on the intuitive decisions he or she makes in response to the child. Teacher confidence in using a range of styles or teaching approaches depending on circumstance appears to be central to pupils' success. For example, consider a primary school classroom where the teacher worked with Reception and Year 1 pupils. The classroom was spacious and well resourced, with the children, organised in three mixed ability groups, engaged in three work activities:

- Work in English, for both the Reception and Year 1 pupils.
- Mathematical investigation: weighing or balancing with non-standard materials, for Year 1 pupils only.
- Number concepts: exploring sets to 10, sequences to 100 and place value, for both the Reception and Year 1 pupils.

It was the first lesson after the morning break, and the lesson began with a class discussion of the work to be done. The language associated with mass/weight was explored and everyone joined in a number sequencing game. The children then collected their materials and began working confidently and appeared to be engaged by the activities. All materials and apparatus were easily accessible to the children.

Initially the teacher worked with the Year 1 group investigating weight. The children discussed, with the teacher, their ideas about heavier than or lighter than, and weighing and balancing; and compared the relative weights of a variety of objects. The technique of weighing with the balancing scale was demonstrated and that of adding or reducing

weight to achieve balance was also practised. Key words such as: 'weigh', 'weight', 'heavier', 'lighter', 'too many', 'too much', 'guess' and 'estimate' were used and tested by the children. After a short period working with their teacher, the children began working in pairs to investigate and record the weights of a variety of fruits and vegetables. Each pair chose their unit of measure and, once everyone had tried the activity, the teacher moved to teach the other groups, before returning later to observe, question and monitor the children's response. A feature of this activity was both the influence and activity of leaders and followers. With four pairs of children working in close proximity, there was some collaborative problem solving which helped everyone sort out the mechanics of the activity. The language explored with the teacher was used in context and in the pupils' recording.

The teacher's strategy with the number activity was to pick up questions as they arose, to demonstrate the use of Unifix, Cuisenaire or Dienes apparatus as appropriate, and also the use of a calculator to explore number patterns. Questioning and observation were limited. The tasks were differentiated for each child, and having a common theme engaged a wide age and ability range.

The teaching and learning styles used in this lesson will be familiar to many readers: demonstration, skills practice, direct teaching, questioning, problem solving, exploration, investigative activities, monitoring, observation and follow-up were among the techniques employed. The teacher's input was differentiated in the Weighing activity and the Number activities were well matched to pupil attainment. It was interesting that the teacher looked to identify opportunities to *test* each pupil's level of understanding in the number activities. Here the strategy was to ask the pupil to apply a concept in a different context. The teacher's evaluation of the two mathematics activities was interesting. By coincidence the school was introducing revised and updated teaching materials which had prompted some reassessment of class organisation and the teaching of groups and individuals. In both the Weighing and Number investigations, the teacher recognised that intervening to *'show or tell'* had sometimes prevented the children from formulating questions and going on to test their own ideas. It was clear from this teacher's reflective approach that a range of carefully structured and more open tasks would be employed to advance the children's mathematical understanding. This teacher demonstrated a confidence to step outside the publisher's scheme.

OFSTED (1994) suggests: 'It needs a particularly confident teacher to take children forward from where their understanding is strongest' (p. 21). The teacher who is confident and effective in teaching mathematics will have developed an insight to the sequence and progression of mathematical experience needed to develop children's skills

and mathematical understanding to the point where they may have confidence in using and applying those skills more widely. The teacher quoted above recognised different teaching techniques to be necessary for the stages of mathematical learning which were described as learning facts, practising skills and using and applying mathematical understanding.

Concurrent to this study, in their review of primary mathematics (OFSTED, 1994), HMI make three criticisms of mathematics teaching in primary schools:

> The first concerns the level of foundation skill in arithmetic, especially in mental arithmetic and numeracy which are established in primary schools. The second concerns the dominance of 'teaching schemes' which have been adopted wholesale by schools and which teachers find both constraining and difficult to break free from. The third concerns individualised learning programmes which place undue responsibility on pupils for controlling the pace and quality of their learning. Such schemes reduce the teacher to a classroom manager ... (p. 16).

These three criticisms form the backdrop to the following discussion of the impact of school practice on the levels of pupil attainment measured in this study. The outcomes invite schools and individual teachers to develop a reflective approach to curricular development and to pursue an agenda which takes account of the issues raised by this study.

Chapter 1

The Mathematics Attainment in Primary Schools Project

• Origins of the Research Project

Four themes influenced the design of the Mathematics Attainment in Primary Schools Project:

1. The dearth of recent detailed research evidence (apart from limited information provided by National Curriculum standard assessment tasks) giving a measure of children's progression in attainment in mathematics during key stage 1.

2. Recent international comparative studies of school attainment which had indicated that British pupils' level of attainment in Number was relatively below that in a number of other industrialised countries whilst relative attainment in Shape and Space was rather higher.

3. National and international studies of school effectiveness which have focused attention on the school's effect upon pupils' level of attainment.

4. Professional development initiatives which were being provided to enhance teachers' managerial and subject expertise, e.g. 20-day training courses for mathematics coordinators.

• Lack of Recent Research Evidence

The introduction of a National Curriculum for mathematics at key stages 1 and 2 in 1989 and 1990 established for the first time in England and Wales a common learning entitlement for all children attending maintained schools. The setting of five mathematics attainment targets in 1990 – Using and Applying Mathematics, Number, Algebra, Shape and Space and Handling Data, with introduction of the associated programmes of study – prompted schools to evaluate their mathematics teaching programmes. In many schools, this has resulted in a complete restructuring of the way in which mathematics was planned, taught and evaluated. This process emphasised the teachers' extended role[1] and stimulated debate about teaching strategies, classroom management and entitlements in mathematics. Attention became focused on whole-school provision through the

[1] including whole-school subject(s) responsibilities for curriculum development in addition to the traditional classteacher's role of planning and delivering a whole-class curriculum

development of mathematics policies and teaching schemes which provide for structured content, continuity, progression, differentiation and continuous assessment. The purpose was to improve professional systems, raise expectations and enhance levels of pupil attainment.

Teachers of key stage 1 pupils had been working with National Curriculum programmes of study for three years, so the mathematics teaching received by children commencing Year 3 in September 1993 had been based on national programmes throughout. This provided the rationale for selecting a sample of Year 1 and Year 3 pupils during the academic year 1993–1994 and for developing assessment activities which would establish a measure of pupils' progress in selected mathematical activities between the autumn and summer terms of that school year. Year 2 was left out because those children were involved in the standard assessment tasks. Year 3 is a transition year, which together with Year 7, HMI (OFSTED, 1994) had found to be lower in achievement than they should have been, and therefore Year 3 was thought to be of particular interest.

• National and International Comparative Studies of Pupil Attainment

For some time there has been a general concern about the teaching of mathematics in primary schools, raised in particular by comparisons with teaching and learning in other countries. The range of mathematical activities included in this study was influenced by the decision to use individually administered assessments for these age groups. The choice of mathematical topics was strongly influenced by research[2] which indicated British school children were performing less well in aspects of Number and Algebra than children in many other comparable school systems but appeared to attain higher levels of competence in shape and spatial awareness. The development of assessment tasks was also informed by knowledge of children's learning and insights into effective teaching approaches in mathematics with young children.[3] The National Curriculum has sought to emphasise the importance of the use and application of mathematical skills (including handling data) whilst HMI (OFSTED, 1994) report that teachers tend to pride themselves on the teaching of Number – it is the one aspect of teaching that they all think they do well (p. 21). A high proportion of teachers of nine-year-olds in this country were reported by Robitaille and Garden (1989) as saying they emphasise the teaching of number and

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[2] See Cresswell and Gubb (1987), Foxman (1992), Reynolds and Cuttance (1992).

[3] See Dickson *et al.* (1984), Haylock and Cockburn (1989), Skemp (1989) and Lumb (1987).

number operations. HMI (OFSTED, 1994), by contrast, state that pupils' understanding of mathematics is judged to be weak in half of all primary schools (p. 20).

These differing perceptions suggested the need for the MAPS project to focus on two areas of mathematical attainment: Number, where reported levels of attainment appear relatively weak, in contrast with teachers' own perceptions of the curriculum; and Shape and Space, where levels of attainment appear generally higher.

• School Effectiveness and Pupil Attainment

> Ten years ago few people seemed to think that schools made a difference to their pupils' levels of development – now the variation between schools in their effectiveness and efficiency is a matter of professional and public concern (Reynolds, 1990, p.163).

As Reynolds states, few people a decade ago were fully aware of the effects of school policies, organisation and practice on the quality of process and outcome in schooling. Knowledge of school effectiveness has been developed by Alexander (1992), Bennett *et al* (1976), Galton and Simon (1980), Mortimore *et al* (1988), Pollard (1985), Reynolds (1985) Tizard *et al* (1988) and Reynolds and Cuttance (1992). These and other writers inform us of some of the characteristics of effective schools. Mortimore *et al* (op. cit.) draw attention to substantial school effects, not upon attainment at a point in time but upon progress over time. His survey identified a number of primary schools, effective in both academic and social areas, that possessed the following characteristics:

- purposeful leadership of the staff by the head
- involvement of the deputy head
- involvement of teachers
- consistency among teachers
- a structured day
- intellectually challenging teaching
- a work-centred environment
- a limited focus within sessions
- maximum communication between teachers and pupils
- thorough record keeping
- parental involvement
- a positive climate (derived from Mortimore *et al* 1988, p.250).

The overall professional practice within a school has strong implications for the quality of teaching and pupils' learning outcomes. With this in mind, schools were questioned about their professional practice and curricular organisation for mathematics. Information on systems of planning and assessment was also collated from schools' documentation and teachers' curriculum plans.

• Professional Development

If, as HMI (OFSTED, 1994) suggest, some of the problems to do with the teaching of mathematics in primary schools appear to lie with the teacher's own confidence in mathematics (p.21), then the role of professional support and training is critical in the development of a greater understanding among teachers of how progress in learning Number occurs. This prompted us to take account of recent INSET provision in participating schools and to enquire of the influence of targeting of GEST funding and the effects of local management on training opportunities now that funding is devolved to individual schools.

• A General Framework for the MAPS Project

The four themes described above suggested a study extending over a full academic year would supply new and interesting data and provide new insights into pupil attainments in at least two main areas of mathematics. Number, and Shape and Space were chosen as the main focus for a set of specially developed assessment tasks. The two age groups chosen for the study (Year 1 and Year 3) had been taught using national programmes of study in mathematics but more significantly little recent research work had been carried out with such children to investigate how they learn or to measure pupils' progress.

Chapter 2

The MAPS Programme: Design and Development

• Objectives and Timescale

The project investigated pupils' mathematical performance in relation to the curriculum taught in their schools. The project schools were situated in nine LEAs and represented a variety of practice. The research was concerned with a range of mathematical concepts and skills but the focus was mainly on Number, and Shape and Space. The main objectives were:

- to investigate and contrast children's knowledge and understanding of different aspects of mathematics at two primary ages: Year 1 and Year 3
- to measure the progress made by children on these aspects of mathematics during the school year in which the research took place
- to study children's knowledge and understanding in relation to the curriculum provided by the project schools

In order to gain an indication of progression in mathematics, the assessment programme was carried out during the school year 1993–1994 and compared data from two assessment occasions for the sample children. As discussed in Chapter 5, the results provide more insights into aspects of young children's learning than have previously been obtained at this age. The project schools' mathematics policy was also examined, and key staff were interviewed about their role and the mathematics curriculum, and its delivery, and were observed in relation to the children studied. This aspect of the study is described in Chapter 3.

• The Partnership with LEAs and Schools

With the assistance of nine LEAs, a sample of schools representing a variety of practice in the teaching of mathematics was established. Five LEAs were large county-based authorities situated in the South, the Midlands and Eastern England. The other five LEAs were smaller metropolitan authorities situated in Greater London, the Midlands and Northern England. Two schools from each LEA were invited to participate in the project, and the criteria for their selection by LEA staff were:

- one school to represent well-developed, effective and consistent practice in the organisation and delivery of the mathematics curriculum
- a second school, by contrast, to represent less developed professional practice
- the selection of schools should also be as representative as possible in terms of location, catchment area, size and type for each LEA.

With assistance from LEA officers, schools were invited to participate, and were given full details of the research programme before agreeing to take part. In addition to information on the main outcomes of the research, schools were provided with feedback on their pupils' attainment and those features of the mathematics curriculum observed during the fieldwork.

After development of the assessments during 1992, the research phase commenced in autumn 1993 with 18 schools participating from nine LEAs.[1]

• The Pupil Sample

This research was concerned with establishing a measure of pupil progress in mathematics over time, so a pupil sample of the appropriate age groups was selected, taking into account gender, age and estimated attainment in mathematics. Schools assisted by providing seven children in a class or classes containing the appropriate age groups. From Year 1, and also Year 3, three pupils were selected to represent the average attainment band and two pupils each were selected as representative of higher and lower attainment bands, making a sample total of seven pupils for each year group. It is important to note that individual schools nominated pupils on the basis of *their* perceptions of pupils' ability and level of attainment. Schools were requested to rank order their pupils and, by over-representing the average attainment band as described above, the important average attainers were appropriately sampled.

Children across the 18 participating schools were drawn from 22 classes containing Year 1 pupils and 25 classes containing Year 3 pupils. This gave a total sample base of 119 Year 1 pupils and 119 Year 3 pupils.[2]

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[1] Ten LEAs were invited to participate but one was forced to withdraw due to unforeseen circumstances.

[2] Two of the participating schools, an infant and a junior school provided only one year group (seven pupils).

• The Assessment Tasks

The pupil tasks were administered in a one-to-one situation near the beginning of the school year and again near the end. They were designed to supply detailed information about an individual pupil's level of attainment, to provide some information about the methods or strategies employed in completing a task and to provide a measure of the progress made during the school year.

The project team looked at current styles of presenting tasks to young children and drew on a number of publications to inform the presentation and content of the assessment tasks.[3] The current version of the National Curriculum was examined and popular published mathematics schemes inspected. These tasks were then trialled in primary classrooms in 1992 and a group of primary teachers advised on the design, wording and refinement of the pupil tasks and also suggested areas to be included within the set of assessments. The final bank of assessment tasks consisted of:

- **Year 1 Tasks: Shape and Space**
    - Visualising 2D Representations of 3D Solids*
    - Naming and Recognising 2D Shapes
    - Understanding Movement and Direction
    - Rotation of 2D Shapes
    - Reflection of 2D Shapes*
- **Year 1 Tasks: Number**
    - Addition and Subtraction
    - Understanding Words Associated with Number
    - Calculations with Money*
    - Division and Multiplication
    - Mental Skills*

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[3] See Clemson and Clemson (1991), Duncan and Dunn (1988), Haylock and Cockburn (1989), Howard (1987), Skemp (1989), Lumb (1987).

- **Year 3 Tasks: Shape and Space**
    - Visualising 2D Representations of 3D Solids*
    - Reflections of 2D Shapes*
    - Making 2D Shapes
    - Area
    - Capacity
- **Year 3 Tasks: Number**
    - Calculations with Money*
    - Mental Skills*
    - Calculator Tasks
    - Understanding and Writing of Fractions

    (* tasks administered to both year groups)

• The Fieldwork Programme

Prior to the autumn and summer term fieldwork, a team of six research associates was recruited and trained in the administration of the assessment materials. The main criterion in selecting the team of research associates was previous teaching and research experience in relevant areas of education. The purpose of the training was to familiarise researchers with the aims of the research and to establish common procedures during administration of the tests. The scope and interpretation of questionnaires and interview schedules were discussed by the team, as a group, to establish an understanding of the issues to be addressed and ensure there was a consistent approach by each researcher. Further guidance was provided by an assessor's fieldwork manual developed to facilitate administration of the pupil assessments. Details of the assessment tasks are given in Appendix 1.

The fieldwork was divided into two phases. Four days were allocated for completion of the assessments, which were repeated during the autumn term (October) and the

summer term (May). Phase 2, in the summer, also included two additional days for classroom observation in each school.

During Phase 1, the autumn term, four days were spent in each school, administering assessment tasks to pupils in Year 1 and Year 3. In each school, the researcher also interviewed the children's classteacher and the school's mathematics coordinator about the mathematics curriculum. An outline agenda was provided and field notes made to describe the school and its organisation with particular reference to the mathematics curriculum. Four key areas were investigated: teaching mathematics, schemes of work, classroom resources and the teaching materials used.

The assessments were organised in two units for each pupil, each unit being administered to the pupil on a different day. The pupils were given positive encouragement to make responses during the assessments, but were given no indication as to whether or not they had made errors. This was particularly stressed in the training of the research associates. The units were:

- **Year 1 –Tasks: Unit 1**
    - Naming and Recognising 2D Shapes: *Shapes Picture* activity – five minutes
    - Addition and Subtraction: *Cubes in the Box* activity – ten minutes
    - Understanding Movement and Direction: *Frog Game* activity – seven minutes
    - Calculations with Money: *Coins* activity – eight minutes
    - Rotation of 2D Shapes: *Rotating Badges* activity – five minutes

    (approximate duration 35 minutes)
- **Year 1 Tasks: Unit 2**
    - Understanding words associated with Number: *Number Words* activity – six minutes
    - Visualising 2D Representations of 3D Solids: *Making Solids* activity – ten minutes
    - Division and Multiplication: *Bears* activity – eight minutes
    - Reflection of 2D Shapes - *Folding pictures* activity – eight minutes
    - Mental Skills - *Mental Sums* activity – eight minutes

    (approximate duration 40 minutes)

- **Year 3 Tasks: Unit 1**
    - Making 2D Shapes: *Drawing and measuring* activity – seven minutes
    - Calculations with Money: *Counting Coins* activity – eight minutes
    - Area: *Working out Areas* activity – eight minutes
    - Mental Skills: *Mental Sums* activity – eight minutes
    - Capacity: *Boxes to Fill* activity – nine minutes

    (approximate duration 40 minutes)
- **Year 3 Tasks: Unit 2**
    - Understanding and Writing of Fractions: *Working out Fractions* activity – 11 minutes
    - Reflections of 2D Shapes: *Folding pictures* activity – eight minutes
    - Calculator Tasks: *Using the Calculator* activity – 11 minutes
    - Visualising 2D Representations of 3D Solids: *Making Solids* activity – ten minutes

    (approximate duration 40 minutes)

During Phase 2 of the research, in the summer term, the assessments were again administered, and features of school organisation were investigated in greater detail. The overall management of the mathematics curriculum was discussed in interviews with the headteacher and mathematics coordinator. The framework for each interview was:

Interview with Headteacher

- Philosophy, policy and approach in teaching mathematics
- Linking mathematics policy to practice
  - schemes of work
  - planning the mathematics curriculum
- Issues in delivering mathematics teaching
  - resources
  - professional development
  - pedagogy
  - involvement of support staff and parents
- Resources
- Priorities for mathematics curriculum development

Interview with Mathematics Coordinator

- Role of mathematics coordinator:
  - activity and achievement
  - professional support
- Issues in delivering mathematics teaching:
  - resources
  - supporting colleagues' professional development:
  - pedagogy: from teaching scheme to practice
  - planning, differentiation, assessment and monitoring
- Focus of mathematics teaching time
- Expectations in mathematics

Researchers were given access to Year 1 and Year 3 classrooms, which enabled them to make judgements of the classteacher's perception of the mathematics curriculum in the school. Features of school organisation were discussed informally and classteachers completed a questionnaire which described the mathematics curriculum of the class. They were helped to fill in the questionnaire where required. Features covered included:

- time spent teaching mathematics
- content and organisation of mathematics lessons
- frequency of teaching activities related to Number, and Shape and Space
- use of calculators
- teaching approaches
- examples of lesson planning in solving problems with money and making 3D shapes with practical apparatus.

One day of the research programme in each school was spent observing mathematics lessons. Six lessons were observed in most schools, three in Year 1 and three in Year 3. Pupils who had completed mathematics assessments were tracked during lessons to observe classroom activity and provide evidence of differentiation in group or individual assignments. The observation schedule was arranged to cover:

1. Classroom features and organisation
2. Teaching style and lesson planning
3. Lesson content
4. Organisation of teaching and work groups
5. Evidence of differentiation and curricular match for target children
6. Type of learning activity and evidence of target pupils' mathematical experience
7. Use and availability of mathematical resources
8. Pupil attitudes to mathematics.

Fieldwork notes provided a description of classroom activity in relation to the areas listed above. The information gathered is discussed in detail in Chapter 3 which reports the characteristics of mathematics teaching observed in primary schools.

Chapter 3

The Primary School Classroom

During the second series of school visits (summer term 1994), 84 lessons were observed in 47 classrooms across 18 schools in the sample. The objective was to observe curricular practice and classroom organisation in the teaching of mathematics. Researchers tracked those pupils who had completed assessment tasks and observed the classroom organisation and teaching style adopted by classteachers.

Each researcher was provided with a classroom observation schedule which focused on general classroom issues and the mathematics experienced by individual pupils. Evidence of differentiation in lesson planning and the match of task to pupil was noted. Subsequent analysis of field notes was organised in a framework of ten descriptors: classroom organisation, teaching style, pupil grouping, pupils at work, learning, lesson content, lesson time, resources, differentiation and professional issues.

The descriptors provide the section headings for the following discussion of some features of the mathematics teaching observed in the sample of schools participating in the work of the project.

• Classroom Organisation

All the classrooms visited were arranged to facilitate children working in groups at tables or desks. Most of the sample schools reflected good standards in the display of children's work but the display of children's work in mathematics was limited. Examples of graphs and tessellations were seen in half the classrooms visited. However the context for much of this work was not seen as mathematical by most classteachers. One school stood out in having several interactive mathematical displays covering both key stage 1 and key stage 2. The school also featured an active mathematics trail. The mathematics coordinator and headteacher of this school had worked hard to develop teachers' expertise in mathematics and placed great emphasis on the use and application of mathematical skills in the context of everyday experience.

In the sample of schools, a preference for subject-specific teaching of mathematics was noted. In seven of the schools studied, it was policy to teach mathematics within an integrated cross-curricular programme but much of the teaching here was also subject-specific. The difference was evident in the use and application of mathematical skills and concepts across broad curricular topics. Recording and

measuring done by Year 3 children in an investigation of growth and decay in the natural world is one example.

• Teaching Styles

All teachers in the sample adopted a range of teaching styles including class, group and individual approaches. The difference was the balance between styles, with some teachers preferring to class teach whilst a majority concentrated on teaching small groups. All teachers worked with individuals but there was a contrast between those teachers who moved proactively among the children and those who waited to react to children's difficulties or questions.

Observation and questioning techniques were most often demonstrated by teachers who expressed professional confidence about teaching mathematics. The prevailing school culture and philosophy exerted strong influence on patterns of teaching. Within the classroom, pupils' attitudes, their level of interest and motivation affected the ethos of learning. The effectiveness of working routines, and the care and control exercised, influenced the teacher's ability to provide quality time for individuals whilst teaching.

In a minority of the classrooms visited, a disproportionate amount of time was absorbed by behavioural issues. The mean class size for the sample classes was 28.5, but even in the most effective classrooms it was unusual to observe sustained pupil teacher interaction lasting more than half a minute. A preferred teaching style was to teach a mathematical concept to a group of five or six pupils. Such teaching sessions typically lasted from five to ten minutes and would extend to follow-up later in the lesson. The success of this approach depended on good classroom organisation where several groups of children, working independently, could be relied upon to work without teacher input for a part of the lesson. Seventy-five per cent of teachers favoured moving between groups after teaching a target group. These teachers were proactive in seeking out pupils' difficulties and in a few classrooms teachers posed further challenges or problems to extend learning. Another feature of effective teaching observed was the time given to providing feedback on the pupils' performance.

The remaining 25 per cent of teachers adopted a teacher-centred approach with children moving to the teacher to seek help. Eight classrooms where this latter approach was observed were associated with a restricted mathematics curriculum which concentrated on computational exercises with little practical or investigative work in any areas of mathematics.

Whole-class teaching was used in 20 per cent of lessons observed in the sample schools, sometimes as a key lesson to introduce a new concept or process but most frequently to draw together class learning in discussion and to practise mental skills. Teachers used individual or group teaching methods for the majority of lesson time in 70 per cent of the lessons observed. In nine classes, additional adults, for example teachers providing special needs support or parents helping out, were working with pupils. This represented ten per cent of lessons observed by the researchers.

• Pupil Grouping

Teachers in the sample grouped pupils for mathematics lessons using three criteria:

- mixed ability (i.e. friendship or year group)
- general ability/attainment (high, average or low, assessed across the curriculum)
- mathematical ability/attainment (based on progress in mathematics).

In 36 per cent of lessons observed, pupils were grouped by mixed ability, 47 per cent by general ability and 17 per cent by mathematical attainment. Most teachers indicated they varied the groupings for different mathematical topics, most frequently changing from mixed- to general-ability grouping. The general-ability groups were usually maintained for other lessons. In six of the schools (14 classes), pupils were grouped specifically for mathematics according to attainment. In a few cases, teachers varied these groups according to the aspect of mathematics being taught. For example, two teachers provided detailed profiles of teaching groups in their teaching plan with topics and materials specified for individuals. This level of detail in planning the teaching programme was rare in the sample schools.

• Pupils at Work

The researchers reported similar amounts of lesson time spent by pupils on individual tasks and working with a partner or in a group. Evidence of collaborative or investigative work was noted in 25 per cent of lessons. Pupils often switched their work mode during lessons and their level of engagement was observed to be highest where the work was presented imaginatively and pupils were involved in working with the teacher for part of the lesson. Some repetitive tasks appeared less challenging and pupils skilfully employed work avoidance strategies like queuing, losing things and chattering.

• Learning

New learning, rather than consolidation, was a feature of 32 per cent of the lessons observed, most frequently in short teaching sessions directed at small groups. Forty-three per cent of lessons consisted of skills practice or reinforcement activities, and in 25 per cent of lessons, pupils were involved in Using and Applying mathematics. In one classroom, a database computer programme was introduced to a group of Year 3 pupils. The problem set was to devise a questionnaire for the class which would provide data about siblings, with the children having to specify the data fields required. This was part of an extended topic where pupils explored the use of databases, beginning with a visit to the school office.

Classroom organisation and the availability of mathematical resources within the school were associated with pupils' level of task engagement in the classrooms observed. Where, for example, the teacher included open-ended activities to encourage the use and application of mathematics in context, pupils appeared more confident in handling mathematical ideas. This was illustrated by the teaching of money in three schools, where pupils were required to use *real* coins and *actual* prices in a classroom supermarket, post office or newsagent. These activities extended learning beyond the range of exercises offered by the published mathematics scheme materials and were usually associated with a broad curriculum topic which included visiting a retail outlet.

In those classrooms where pupils were encouraged to work independently, it was noted that there was increased opportunity for them to think creatively, to question and apply mathematical ideas in context.

• Lesson Content

Teachers were asked about the focus of each mathematics lesson observed and, where available, reference was made to teaching plans. The content of the mathematics teaching was assessed in relation to the (then) four National Curriculum content attainment targets. A summary of the perception of classteachers for the whole class and of researchers for those children observed is set out in Table 3.1.

Table 3.1: Mean for observed and planned lesson content

Lesson content	Year 1 and Year 3	Number	Algebra	Shape and Space	Handling Data
Observed lesson content	84 lessons	47%	14%	26%	13%
Planned teaching content	38 teachers	51%	12%	24%	13%

There was general agreement between the observed lesson content and the classteacher's planning. The strong emphasis on teaching Number inevitably meant less time was devoted to Algebra, Shape and Space and Handling Data. Many teachers perceived Algebra and Handling Data as an extension of Number work, which meant 75 per cent of the mathematics curriculum could be Number-related. This left just 25 per cent for teaching the concepts of Shape and Space.

This impression of a mathematics curriculum dominated by Number operations could have been misleading because of the relatively small number of classroom observations made during a restricted time period, the summer term. To check on this, the evidence provided by classteachers in questionnaire returns was examined. Classteachers were asked to describe the mathematics curriculum taught over a full school year in relation to content, teaching style, time spent teaching mathematics, organisation and planning. The evidence summarised in Table 3.2 describes a subject-specific teaching context with ten per cent less time spent Using and Applying Mathematics in a cross-curricular context in Year 3 than was the case with Year 1. The percentages of teaching time recorded by teachers as relating to Number, Algebra, Shape and Space and Handling Data were almost identical to that observed in the classroom. This suggests the lessons observed were representative of general classroom practice in the sample of schools participating in the project.

Table 3.2: Summary of the context and content of mathematics teaching

	Context		Content			
	Subject-specific	**Cross-curricular**	**Number**	**Algebra**	**Shape and Space**	**Handling Data**
Y1 Mean (SD) (22 classes)	72% (22%)	28% (22%)	53% (12%)	12% (5%)	23% (7%)	14% (6%)
Y3 Mean (SD) (25 classes)	82% (12%)	18% (12%)	49% (12%)	13% (5%)	25% (11%)	13% (6%)

• Lesson Time

There was wide variation between schools in the proportion of lesson time spent in teaching mathematics. For Year 1, the proportion ranged from 12 per cent of lesson time (150 minutes per week) in two schools to 32 per cent of lesson time (420 minutes per week), again in two schools. The mean for Year 1 classes was 24 per cent (311 minutes per week).

In Year 3 classes, the proportion of time ranged from 18 per cent of lesson time (240 minutes per week) in two schools to 30 per cent (400 minutes per week) in one school. The mean for Year 3 classes was 23 per cent of lesson time (316 minutes per week). In the majority of classrooms, between one-fifth and one-quarter of the total lesson time was spent in teaching mathematics.

• Resources

The majority of mathematics lessons observed took place in classrooms which were judged to be well resourced for teaching mathematics. Classrooms in five schools were rated by the researchers as poorly resourced and in some cases there was tremendous variation between classrooms within the same school. Much depended on the overall organisation of a school's mathematical resources and whether a whole-school, or a class-based, resources policy existed. Resourcing individual classrooms was often associated with large variations within the same school. An open, whole-school view of resourcing was associated with the work of influential mathematics coordinators. Professional discussion of the teaching of mathematics involved an audit of resources supported by professional development and a purchasing policy. The largest area of expenditure was on mathematics textbooks, workcards and

photocopiable teaching materials. The involvement of teachers in decision making about teaching and resource issues had produced interesting arrangements in some schools, to ensure the maximum availability of a wide range of mathematical resources. Features of school organisation included:

- teachers' library of mathematics reference books and articles
- resource books linked to teaching schemes
- a bank of pupil resources (text books, worksheets, etc.)
- a bank of practical apparatus and materials (often in a resources area or cupboard)
- teaching resource collections, e.g. materials and apparatus to support work on a mathematical topic such as measurement.

In a few of the sample schools, dedicated mathematics resource rooms were established and collections of teaching materials linked to specific mathematical topics were available to teachers. In some cases, the use of such resources was tightly timetabled. This type of arrangement, whilst ensuring an equitable distribution of materials, caused teachers to express reservations about restricting children's access to the equipment required for a particular topic in mathematics to, say, one half-term.

Seventy-six per cent of lessons observed were judged to be well resourced with the children using materials appropriately. In 40 per cent of lessons, mathematics resources were well organised and readily accessible to the children, who used these materials independently. Confidence in the use of materials and apparatus was associated with high levels of interest and involvement in mathematics tasks. In many lessons, however, a substantial amount of teaching time, up to 60 per cent, was absorbed in allocating and collecting apparatus, worksheets, etc.

• Differentiation

Teachers in the sample schools were observed to use four main strategies to differentiate mathematics teaching and learning:

- by published materials or worksheets
- by outcome
- by teaching input
- by matching task content to group or individual (including the structuring of tasks to take account of reading and language ability).

During 84 classroom observations, the pupils who had completed the assessments were observed working on mathematical assignments, usually for a full lesson. By relating the teaching and presentation of pupils' mathematics assignments to the four strategies for differentiation given above, a balanced picture emerged. In 28 per cent of lessons tasks were differentiated by a published scheme, 20 per cent by outcome, 31 per cent by direct teaching and 21 per cent by task design. There was considerable crossover between strategies during some lessons. The classification used here attempts to reflect the predominant strategy used by individual teachers to differentiate mathematics tasks for the observed pupil sample.

• Professional Issues

The researchers judged there to be an over-reliance on the use of a core mathematics scheme in most schools. In some schools, the mathematics teaching depended solely on one published scheme. Headteachers and mathematics coordinators were often critical of the way in which schemes were used and, in effect, this depended on the skills and insights of the classteacher and the strength of the school's influence on professional and curriculum development.

In the sample of lessons observed, the researchers examined the match of mathematics teaching and of task to child. In 53 per cent of lessons, the match of work to child was assessed to be reasonable, and in 47 per cent, it was classified as good. Where teachers showed evidence of detailed lesson planning and appeared confident about the sequence of learning to develop, this was associated with a better match between work and child.

Chapter 4

Analysis of Pupils' Attainment

The assessments outlined in Chapter 2, which are shown in Appendix 1, were administered to seven pupils in each school, three from the average attainment band in the school, two from the highest attainment band and three from the lowest band. The assessments were marked using exactly the same marking scheme for both the autumn and summer administrations, and thus progress made between these two points could be measured on a consistent basis.

Each activity consisted of a series of questions, each of which could be scored as correct or incorrect. The questions were devised in a criterion-referenced manner, each one testing a particular criterion, an aspect of the topic concerned. In the 'Coins' task, for example, the criteria included counting money, paying set amounts of money and recognising if change was needed and, if so, how much. Different questions within the activity required pupils to deal with increasingly larger amounts of money, thus giving criteria involving the same basic task but with increasing complexity. Success on these criteria has been used to calculate scores for each topic in the analyses which follow.

The marking scheme identified both pupils' correct and incorrect responses and, where appropriate, a range of different correct responses. In addition, common errors were recorded. Information was also collected about the strategies used by pupils in answering particular questions.

• Overall Analysis: Criteria Correct

The initial analysis of data focused on the success rate for each criterion (question). The tasks are listed below, and the list indicates those tasks used with both Y1 and Y3 pupils with an asterisk For each task, the Number of assessment criteria given is the total of those scored as correct or incorrect; data relating to the strategy used are excluded.

Results are arranged by tasks and grouped for Year 1 and Year 3:

Year 1: Shape and Space Tasks

S1	Visualising 2D Representations of 3D Solids*	(4 criteria)
S2	Naming and Recognising 2D Shapes	(16 criteria)
S3	Understanding Movement and Direction	(24 criteria)
S4	Rotation of 2D Shapes	(4 criteria)
S5	Reflection of 2D Shapes*	(12 criteria)

Number Tasks

N1	Addition and Subtraction	(22 criteria)
N2	Understanding Words Associated with Number	(14 criteria)
N3	Calculations with Money*	(12 criteria)
N4	Division and Multiplication	(10 criteria)
N5	Mental Skills*	(14 criteria)

Year 3: Shape and Space Tasks

S1	Visualising 2D Representations of 3D Solids*	(4 criteria)
S5	Reflection of 2D Shapes*	(12 criteria)
S6	Making 2D Shapes	(10 criteria)
S7	Area	(9 criteria)
S8	Capacity	(8 criteria)

Number Tasks

N3	Calculations with Money*	(12 criteria)
N5	Mental Skills*	(14 criteria)
N6	Calculator Tasks	(20 criteria)
N7	Understanding and Writing of Fractions	(17 criteria)

For Year 1 and Year 3 pupils, the mean percentages of criteria correct in the autumn and summer assessment are illustrated in Figures 4.1 and 4.2. Shape and Space tasks are shown first, followed by Number tasks. Individual tasks are labelled using the task references given above.

Figure 4.1:

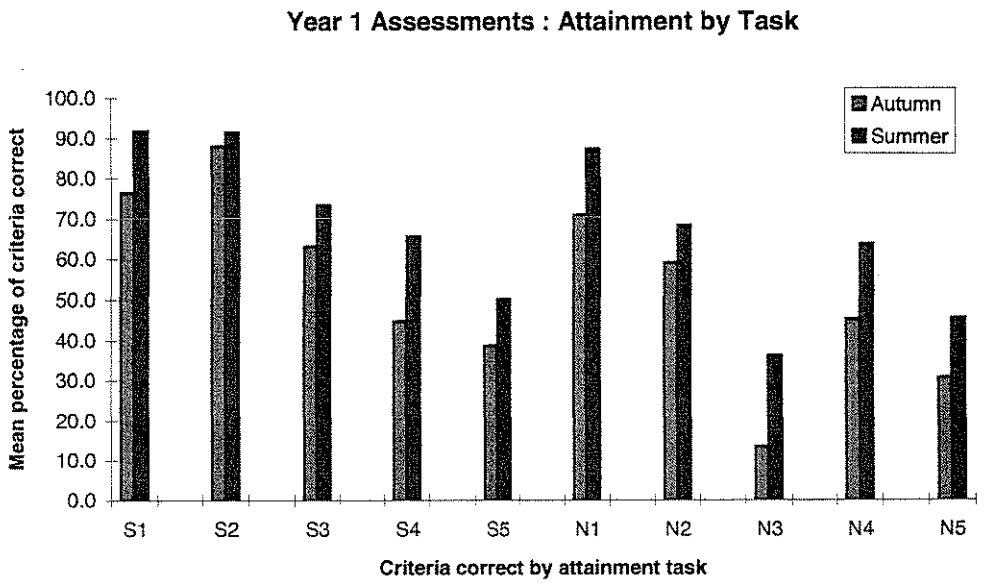
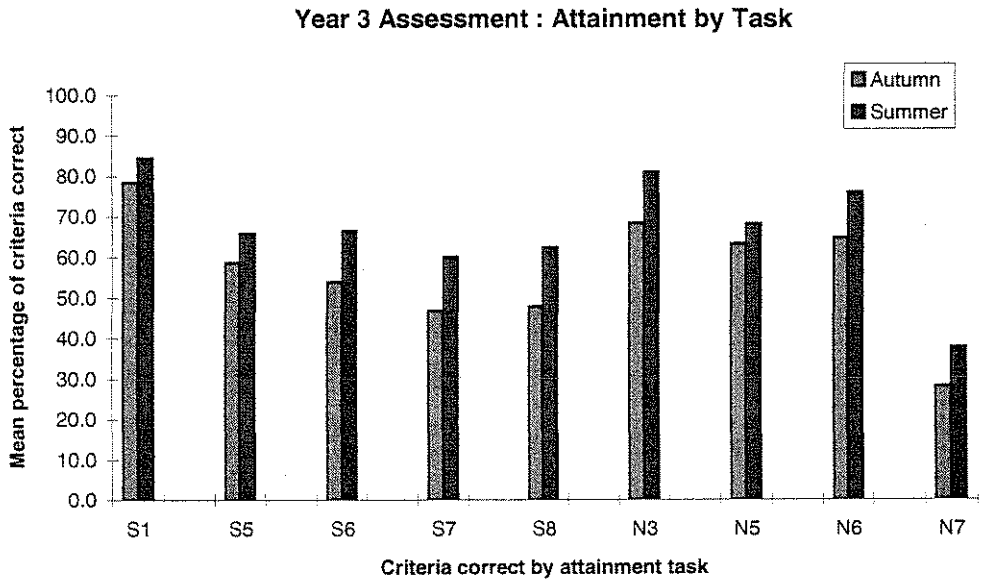


Figure 4.2:



For Year 1 pupils, the mean proportion of criteria correct in the autumn assessment was 53 per cent, while this increased to 67 per cent at the summer assessment. The results for Year 1 show higher success rates for Shape and Space tasks – 56 per cent at the autumn assessment and 70 per cent at the summer assessment – than for Number tasks – 44 per cent in the autumn and 60 per cent in the summer.

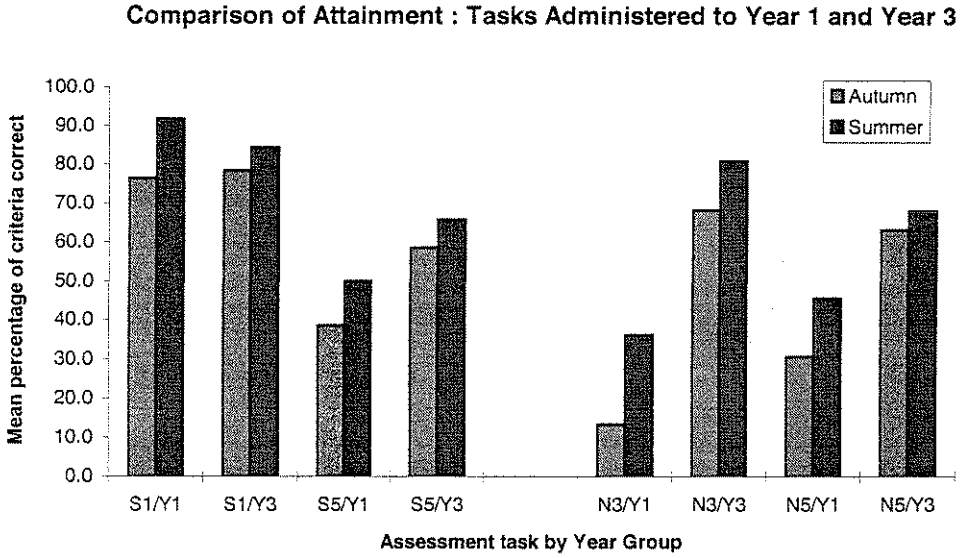
For Year 3 the mean proportion of criteria correct was 57 per cent in the autumn and 67 per cent in the summer. The profile of results for Year 3, illustrated in Figure 4.2, shows less variation between Number and Shape and Space tasks than was the case with Year 1.

Although the results for Year 3 showed less marked differences between Number and Shape and Space than for Year 1, there were still large variations between tasks. Year 3 pupils recorded their lowest success rate for task N7, Understanding and Writing of Fractions, and their highest success rates in task S1, Visualising 2D Representations of 3D Solids, and task N3, Calculations with Money.

For Year 3 pupils, the mean proportions of criteria correct for Shape and Space and Number were 57 per cent and 56 per cent respectively in the autumn. In the summer, the comparable figures were 68 per cent and 66 per cent.

The performance of both year groups on the four tasks, S1, S5, N3 and N5, which were common to the assessment packages for Year 1 and Year 3 is compared in Figure 4.3. Results for the autumn and summer are shown.

Figure 4.3:



Year 1 pupils recorded an increase of 23 per cent in the number of criteria correct in task N3 (Calculations with Money), while Year 3 showed a gain of 13 per cent. For the Shape and Space activity S1 (Visualising 2D Representations of 3D Solids), the mean for criteria correct in Year 3 was seven per cent below that for Year 1 in the summer term assessment. This may well be explained by changes in curricular

practice, there being less emphasis on practical activities in Shape and Space with Year 3 pupils in many classrooms, or possibly by an over-confidence shown by average and above-average pupils in completing this activity.

To enable the increase in success between the autumn and the summer by the two year groups to be compared for different tasks, Figures 4.4 and 4.5 re-present the information given in Figure 4.3 concentrating on the difference in performance – the gain. Greater gains are apparent for Year 1 pupils, particularly in Number tasks, while the gain for Year 3 pupils was more consistent.

Figure 4.4:

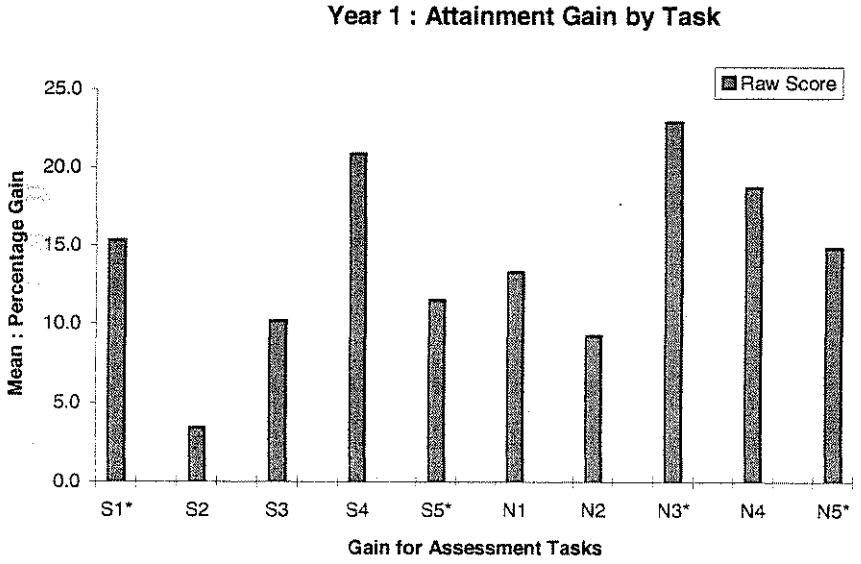
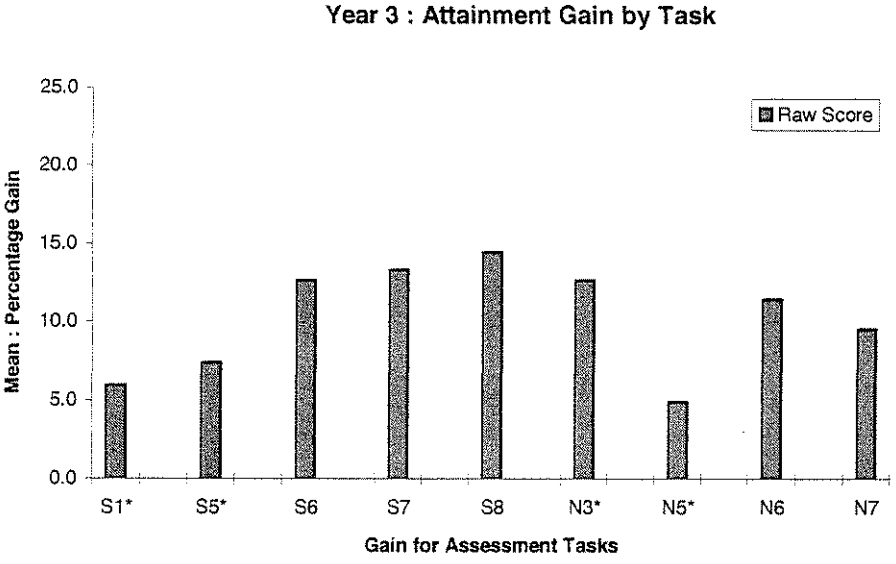


Figure 4.5:



The Figures above show the simple gain in criteria correct, in percentage points, between summer and autumn. This percentage point gain, however, takes no account of how successful pupils were in the autumn – what the baseline level of performance was at the start of the year. To make allowance for this, a second measure of performance gain has been calculated. This second measure has been produced by expressing the percentage point gain as a percentage of the autumn baseline score. Table 4.1 compares the percentage point gain with the percentage of baseline gain. The last column clearly shows that the amount of progress made by Year 1 pupils in Number was large in the light of the relatively low starting point in the autumn.

Table 4.1: Mean for Year 1 and Year 3 pupils' gain in attainment

	Percentage point gain	**Baseline gain**
Year 1	(summer % – autumn %)	(summer % – autumn % as a % of autumn Score)
Shape and Space tasks	14%	25%
Number tasks	16%	36%
Overall	14%	26%
Year 3		
Shape and Space tasks	11%	19%
Number tasks	10%	18%
Overall	10%	18%

- **Overall Analysis: Success Rates by Attainment Band**

When teachers were asked to select seven pupils from Year 1 and seven pupils from Year 3 for the research programme, they were also asked to group pupils by attainment: Band 1 – high attainment (two pupils); Band 2 – average attainment (three pupils); and Band 3 – low attainment (two pupils). To enable performance of pupils of different attainment in different schools to be compared on a similar basis, the analyses reported here maintain the 2 : 3 : 2 ratio between the three bands but the allocation of pupils to bands has been made on a statistical basis using the whole

sample as a base. Each school's allocation of pupils to bands has therefore been used as a stratifying device for sampling within school.

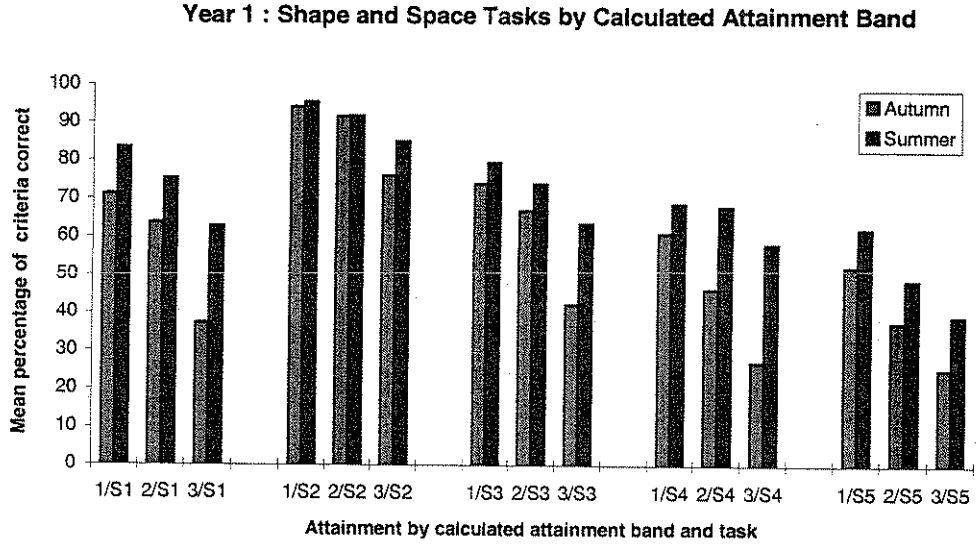
Since the banding used here relates to the whole sample, it would be expected that this would differ from the banding used by individual schools. In practice, for 70 per cent of Year 1 pupils there was agreement at the autumn assessment between schools' attainment bands and the calculated bands based on the whole sample. For Year 3, the figure was 64 per cent.

Using this calculated banding, the success rates for the different attainment bands are shown in Figures 4.6 and 4.7 for Year 1 pupils. To assist interpretation, individual tasks are identified by the task reference numbers used previously. Tasks are shown in a consistent order: Shape and Space followed by Number and arranged by year group and calculated attainment band. The first pair of columns in each Figure are for Band 1, the highest attainers, the second pair for Band 2, the middle band, and the third pair for Band 3, the lowest attainers.

The common pattern is that the degree of progress made by Band 1 and Band 2 pupils is similar. Similar is used here where the difference in performance gain between attainment bands was not significant at the five per cent level. A difference is therefore only regarded as significant if there is a less than one in 20 chance that this difference arose by chance. The tables included in Figures 4.6 and 4.7 show where significant differences were found between attainment bands and their direction. In Figure 4.6, below, there were no significant differences in gain between the attainment bands for tasks S1, S2 and S5. For task S3, Band 3 pupils, the lowest attainers, made significantly more progress than either Band 1 or Band 2. For task S4, Band 1 pupils, the highest attainers, made significantly less progress than Bands 2 and 3.

In Figure 4.6 the Shape and Space tasks show a fairly uniform pattern of gain in attainment across the bands. This is most clearly shown by task S1 (Visualising 2D Representations of 3D solids) and the pattern is repeated in task S5 (Reflection of 2D Shapes). The exception is S2 (Naming and Recognising 2D Shapes) where attainment Bands 1 and 2 recorded a success rate above 90 per cent and Band 3 above 75 per cent at the autumn assessment. The 'ceiling effect' within the assessment meant there was little scope for improvement, except in Band 3.

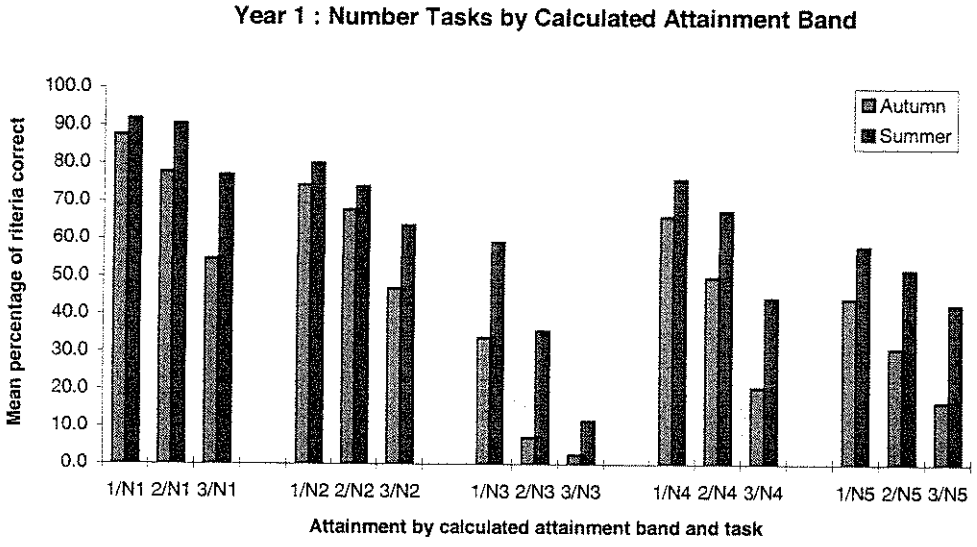
Figure 4.6:



Significant differences at the five per cent level

	Task S1		Task S2		Task S3		Task S4		Task S5	
	Band 1	Band 2	Band 1	Band 2	Band 1	Band 2	Band 1	Band 2	Band 1	Band 2
Band 2							>			
Band 3					>	>	>			

Figure 4.7:



Significant differences at the five per cent level

	Task N1		Task N2		Task N3		Task N4		Task N5	
	Band 1	Band 2	Band 1	Band 2	Band 1	Band 2	Band 1	Band 2	Band 1	Band 2
Band 2	>									
Band 3	>	>	>	>	<	<	>			

Tasks S4 (Rotation of 2D Shapes) and S5 (Reflection of 2D Shapes) recorded the lowest overall success rates, suggesting pupils found it difficult to visualise mentally a change process. This was also shown by the relatively low baseline of attainment for Band 3 in task S1 (Understanding Movement and Direction), where pupils were required to listen to instructions and plot the journey of a model frog on a grid. In general, the Shape and Space tasks which were relatively easy in the autumn assessment showed a levelling out of performance between the bands in the summer assessment.

The pattern of attainment gain in Number tasks for Year 1 pupils, shown in Figure 4.7, shows wide variation between bands and between tasks. Pupils achieved high overall success rates in task N1, Addition and Subtraction, and task N2, Understanding Words Associated with Number. There were consistent gains in attainment for Bands 2 and 3 in task N1 and for all three bands in task N2. Band 1 pupils had limited scope for improvement in task N1. The tasks recording the lowest overall success rates were tasks N3, Calculations with Money and N5, Mental Skills: however, significant overall improvements were made in these tasks. In tasks N1, N4 and N5, Band 3 made gains in attainment of around 25 per cent. Band 1 and Band 2 pupils recorded similar gains of 25 and 28 per cent in task N3, Calculations with Money, with Band 3 pupils making significantly less progress from a very low starting point. Again the levelling out of performance between bands in the summer assessment was evident for tasks found relatively easy in the autumn.

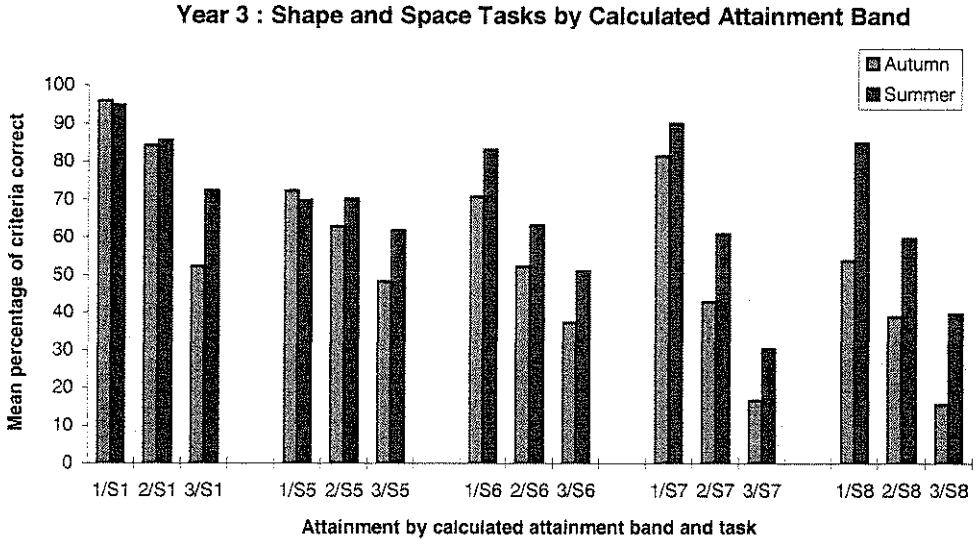
The previous Figures show the overall pattern of gain for each Year 1 attainment band and whether particular bands made more progress than others. To complete the information on whether significant progress was made, Table 4.2 summarises whether or not the summer performance by each attainment band on each task was significantly better (at the five per cent level) than the autumn performance. The only cases where gains were not made, task S2 and Band 1 pupils on task S4, can largely be accounted for by 'ceiling effects'.

Table 4.2: Significant gains in attainment at the five per cent level, Year 1 pupils

Year 1 tasks	Attainment Band 1	Attainment Band 2	Attainment Band 3
Task S1	*	*	*
Task S2			
Task S3	*	*	*
Task S4		*	*
Task S5	*	*	*
Task N1	*	*	*
Task N2	*	*	*
Task N3	*	*	*
Task N4	*	*	*
Task N5	*	*	*

Figures 4.8 and 4.9 show patterns of attainment gain for Year 3 pupils which suggest the gains made by the lower attainment bands were often similar. Ceiling effects are evident in task S1, Visualising 2D Representations of 3D Solids, and task N3, Calculations with Money, where Band 1 pupils had little scope for improvement.

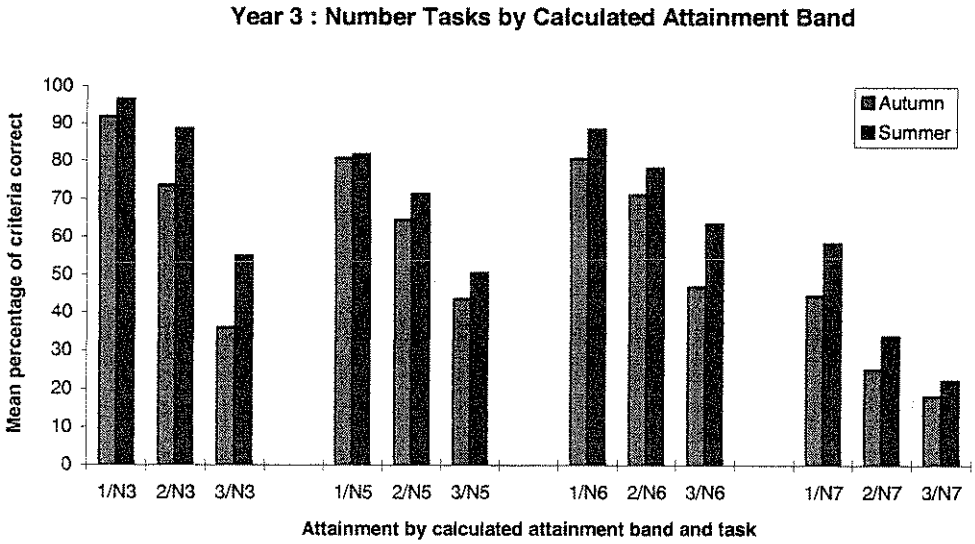
Figure 4.8:



Significant differences at the five per cent level

	Task S1		Task S5		Task S6		Task S7		Task S8	
	Band 1	Band 2	Band 1	Band 2	Band 1	Band 2	Band 1	Band 2	Band 1	Band 2
Band 2			>							
Band 3	>	>	>							

Figure 4. 9:



Significant differences at the five per cent level

	Task N3		Task N5		Task N6		Task N7	
	Band 1	Band 2	Band 1	Band 2	Band 1	Band 2	Band 1	Band 2
Band 2	>							
Band 3	>				>	>		

In Number activities, similar degrees of progress were made by Band 1 and Band 2 pupils. The overall level of attainment for task N7, Understanding and Writing of Fractions, was relatively low. Gains in attainment from autumn to summer for pupils in each attainment band were usually significant at the five per cent level. Table 4.3 shows there were exceptions in four tasks. Band 3 pupils found aspects of task N5, Mental Skills, and task N7, Understanding and Writing of Fractions, particularly difficult, and in task S1, Visualising 2D Representations of 3D Solids and task S5, Reflection of 2D Shapes, 'ceiling effects' and an over-confidence by some Band 1 and Band 2 pupils at the summer assessment may have contributed to the lack of significant change in performance.

Figures 4.10 and 4.11 show the percentage gain in attainment from autumn to summer for each attainment band in Year 1. The predominant pattern of greater gains by Band 3 pupils changes in task N3, Calculations with Money. Many Band 3 pupils could not name or recognise coins, had little concept of value and frequently counted the number of coins instead of calculating the value. This suggests many common classroom activities assume a degree of knowledge and experience which many pupils do not have by the end of Year 1.

Table 4.3: Significant gains in attainment at the five per cent level, Year 3 pupils

Year 3 Tasks	Attainment Band 1	Attainment Band 2	Attainment Band 3
Task S1			*
Task S5		*	*
Task S6	*	*	*
Task S7	*	*	*
Task S8	*	*	*
Task N3	*	*	*
Task N5	*	*	
Task N6	*	*	*
Task N7	*	*	

Figure 4.10:

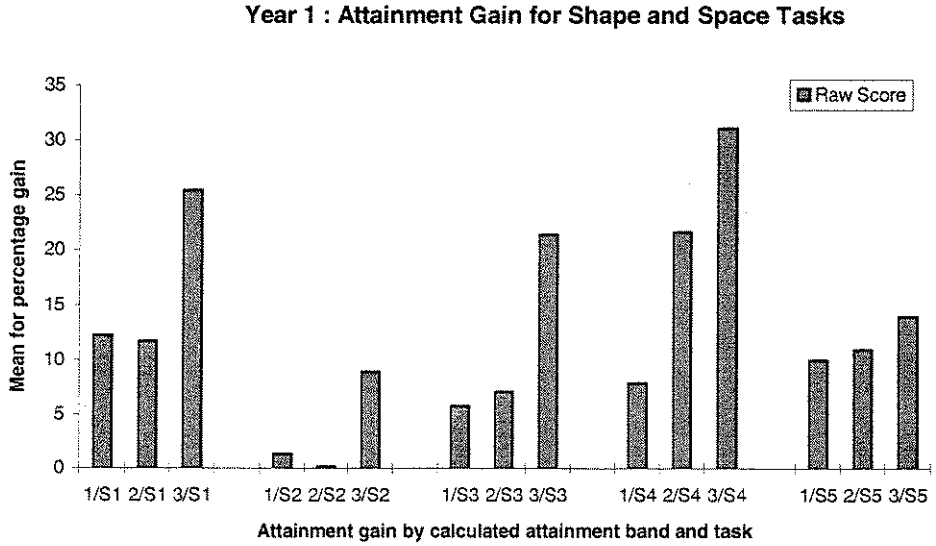
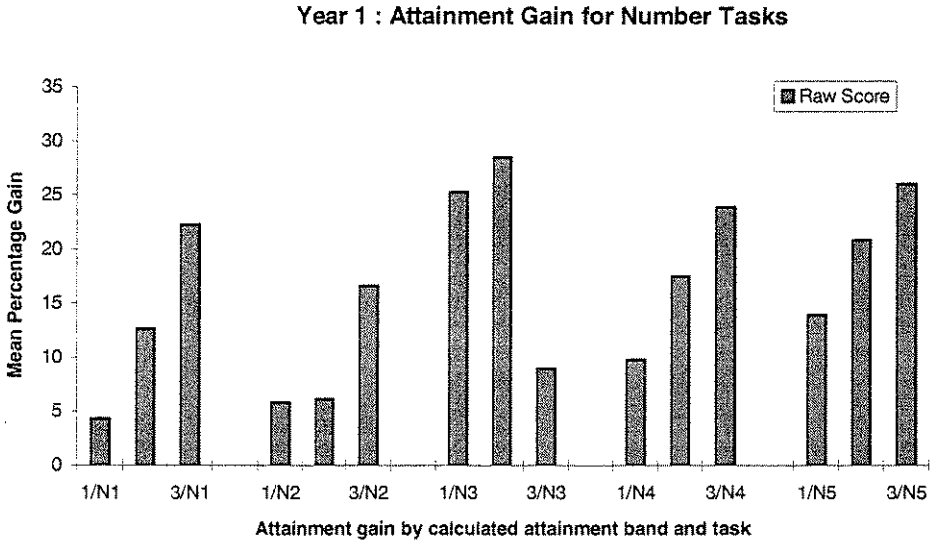


Figure 4.11:



The pattern of attainment gain for Year 3 pupils shown in Figures 4.12 and 4.13 is more varied. In many tasks, the pattern is most frequently for Band 2 and Band 3 pupils to make greater gains than Band 1. The differences between attainment levels in Shape and Space and Number tasks shown for Year 1 pupils are greatly reduced by Year 3. A summary of overall gains for Year 1 and Year 3 is given in Table 4.4. The attainment gains are calculated between autumn and summer assessments and the percentages are arranged by attainment band.

Figure 4.12:

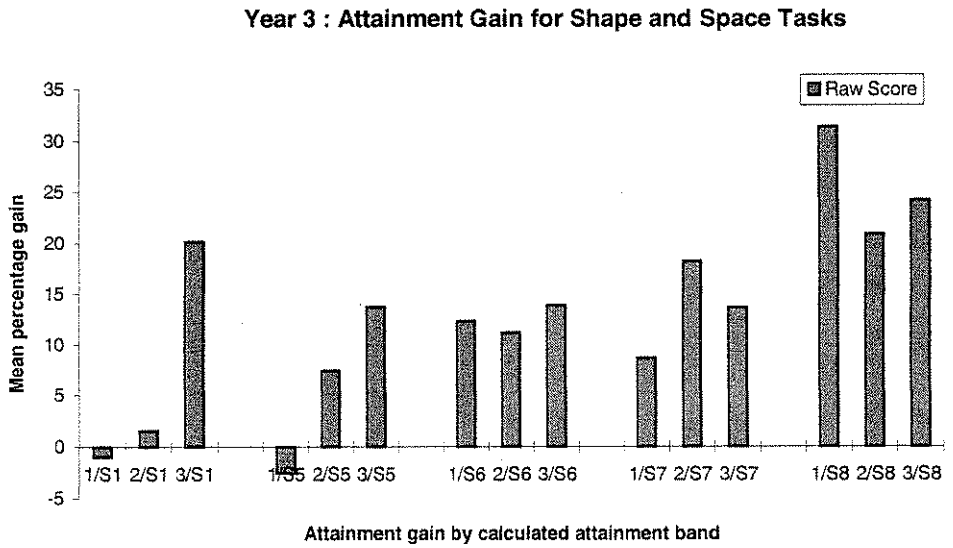
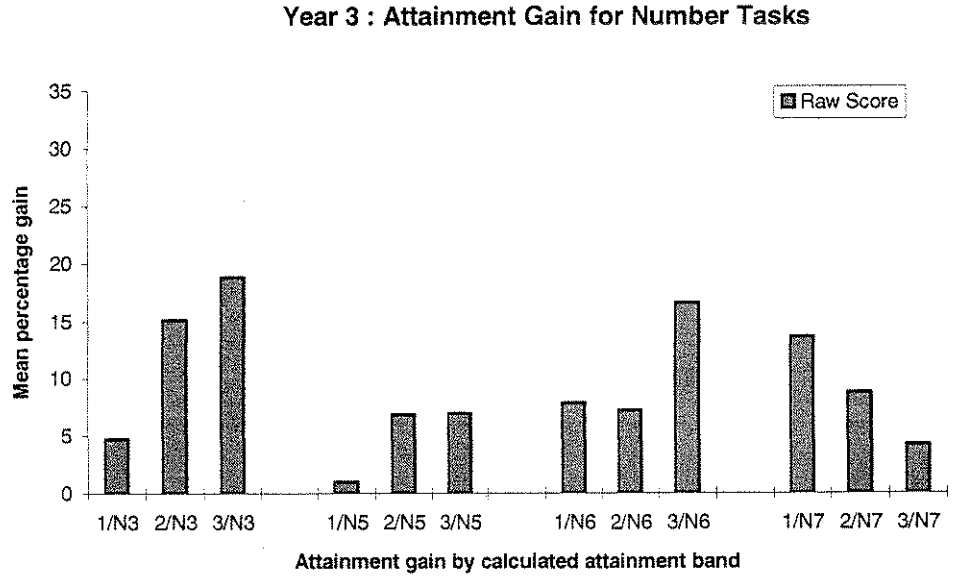


Figure 4.13:



Improvements were generally more consistent in Number tasks for both year groups, but the gain made by the higher-attaining pupils was disappointingly low, whether looked at in terms of raw gain or baseline gain. While some 'ceiling effects' were present for this group, these do not account for the disappointing progress. The results suggest that higher-attaining pupils could be taken further in their mathematical understanding through more challenging and less repetitive work. A common feature of the mathematics curriculum was the predominance of Number activities, largely at the expense of time spent on a broader mathematical content. In those classrooms where the content of mathematics taught was more evenly balanced, there appeared to be greater scope for children to engage in practical activities investigating aspects of Shape and Space and learning to apply numerical skills in context.

Table 4.4: Summary of percentage point and baseline attainment gain

	Calculated attainment	Autumn assessment % criteria correct	Summer assessment % criteria correct	% Point gain	Baseline gain
Year 1:					
Mean for Shape & Space:	Band 1	71%	78%	8%	11%
	Band 2	61%	72%	10%	16%
	Band 3	42%	62%	20%	48%
Mean for Number tasks:	Band 1	61%	73%	12%	20%
	Band 2	47%	64%	17%	36%
	Band 3	28%	48%	20%	71%
Year 3:					
Mean for Shape & Space:	Band 1	75%	85%	10%	13%
	Band 2	56%	68%	12%	21%
	Band 3	34%	51%	17%	50%
Mean for Number tasks:	Band 1	75%	81%	7%	9%
	Band 2	59%	68%	10%	16%
	Band 3	36%	48%	12%	33%

Chapter 5

Teaching Aspects of Shape and Space

• Frequency of Teaching Content and Strategies

The curriculum in the schools working with the project was examined both by visits and by questionnaire. The questionnaire revealed that the mathematical activities concerned with Shape and Space featured in the questionnaire were taught less frequently than those concerning Number. In one-third of the schools studied, the overall mathematics teaching plan or the availability of sufficient resources for the whole class determined when a topic was taught. This suggested many children had limited opportunity to engage in practical investigations to extend their experience, or apply knowledge in context. This type of organisation also limited opportunities to revisit units of work. Teachers were asked to report on the frequency of teaching aspects of Shape and Space, and the results are shown in Tables 5.1 and 5.2. Information was provide by 18 Year 1 and 20 Year 3 teachers.

Table 5.1: Frequency of teaching activities involving aspects of Shape and Space with Year 1 classes

Year 1 classes	**More frequent teaching**			**Less frequent teaching**		
Frequency of teaching content	**3–4 times per week**	**1–2 times per week**	**1–2 times per month**	**1–2 times per term**	**1–2 times per year**	**Never**
Name and draw 2D shapes	0%	33%	22%	45%	0%	0%
Movement: position and direction	6%	44%	22%	0%	28%	0%
Making 3D shapes with apparatus	0%	33%	17%	33%	17%	0%
Measuring with a ruler	0%	11%	11%	28%	33%	17%
Reflection and rotation	0%	0%	22%	11%	39%	28%

Table 5.2: Frequency of teaching activities involving aspects of Shape and Space with Year 3 classes

Year 3 classes	More frequent teaching:			Less frequent teaching:		
Frequency of teaching content	**3–4 times per week**	**1–2 times per week**	**1–2 times per month**	**1–2 times per term**	**1–2 times per year**	**Never**
Name and draw 2D shapes	0%	5%	25%	35%	35%	0%
Movement: position and direction	0%	15%	15%	10%	60%	0%
Making 3D shapes with apparatus	0%	10%	15%	40%	35%	0%
Measuring with a ruler	0%	10%	60%	30%	0%	0%
Areas of simple shapes	0%	0%	15%	30%	45%	10%
Volume & capacity of 3D shapes	0%	0%	20%	15%	40%	25%
Reflection and rotation	0%	5%	15%	20%	55%	5%

For Year 1 classes there was wide variation in the frequency of teaching Shape and Space activities. By splitting Table 5.1 into more frequent and less frequent categories, as shown, there are distinct differences, particularly in naming and drawing 2D shapes, movement, position and direction and making 3D shapes.

Work on measuring with a ruler and reflection and rotation was infrequently taught to Year 1 pupils, but in approximately one-fifth of Year 1 classes, these aspects were not taught at all.

In Table 5.2 the frequency of teaching aspects of Shape and Space to Year 3 classes is summarised. For the first three categories, naming and drawing 2D shapes, movement: position and direction, and making 3D shapes with apparatus, the practice was similar across classes.

The skills of measuring with a ruler were taught frequently in 70 per cent of classes and illustrate a distinct change of emphasis compared with Year 3 classes.

Areas of simple shapes, volume and capacity, reflection and rotation were not taught at all in a minority of classes, and in the rest, teaching of these aspects was mostly infrequent.

Teachers were also asked to indicate how frequently they used a range of strategies and teaching approaches when teaching children to make 3D shapes using practical apparatus. Five teaching approaches were briefly described and appear in Tables 5.3 and 5.4, with a summary of results for Year 1 and Year 3 classes. Again information was provide by 18 Year 1 and 20 Year 3 teachers.

Table 5.3 Teaching strategies used with Year 1 classes when making 3D shapes with practical apparatus.

Teaching strategies with Year 1	**Frequency of strategy**				
Making 3D Shapes with practical apparatus	**Never**	**Seldom**	**Some-times**	**Often**	**Nearly always**
1. Demonstrate the type of work to be done using practical apparatus, and then give children problems to work on in a practical way.	0%	6%	28%	50%	17%
2. Ask children in pairs or small groups to make up and answer their own questions using practical apparatus, and then interact with the children while they are working.	22%	17%	39%	17%	6%
3. Discuss with the class their ideas concerning the work to be done, helping them towards suitable methods, and after the work has been finished hold further discussion.	0%	11%	22%	56%	11%
4. Do a number of drawings on the board or flip chart explaining carefully and clearly, and then give similar problems to the children to work on using apparatus, asking them to make drawings in their workbooks.	33%	22%	17%	17%	11%
5. Give the children an investigation to work on in pairs or small groups using their own ideas, and later ask them to say what they have discovered.	6%	17%	33%	28%	17%

Table 5.4 Teaching strategies used with Year 3 classes when making 3D shapes with practical apparatus.

Teaching strategies with Year 3	Frequency of strategy				
Making 3D Shapes with practical apparatus	**Never**	**Seldom**	**Some-times**	**Often**	**Nearly always**
1. Demonstrate the type of work to be done using practical apparatus, and then give children problems to work on in a practical way.	0%	15%	45%	30%	10%
2. Ask children in pairs or small groups to make up and answer their own questions using practical apparatus, and then interact with the children while they are working.	0%	40%	45%	15%	0%
3. Discuss with the class their ideas concerning the work to be done, helping them towards suitable methods, and after the work has been finished hold further discussion.	0%	10%	30%	60%	0%
4. Do a number of drawings on the board or flip chart explaining carefully and clearly, and then give similar problems to the children to work on using apparatus, asking them to make drawings in their workbooks.	5%	50%	35%	10%	0%
5. Give the children an investigation to work on in pairs or small groups using their own ideas, and later ask them to say what they have discovered.	0%	25%	45%	30%	0%

The majority of Year 1 classteachers indicated a preference for using strategies 1 and 3 when teaching children about 3D shapes. Strategies 2, 4 and 5, which involve investigative and collaborative work by the children, were least used with this age group.

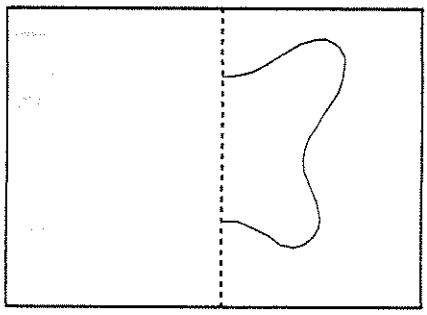
Teachers of Year 3 classes used group or class discussion of working methods (strategy 3) frequently but seldom asked children to make drawings of 3D shapes. Investigative methods (strategy 5) were often used in one-third of Year 3 classes.

Against this background, the patterns of performance in four of the assessment tasks concerned with aspects of Shape and Space are now described.

- **Reflection of 2D Shapes**

This activity was used with Year 1 and Year 3 pupils and was introduced to the children by asking them if they were familiar with mirror painting. The technique where a shape is painted on one-half of a piece of paper and folded over to make a copy on the other side was described. The example given was of a butterfly painting as shown in Figure 5.1. The picture shows the line of reflection and each child was asked to draw the reflected wing shape to practise the kind of response required in the following questions. Most pupils made a positive response to this introductory activity.

Figure 5.1: Card showing line of reflection and butterfly wing shape



At the autumn assessment, all Band 1 pupils said they were familiar with the mirror painting technique. The response was similar for Band 2 pupils: 77 per cent in the autumn, increasing to 93 per cent at the summer assessment. For Band 3 pupils, 27 per cent of pupils said they had done this type of work before with 14 per cent not sure. These proportions remained similar at the summer assessment, and suggest a tendency for high and middle attainers to be introduced to this sort of activity far more often than low attainers.

The task required pupils to draw reflections of three shapes: a rectangle, a bat and a flag. The shape was printed on one-half of a card, with a dotted line marking the line of reflection. Pupils were shown an example and instructed: 'What I want you to do is imagine that this shape has been painted in, and the card folded along the dotted line to make a picture on the other side. Draw, as best you can, what you think it would look like on this side.' The cards are illustrated in Figures 5.2–5.4.

Each shape drawn by the pupil was marked for orientation, position, size and ratio. Orientation and position of the shape were assessed in relation to the distance from the line of reflection, and the overall size of each shape drawn was assessed in relation to the original. The ratio between length of sides for the rectangle, between bat and handle for the bat and between flag and pole for the flag were also assessed.

Figure 5.2: Card showing rectangle

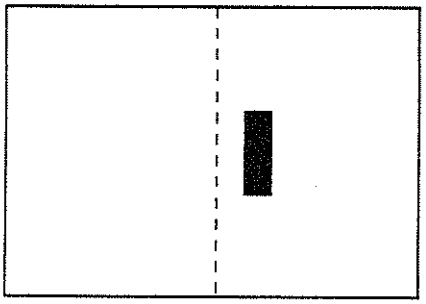


Figure 5.3: Card showing bat shape

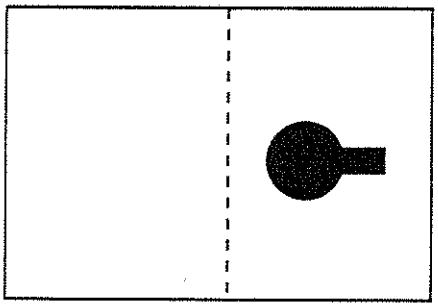
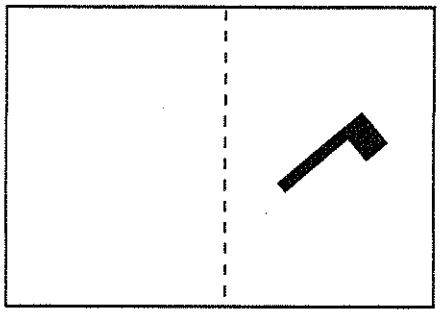


Figure 5.4: Card showing flag shape



For Year 1 pupils, the performance of the three attainment bands was clearly different in the autumn assessment but there was greater variation in levels of performance in the summer, as shown in Figures 5.5–5.7. Letters, A, B etc. are used to identify each aspect of reflecting the shape – orientation, for example – and the following numerals indicate Bands 1, 2 and 3. Significant gains in attainment between autumn and summer, at the five per cent level, are indicated by an asterisk. On some aspects, such as the size and ratio of the bat shape, performance had not improved by the summer.

The reflection of the rectangle appeared to be the easiest shape for the children to visualise. This is shown by the pattern of significant gains in attainment recorded for aspects of the rectangle. Pupils in each attainment band found the difficulty levels for drawing the reflections of the bat and flag shapes to be about the same (Figures 5.6 and 5.7), the exception being Band 1 pupils, who showed a significant improvement in drawing the reflected shapes in the correct orientation.

This task was administered to Year 3 pupils in exactly the same format as that for Year 1 pupils. Similar proportions of pupils in each attainment band to those in Year 1 said they were familiar with mirror painting.

The results for Year 3 pupils are illustrated in Figures 5.8–5.10 and show higher overall levels of performance than for Year 1 pupils, for most criteria. Significant gains in attainment at the five per cent level were most frequently recorded by Band 2 and Band 3 pupils for aspects of the rectangle. Levels of performance were similar for each attainment band in drawing the reflected bat and flag shapes. There was some levelling up of performance between attainment bands for recording aspects of the position, size and ratio of these shapes. Visualising and drawing a reflected shape in the correct orientation proved the most difficult part of the task for each attainment band.

Figure 5.5: Year 1 assessment task: *Folding Pictures*

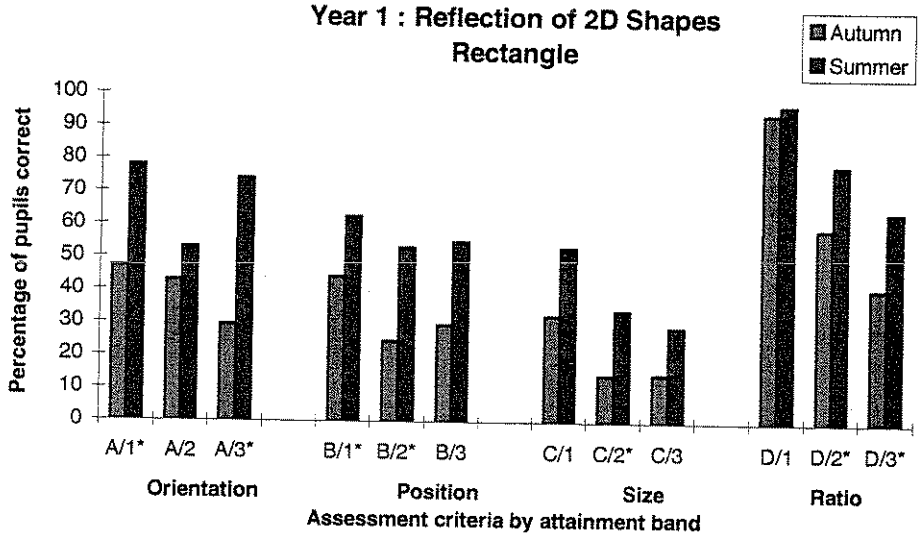


Figure 5.6 Year 1 assessment task: *Folding Pictures*

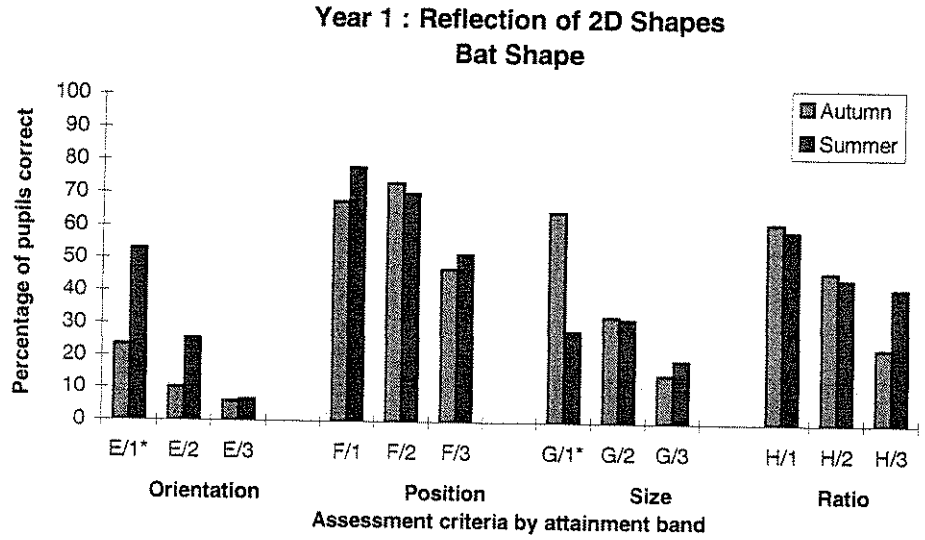


Figure 5.7 Year 1 assessment task: *Folding Pictures*

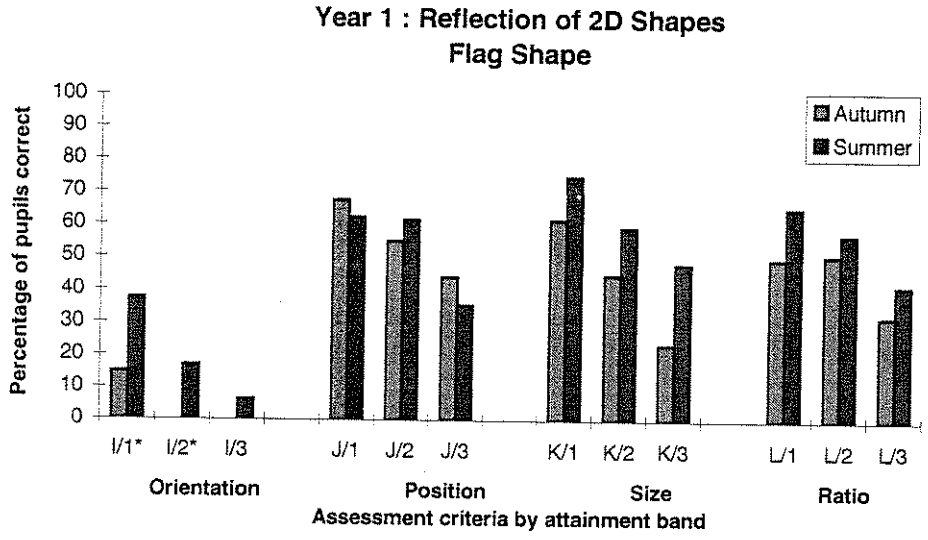


Figure 5.8: Year 3 assessment task: *Folding Pictures*

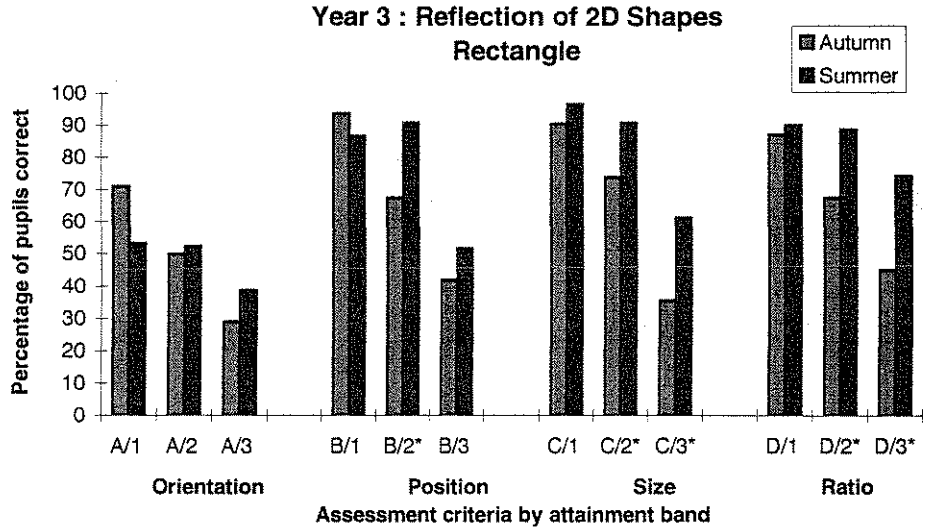


Figure 5.9: Year 3 assessment task: *Folding Pictures*

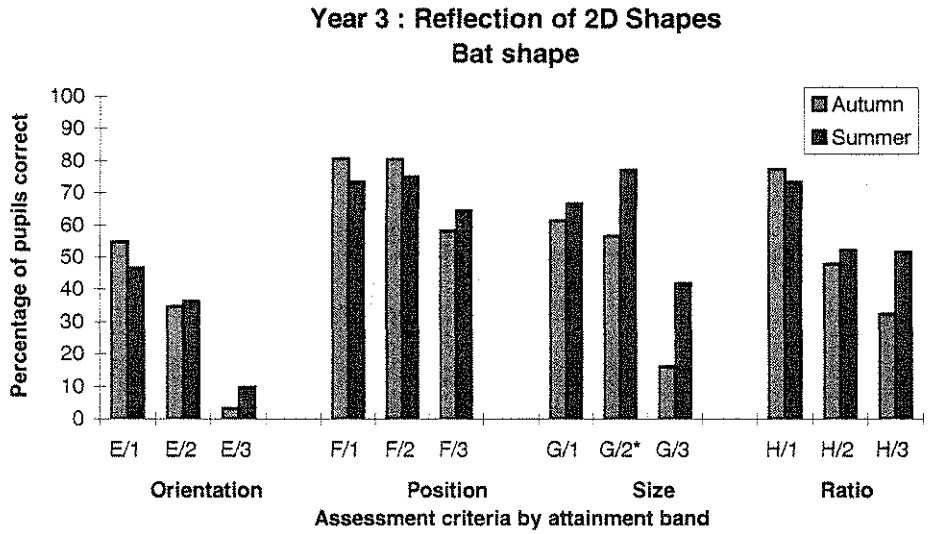
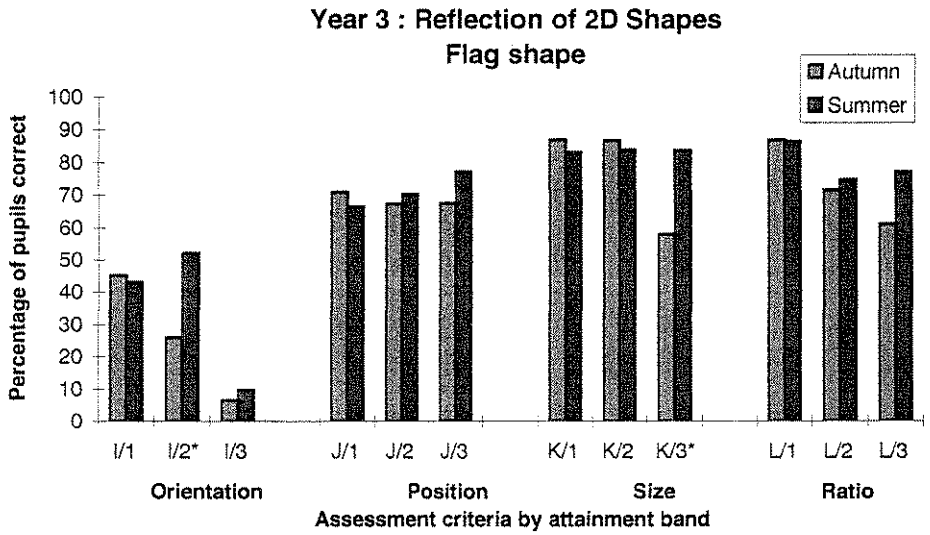


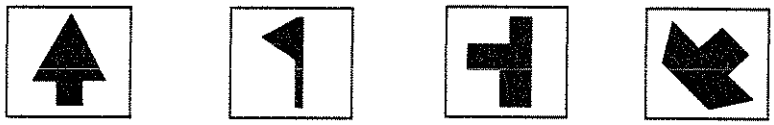
Figure 5.10: Year 3 assessment task: *Folding Pictures*



- **Rotation of 2D Shapes**

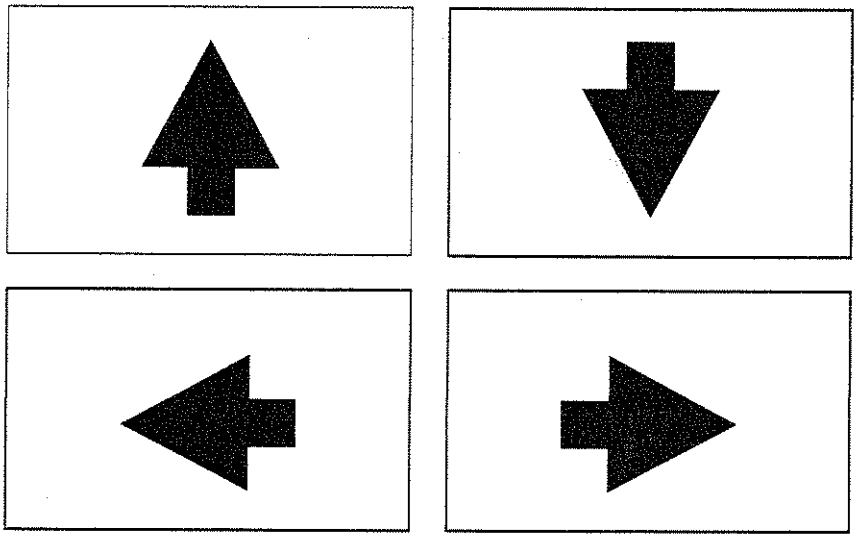
For this task, children were shown four badges in turn, depicting the shapes shown below :

Shapes used for rotation activity



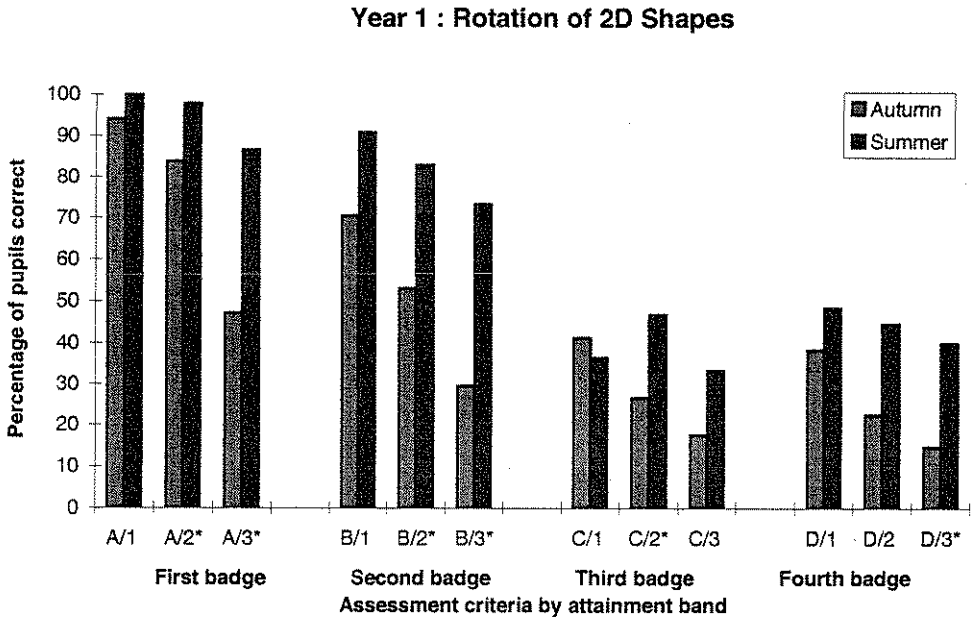
First badge Second badge Third badge Fourth badge

The shapes illustrated above were printed on small cards and presented in a clear plastic badge holder for this activity. Each badge was shown to the pupil in the orientation shown above, and the assessor then slid the card partly out of the badge holder to show it could be taken out and replaced. The pupil was then told: 'What I want you to do is to imagine that the card is taken out, turned upside down, and slid back into the plastic holder. Which of these drawings would it look like?' The pupil was then shown a set of a set of four pictures printed on a separate sheet of paper:



The results for this activity are shown in Figure 5.11. The highest levels of performance were recorded for the first two shapes, with some significant gains in attainment, at the five per cent level, recorded by average and lower attainers throughout this activity.

Figure 5.11:



- **Area**

For this assessment activity, children were asked to work out the area of a series of plane shapes, printed to scale, on a sheet of paper. At the beginning of the task, children were asked to give an explanation of what they understood area to mean in mathematics. Eleven per cent of children at the autumn assessment and 40 per cent of pupils at the summer assessment gave a mathematical explanation, such as 'the space inside a shape', with approximately a quarter of pupils on each occasion giving an everyday explanation, most frequently relating to a room, a building or the locality.

The first three shapes were shown on a centimetre square grid, starting with one where only whole squares had to be counted and moving on to shapes where half-squares also had to be dealt with:

Criterion B: an L shape covering 12 whole centimetre squares;
Criterion C: an isosceles right-angled triangle with area 8 squares;
Criterion D: a cross-section of a house with chimney of area 16½ squares.

The results for working with these shapes are summarised in Figure 5.12. All three attainment bands coped well with the L shape, but the shapes with half-squares produced sharp differences between the bands, and only the middle attainers in Band 2 improved their performance significantly in the summer.

Children were then asked to draw two shapes of a specified area on a centimetre square grid:

Criterion E: draw a shape with an area of 17 squares;
Criterion F: draw a shape with an area of 13½ squares.

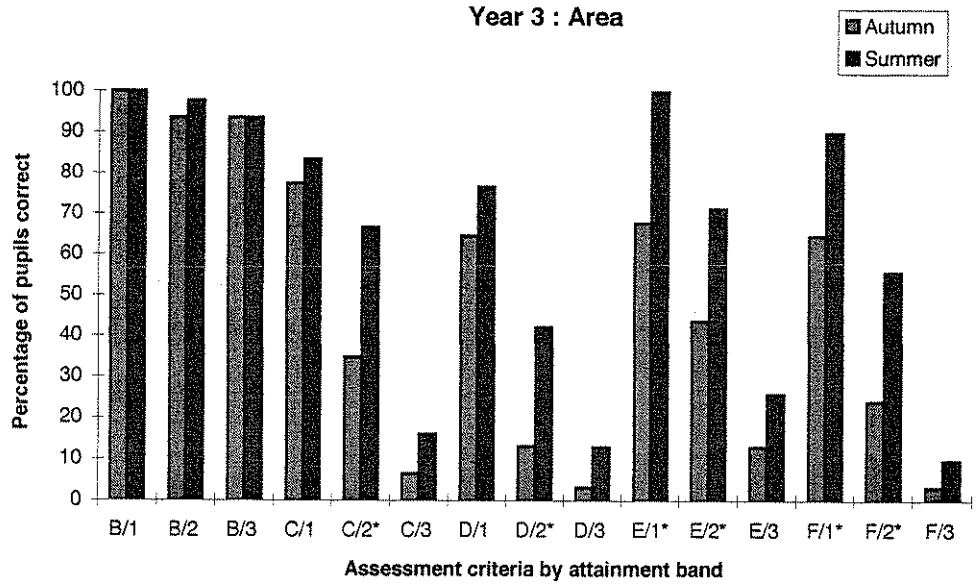
Above-average and average attainers, Bands 1 and 2, made significant progress at the five per cent level, showing improved skills in drawing shapes of a specified area. The attainment bands were again sharply differentiated.

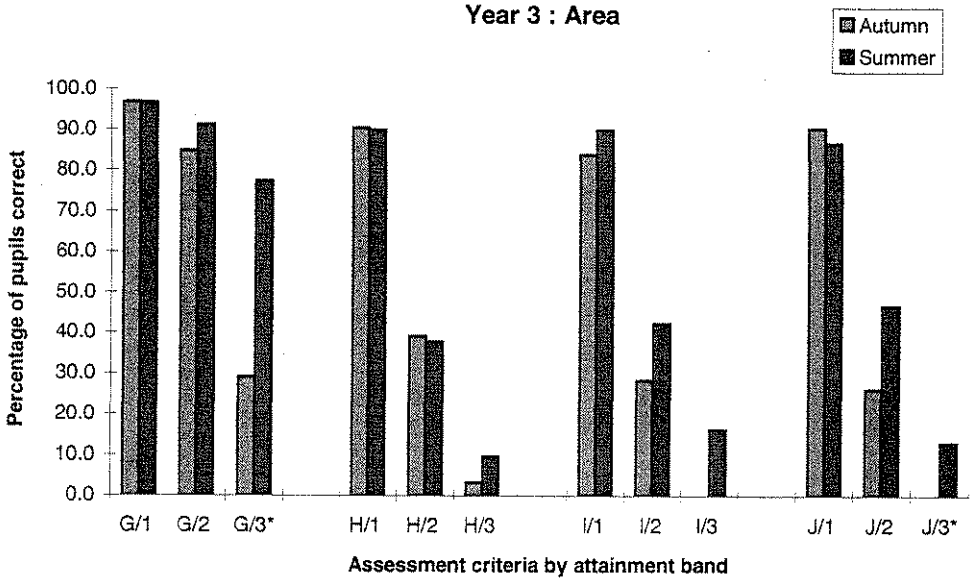
For criteria G–J children used a transparent centimetre grid to calculate the area of four shapes of increasing complexity; cardboard cut-outs of the shapes were used:

Criterion G: a T shape with an area of 17 squares, whole squares only;
Criterion H: an L shape with a sloping end with an area of 14 squares;
Criterion H: a saw tooth shape with an area of 11½ squares;
Criterion H: a rotated L shape with an area of 9½ squares.

High attainers, Band 1, showed similar high levels of performance at each assessment, but the requirement to deal with half- squares affected the performance of Band 2 and Band 3.

Figure 5.12


Year 3 : Area
Autumn
Summer
Percentage of pupils correct
100
90
80
70
60
50
40
30
20
10
0
B/1 B/2 B/3 C/1 C/2* C/3 D/1 D/2* D/3 E/1* E/2* E/3 F/1* F/2* F/3
Assessment criteria by attainment band


Year 3 : Area
Autumn
Summer
Percentage of pupils correct
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
G/1 G/2 G/3* H/1 H/2 H/3 I/1 I/2 I/3 J/1 J/2 J/3*
Assessment criteria by attainment band

Chapter 6

Teaching Aspects of Number

• Frequency of Teaching Content and Strategies

There was a strong emphasis on the teaching of aspects of Number in all the schools visited. However, there was considerable variation in the content and the range of Number work activities between schools and between classes within the same school.

Teachers completed a questionnaire which asked them to indicate the frequency of teaching aspects of Number to their class, through a range of activities. The activities included were related to the assessment tasks used with Year 1 and Year 3 pupils. A summary of the information given by Year 1 and Year 3 classteachers is shown in Tables 6.1 and 6.2. Information was provided by 18 Year 1 and 20 Year 3 teachers.

Table 6.1: Frequency of teaching mathematical activities involving aspects of Number with Year 1 classes

Year 1 classes	**More frequent teaching:**			**Less frequent teaching:**		
Frequency of teaching content	**3–4 times per week**	**1–2 times per week**	**1–2 times per month**	**1–2 times per term**	**1–2 times per year**	**Never**
Practising times tables	0%	11%	0%	6%	33%	50%
Simple sums mentally	61%	28%	11%	0%	0%	0%
Sums: pencil and paper	39%	44%	17%	0%	0%	0%
Problems with money	17%	11%	33%	33%	0%	6%
Working with fractions	0%	11%	0%	28%	50%	11%
Whole-number concepts	17%	33%	11%	11%	17%	11%

Table 6.2: Frequency of teaching mathematical activities involving aspects of Number with Year 3 classes

Year 3 classes	More frequent teaching:			Less frequent teaching:		
Frequency of teaching content	**3–4 times per week**	**1–2 times per week**	**1–2 times per month**	**1–2 times per term**	**1–2 times per year**	**Never**
Practising times tables	15%	55%	25%	0%	5%	0%
Simple sums mentally	10%	85%	5%	0%	0%	0%
Sums: pencil and paper	35%	65%	0%	0%	0%	0%
Problems with money	0%	15%	25%	55%	5%	0%
Working with fractions	0%	0%	45%	20%	35%	0%
Whole-number concepts	15%	55%	25%	5%	0%	0%

In half the Year 1 classes, the teaching of times tables was thought to be inappropriate, and in a further third of classrooms, this occurred only once or twice a term. In contrast, tables were taught once or twice a week in 11 per cent of classrooms, indicating considerable variation in practice among schools all working to the same National Curriculum. Teachers placed strong and frequent emphasis on whole-number concepts, mental skills and pencil and paper sums. A thorough grounding in number bonds, through mental and practical activities, was seen as a prerequisite for teaching tables. Times tables were introduced as continuous addition, using practical apparatus. Whole-number concepts were taught infrequently in approximately one-third of classes.

Two aspects of Number – problems with money and working with fractions – received more varied coverage in Year 1 classes, with a small number of teachers not covering these topics at all. In around one-third of classes, activities involving money and fractions were taught once or twice per term, and in half the classes, fractions were taught once or twice a year.

In comparison with Year 1, pupils in nearly all Year 3 classes practised times tables regularly, and more frequently worked on pencil and paper sums, fractions and whole-number concepts. Mental sums and problems with money were given less emphasis in Year 3 than in Year 1. Again, the variation in practice between schools was marked.

Teachers were also asked to indicate their preferred strategies when teaching aspects of problems with money. Five descriptions of teaching approaches were provided and the results are shown in Tables 6.3 and 6.4. Again, information was provided by 18 Year 1 and 20 Year 3 teachers.

Table 6.3: Teaching strategies used with Year 1 classes when investigating problems with money.

Teaching strategies with Year 1	**Frequency of strategy**				
Problems with money	**Never**	**Seldom**	**Some-times**	**Often**	**Nearly always**
1. Demonstrate the type of work to be done by using concrete examples with real or pretend coins, and then give children problems to work on in a practical way.	6%	0%	39%	28%	28%
2. Ask children in pairs or small groups to make up and answer their own questions using classroom resources, and then interact with children while they are working.	28%	22%	33%	6%	11%
3. Discuss with the class their ideas concerning the work to be done, helping them towards suitable methods, and after the work has been finished hold further discussion.	6%	11%	44%	17%	22%
4. Do several examples on the board or flip chart, explaining the methods to be used carefully and clearly, and then give similar problems to the children for them to do.	28%	11%	39%	11%	11%
5. Give the children an investigation to work on in pairs or small groups using their own ideas, and later ask them to say what they have discovered.	22%	22%	33%	22%	0%

Table 6.4: Teaching strategies used with Year 3 classes when investigating problems with money.

Teaching strategies with Year 3	Frequency of strategy				
Problems with money	**Never**	**Seldom**	**Some - times**	**Often**	**Nearly always**
1. Demonstrate the type of work to be done by using concrete examples with real or pretend coins, and then give children problems to work on in a practical way.	0%	5%	15%	55%	25%
2. Ask children in pairs or small groups to make up and answer their own questions using classroom resources, and then interact with children while they are working.	0%	5%	70%	25%	0%
3. Discuss with the class their ideas concerning the work to be done, helping them towards suitable methods, and after the work has been finished hold further discussion.	0%	0%	40%	55%	5%
4. Do several examples on the board or flip chart, explaining the methods to be used carefully and clearly, and then give similar problems to the children for them to do.	0%	5%	40%	45%	10%
5. Give the children an investigation to work on in pairs or small groups using their own ideas, and later ask them to say what they have discovered.	0%	10%	60%	30%	0%

The results show that all five teaching strategies were used in all of the Year 3 classes. Strategy 4, using a board or flip chart was adopted more frequently in Year 3 classes than in Year 1 classes. Teachers showed a clear preference for strategy 1, choosing similar approaches in teaching Number and Shape and Space.

The patterns of performance in three of the assessment tasks concerned with aspects of Number are now described.

• Calculations with Money

This task was used with Year 1 and Year 3 pupils and tested the ability to name and recognise coins, to add up the total value of a mixed group of coins and to make up specified amounts using combinations of coins. Pupils were also asked about giving change.

The sample size for Year 1 was 119 pupils for the autumn assessment and 112 pupils for the summer assessment. In the Year 3 sample there were 110 pupils in the autumn term assessment and 116 pupils in the summer term assessment.[1] The results shown below are based on those pupils present on both occasions, over 100.

The Coins activity used three packets of money :

Packet I	containing three 2p coins and two 1p coins (8p);
II	containing two 5p coins, one 2p coin and three 1p coins (15p);
III	containing one 10p coin and three 5p coins (25p).

Pupils were asked (criteria A, B, C, and D) to 'find out how much money is in this packet' followed by 'give me *x* pence' (Packet I: total 8p, give 5p; Packet II: total 15p, give 7p). The coins used were recorded on each occasion. For criteria E and F, the task was to select coins to pay for an article (10p) and to determine whether or not change was required (no). Criteria G to I followed a similar pattern (Packet III: total 25p, give 17p, change 3p) and for the final criteria, J to L, the coins from all three packets were used (total 48p, give 33p, no change).

Figure 6.1 shows the results for the earlier tasks in this activity for Year 1 pupils in the summer and autumn. Figure 6.2 deals with the later ones. For some of the later criteria, the success rate was zero, particularly in the autumn assessment. Significant gains in attainment (at the five per cent level) from autumn to summer are indicated by an asterisk. Year 1 high attainers, Band 1, and average attainers, Band 2, recorded significant gains for most criteria. Attainment levels for low attainers, Band 3, remained similar.

The differences in performance between the attainment bands were sharp for most criteria in this activity. Many Year 1 pupils found the recognition and naming of coins difficult, and, for example, the level of performance of low attainers, Band 3, remained at a similar low level in both the autumn and the summer.

[1] The smaller number of pupils at the autumn assessment was due to absence.

Figure 6.1:

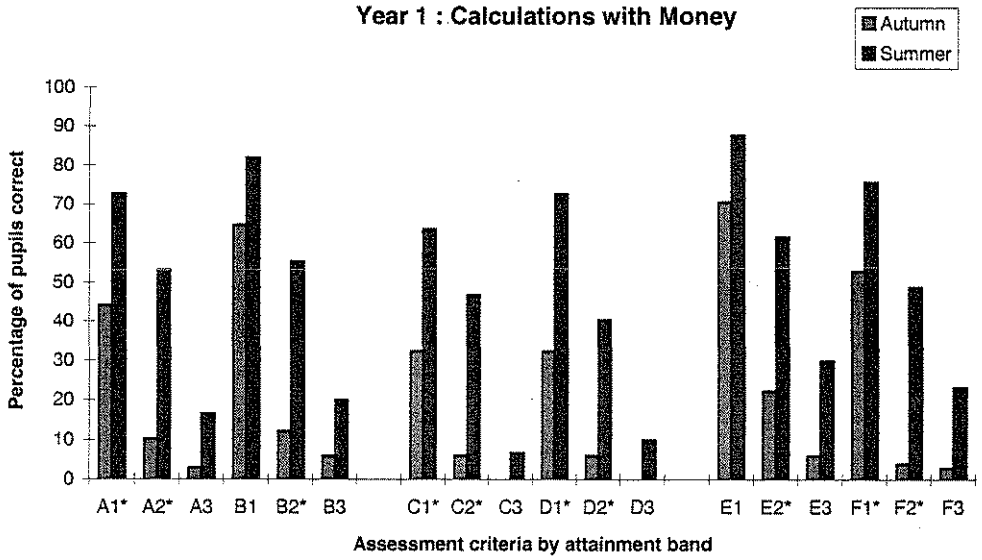
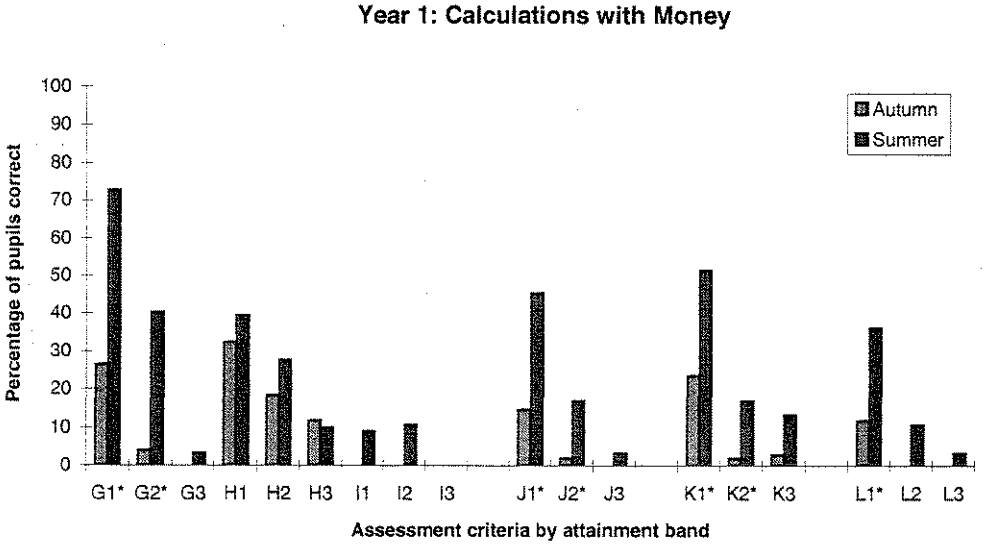


Figure 6.2:



For criteria J, K and L, which involved using coins to a total value of 48p, the high- and average-attaining groups made significant progress during the year. Generally the higher attainers had learned to count coins in value order, but many average attainers counted haphazardly without grouping coins of the same value first.

The giving of change appeared to be a difficult concept, and few pupils could count on to a given amount as shown by criteria H and I where performance remained similar across all attainment bands.

The overall level of performance for Year 3 pupils is shown in Figures 6.3 and 6.4. The performance of Band 1 (higher attainers) and Band 2 (average attainers) was similar for most criteria. In I, where pupils were asked to work out the correct amount of change needed, pupils in the average attainment group made a significant gain in performance at the five per cent level.

For J, which required pupils to count assorted coins to a total value of 48p, the attainment groups were evenly differentiated, with the lower attainers recording a significant gain in performance. The higher-attaining pupils had learned to count coins in value order but many pupils of average and lower attainment counted the coins by size or in random order. Arrival at the correct answer appeared to depend on the child's knowledge of number bonds, or their skill in mental calculations. Many children preferred to 'count on' in ones for each coin in turn rather than use their knowledge of number bonds. This appeared to be a question of developing the confidence to apply number bonds in context. Some pupils used number bonds to arrive at an answer and then checked using the counting strategy.

For criteria K and L, counting coins to 33p and determining if change was required, Band 2 and Band 3 pupils showed a significant gain in attainment at the five per cent level. Levels of performance were similar for these activities at each assessment.

- **Division and Multiplication**

Children were provided with three pictures of bears and up to 20 centimetre cubes to use as counters in this activity. The first four criteria required children to share a given number of cubes (14 for B, 9 for D) between two bears, and then between three bears (15 for F, 8 for H). The number of cubes in D and H necessitated a remainder and the results shown in Figure 6.5 indicate a lower overall level of performance across each attainment group.

For the remaining criteria, children were told 'each bear gets ... cubes' and asked 'how many cubes is this all together?' In those criteria where the necessary cubes were provided, or the child was given access to cubes in working out the answer, levels of performance were relatively high. Few children chose to work mentally, the majority preferring to use concrete apparatus and to check their use of number bonds using a counting-on strategy with single cubes. Many of the more able children were able to count in sets mentally, but over half of the sample chose not to apply these skills. For criteria J and O, only sufficient cubes for one bear were provided and levels of performance were relatively low.

Figure 6.3:

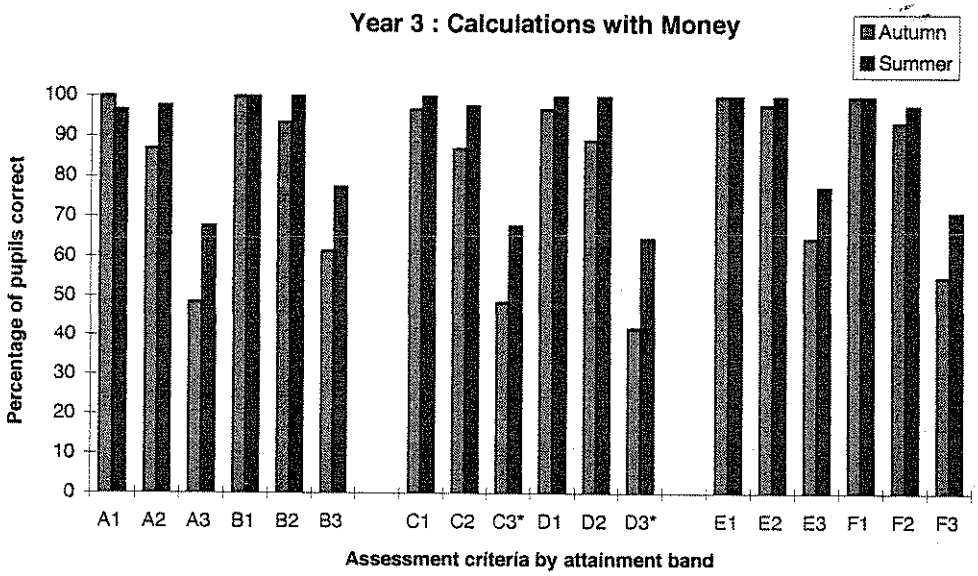
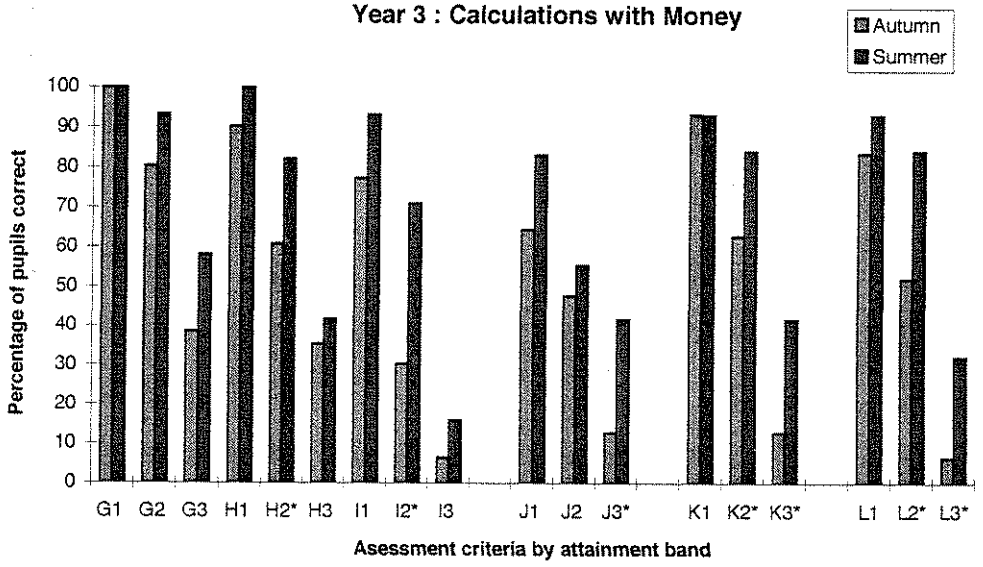


Figure 6.4:



For criteria L and Q, no cubes were used. The numbers of cubes to be counted for each bear were 5 and 3, numbers which most children were confident in handling. Levels of performance for these criteria, shown in Figure 6.6, show even differentiation between attainment bands, with Band 2 pupils recording significant progress at the five per cent level.

Figure 6.5:

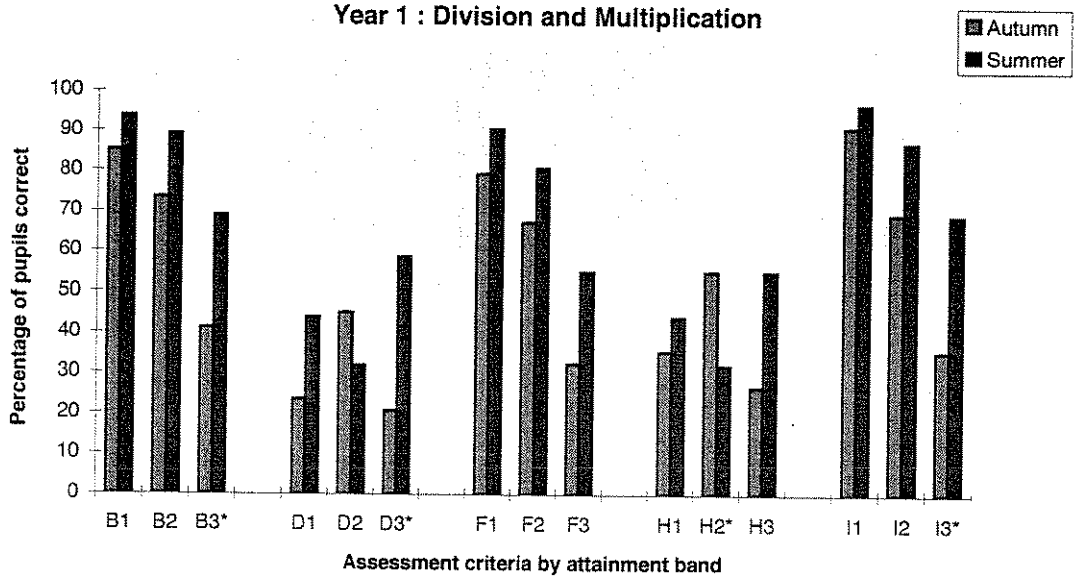
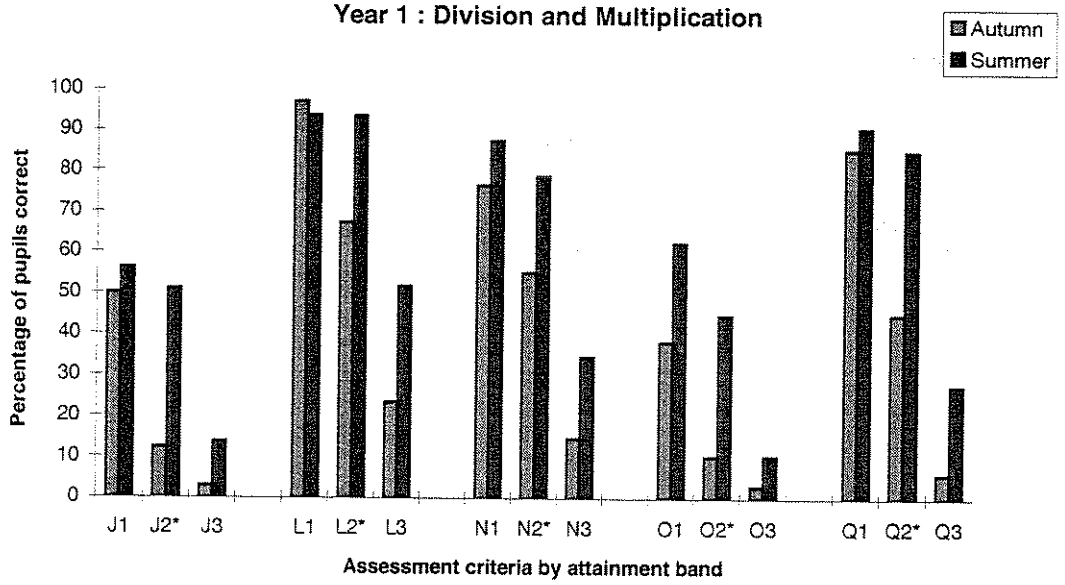


Figure 6.6:



Significant gains in attainment at the five per cent level are indicated by an asterisk and these show pupils of average attainment to have made the most overall progress in aspects of division and multiplication.

• Calculator Tasks

In working on the activities in this task, children used the type of calculator they were most used to handling at school. The first four questions, shown as criteria A–D in Figure 6.7, asked the children to name the four signs used in number operations. For the remaining questions, a series of calculations, of increasing difficulty, was set out on a printed sheet for the child to work from. The assessor explained what was required, and recorded the keys used to enter each sum and whether or not the child read the answer as a whole number or as single digits. The last four questions were presented as calculations in context and the child had to decide the operation needed to work out the correct answer. The results for this activity are shown are in Figures 6.7–6.9.

Most children were able to give the meaning of the addition and subtraction signs, criteria A and B, in the autumn, and virtually all were successful in the summer. Informal terms such as 'take away' were accepted as correct. For the multiplication and division signs, criteria C and D, the picture was very different, with considerable differences in performance between the attainment bands in the autumn, and significant gains in performance by Bands 2 and 3 by the summer. Again, informal terms such as 'times' and 'share' were accepted as correct.

Criteria E to P deal with a series of six computations presented to the child as shown below. In each case, the assessor recorded whether the answer was correct and whether the child could read out the answer correctly:

Calculation	Answer	Reading out
25 + 57 =	E	F
186 – 29 =	G	H
28 × 47 =	I	J
486 ÷ 9 =	K	L
34 × 59 =	M	N
130 ÷ 4 =	O	P

Performing the calculation was a relatively easy task for most pupils, but reading out the answer correctly was difficult for 2006 and 32.5 (criteria N and P).

Criteria R to X involved simple word problems where the child had to decide which operation to use and then perform it correctly using the calculator. This extra requirement generally produced much sharper differentiation between the performance of the three attainment bands. Significant gains in attainment at the five per cent level are shown by an asterisk.

Figure 6.7:

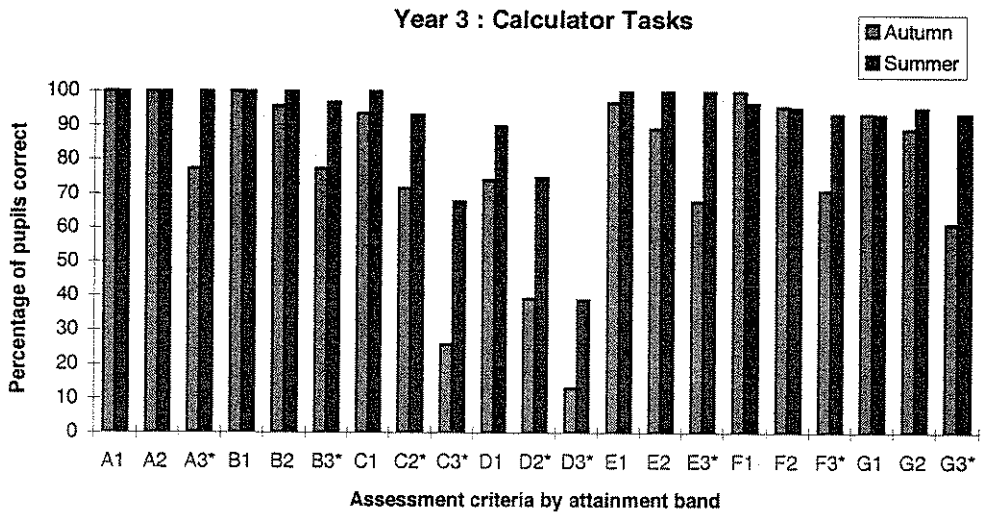


Figure 6.8:

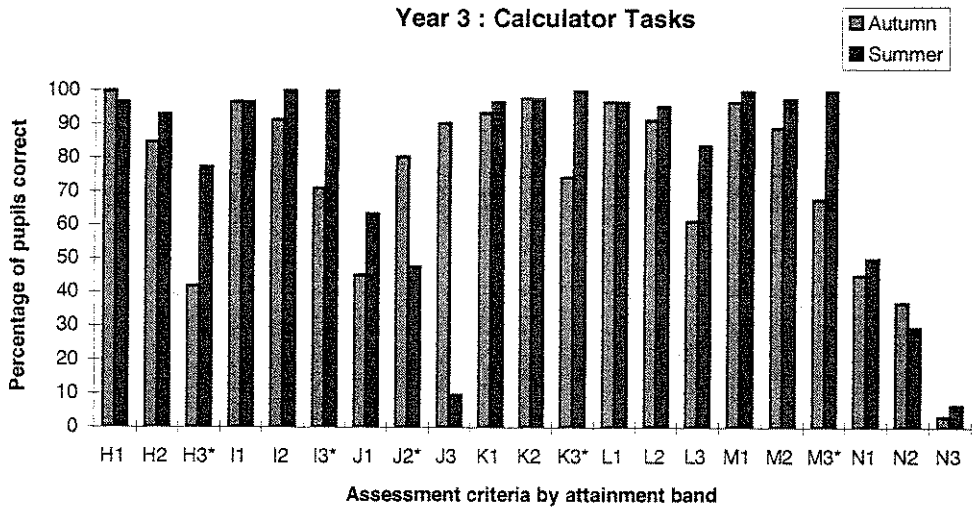
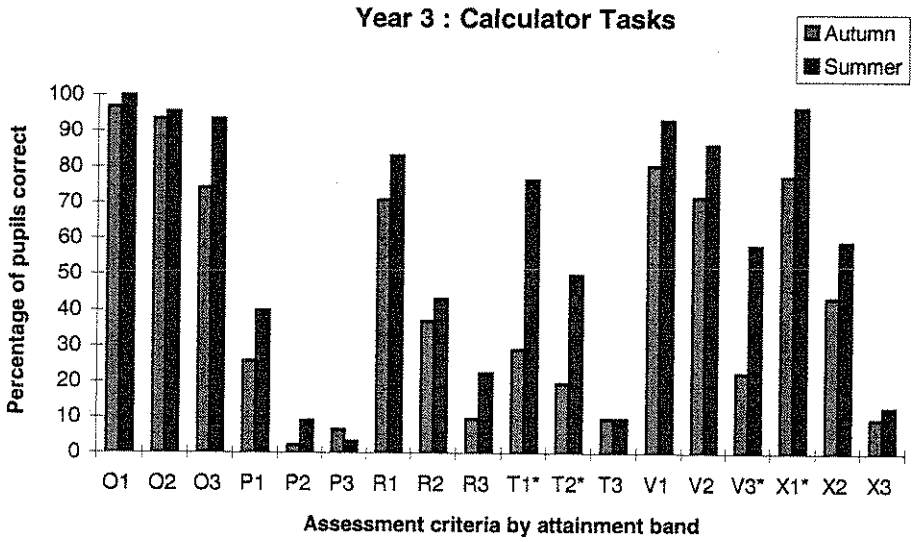


Figure 6.9:


Year 3 : Calculator Tasks
Autumn
Summer
Percentage of pupils correct
100
90
80
70
60
50
40
30
20
10
0
O1 O2 O3 P1 P2 P3 R1 R2 R3 T1* T2* T3 V1 V2 V3* X1* X2 X3
Assessment criteria by attainment band

Chapter 7

Pupil Attainment in Mathematics and Features of School Organisation

The purpose of this chapter is to review the overall attainment gain recorded by each school for Year 1 and Year 3 pupils. To place the percentage gain in attainment for each school in context, a brief description of schools' organisational and situational characteristics is included.

The results from the autumn and summer term assessments were used to calculate the average overall gain for Y1 pupils in each school, for Y3 pupils in each school and, by combining these two sources of information, an average percentage point gain for each school. The outcome was a wide variation between schools. The smallest attainment gain was 3.5 per cent and the largest 29 per cent. It is interesting that the schools with the highest and lowest gains were of similar size and situated in, and serving, similar socially disadvantaged, urban, multi-ethnic communities. The following discussion reflects on the differing characteristics of schools and suggests that certain features of school organisation and culture are related to levels of attainment.

It was thought that overall levels of school performance might be linked to organisational and contextual features of schools, but no direct correlation was found. Instead there appear to be a number of interrelated features, which have a compensating effect, and may mask the effects of some aspects of school practice.

The schools are described in three groups arranged by attainment gain: the first group recording an average attainment gain of between 12 and 29 per cent; the second between eight and ten per cent; and the third less than eight per cent.

The attainment gains for the first group of schools are given in Table 7.1. In addition, information about the time spent teaching mathematics each week and the percentage of total lesson time devoted to mathematics is included. All of the schools in this group taught both infant and junior children. Class sizes are given for Year 1 and Year 3 classes, which were mostly organised by age. There were three exceptions: Schools 2 and 14, where both classes had a two or three year age range, and School 11, where the Year 3 pupils were in a vertically grouped class with Year 4 pupils.

Further information about the size of the schools and the area which they served is set out in Table 7.2. Each of these schools reported strong parental support of the school and interest shown in the children's education. There was great variation in the manner of that support. A small proportion of parents assisted in school, the majority attended school open evenings and fund-raising functions, and many regularly worked with their child in partnership with the classteacher. Parents from ethnic minority communities were less directly involved in the children's education. At School 15, for example, there was minimal parental involvement in the school but the community was supportive of the school and its professional objectives. The headteacher saw this as an expression of cultural diversity.

Table 7.1: Schools recording the highest overall attainment gain in mathematics assessments for Year 1 and Year 3 pupils

School organisation and mathematics lesson time							**Mean for attainment gain**		
	Year 1			**Year 3**					
School number	Time per week	Class size Y1	% total lessons	Time per week	Class size Y3	% total lessons	Overall % Gain	% Gain for Y1	% Gain for Y3
15	295min	25	22	330min	26	24	29	30	29
10	340min	28	26	330min	22	24	18	24	12
2	300min	20	22	285min	17	21	17	21	13
11	150min	23	12	360min	37	27	15	24	6
14	420min	48	32	255min	36	19	15	13	16
7	240min	27	19	285min	30	21	12	15	10
18	300min	30	22	400min	23	30	12	12	13

Table 7.2: Characteristics of schools recording the highest overall attainment gain in mathematics assessments

Characteristics of school and locality					
School no.	**Size of school**	**School setting**	**General characteristics of population and school catchment area**		
15	400+ Nursery	Urban	Mostly working-class: social and economic disadvantage	80% multi-ethnic: ESL support	Inner-city: urban renewal area
10	170	Urban	Very mixed catchment area: professional, working-class	12% multi-ethnic: ESL support	Country town
2	53	Rural	Professional, working-class: social/economic advantage	Playgroup in school	Prosperous village
11	150	Urban fringe	Mostly middle-class but with some rented housing		Country town
14	114	Rural	Mostly middle-class, semi-professional	Expanding school – large classes	Developing village
7	325	Urban	Very mixed catchment area: professional, working-class		Country town
18	618+ Nursery	Urban	Very mixed catchment area: professional, working-class		School serves wide area

Table 7.3 shows the overall baseline attainment level for each school. The table also shows how many pupils in each school were allocated to attainment Bands 1, 2 and 3 using the results of the relevant year group as a base. The ratio of pupils in each attainment band in the whole sample was 2 : 3 : 2. In Table 7.3 Schools 10 and 2 share this profile, while School 15 has a preponderance of low attainers, Band 3, in both Y1 and Y3.

Table 7.3: Mean for baseline of attainment and calculated pupil attainment profile for schools recording the highest overall attainment gain

School number	Y1 mean for pupils' baseline attainment	Y1 attainment profile by calculated attainment band:			Y3 mean for pupils' baseline attainment	Y3 attainment profile by calculated attainment band:		
		Band 1	Band 2	Band 3		Band 1	Band 2	Band 3
15	41%	1	1	5	42%	1	2	4
10	48%	2	3	2	56%	2	4	1
2	56%	2	3	2	70%	4	2	1
11	50%	1	5	1	61%	3	3	1
14	49%	2	1	4	67%	5	1	1
7	54%	3	2	2	60%	1	5	1
18	57%	3	2	2	57%	2	4	1

Most schools either maintained or increased the proportion of lesson time spent on mathematics activities from Year 1 to Year 3. Schools 11 and 14 showed the greatest variation between classes. In School 11, teachers planned mathematics teaching for their classes without reference to school guidelines or an overall scheme of work. The teacher of Y3 pupils said it was necessary to spend a great deal of time improving children's computational skills due to poor levels of attainment at the beginning of the school year. The large class and limited resources imposed further constraints, with the teacher spending a great deal of time making worksheets. In School 14, the large class containing Year 1 pupils spent 13 per cent more lesson time on mathematics than Year 3.

School 15 recorded the highest attainment gain but this must be seen in context. The baseline attainment level was relatively low: 41 per cent at Year 1 and 42 per cent Year 3. Table 7.3 shows the baseline for each school in the group for comparison. The Year 1 classteacher, who was also the school mathematics coordinator, and the Year 3 teacher maintained detailed records of lesson content and pupil attainment. There was evidence of regular evaluation and assessment. A staff working party had completed a scheme of work for mathematics describing the progression of skills to be taught, the mathematical language used and the techniques and resources available for each (NC) content attainment target. This document was accepted by the staff and was to be trialled over the next academic year.

The mathematics teaching was focused in both classes with a preference for class teaching in Year 1. There was strong emphasis on oral work as most pupils had English as a second language. The ESL teacher, who worked in the classroom, had produced a mathematical language resource for classteachers, to help pupils gain access to the mathematics curriculum. This consisted of English and Punjabi words related to a range of mathematical skills and concepts.

The mathematics teaching was organised in topics or themes: shape, time, volume and capacity, measurement and weight. Topics were timetabled for each class in half-term units. This arrangement had been adopted partly to ensure the availability of teaching resources. The mathematics resource rooms were well organised, but teachers expressed concern about limiting the children's opportunity to revisit aspects of mathematics.

Mathematics curriculum development had a high profile in the school. The two teachers observed played a key role in writing the mathematics curriculum document which they used as the framework for lesson planning. The lesson plans showed a sequential development in mathematics teaching, resources were identified and differentiated and there was evidence of monitoring the attainment of individual pupils.

School 10 shared a high standard of professional practice. The mathematics coordinator, who was also deputy headteacher with responsibility for staff development, had been in post for four years. The staff had produced a mathematics policy and scheme of work. This included advice on record keeping, special needs, calculators, computers, methodology and resources in addition to a general statement of teaching approach for key stage 1 and key stage 2. There was a common approach to lesson planning, record keeping and evaluation. The classteachers of Year 1 and Year 3 expressed ownership of mathematics documents and school systems of planning. These included details of pupil grouping and differentiated activities for the more and less able pupils. In the staffroom, there was professional confidence in discussing progression and entitlement in mathematics.

The role of the mathematics coordinator in giving direction and support to mathematics teaching was significant. For example time was identified in the INSET programme for the mathematics coordinator to work with particular teachers on

aspects of mathematics planning and teaching. This included lesson time supporting the teacher in the classroom.

School 2 was very different. School record and planning systems were informal, but the teachers were highly motivated and questioned their teaching programme as a matter of course. Mathematics teaching was tailored to individuals but much of the content was scheme-driven. Attainments were good overall, but the attainment profile for the school included no Band 3 (lower-attaining) pupils. Observation suggested there were few in Year 1 and none in Year 3. A generalist approach was followed in planning a thematic curriculum, with little evidence of detailed planning for mathematics teaching.

At School 11, the content and quality of the provision for mathematics lessons appeared to depend on the skills and tenacity of individual teachers. There was little evidence of professional support for mathematics teaching from the mathematics coordinator or a school INSET programme.

There appeared to be a difference in emphasis between Year 1 and Year 3 mathematics teaching at School 14, but here the lesson planning was detailed and showed an ordered sequential development supported by a scheme of work and records of attainment. The Year 3 teacher was also mathematics coordinator and worked with colleagues to ensure there was appropriate coverage of attainment targets by each year group.

The role of the mathematics coordinator in monitoring mathematics content, advising on teaching strategies and the use of resources was well developed in Schools 7 and 18. The teaching approaches adopted in these schools were quite distinct. The first planned an integrated curriculum in an open plan school. Planning for mathematics lessons was carried out by teachers working in small teams using a scheme of work based on a two-year cycle of mathematics topics. School 18 was more traditional with 90 per cent of mathematics lessons subject-specific. Teachers worked on curriculum plans in small teams. This method of working appeared to ensure greater consistency and progression in mathematics teaching. The staff had developed a school mathematics policy and an age group-based teaching scheme, and the mathematics teaching was reviewed each half-term by the teaching team with advice from the mathematics coordinator. In these schools, it appeared consistent professional practice between classes enabled pupils to maintain good levels of progress in all areas of mathematics.

Information about those schools recording an overall attainment gain of between eight and ten per cent is given in Tables 7.4–7.6.

Table 7.4: Schools recording an overall attainment gain between eight per cent and ten per cent in mathematics assessments for Year 1 and Year 3 pupils

School organisation and mathematics lesson time							Mean for attainment gain		
	Year 1			Year 3					
School no.	Time per week	Class size Y1	% total lessons	Time per week	Class size Y3	% total lessons	Overal l % gain	% gain for Y1	% gain for Y3
8/9	375min	24	29	360min	26	27	10	13	8
16	405min	29	31	300min 365min	32 31	22 27	10	13	6
6	160min	28	12	240min	30	18	9	9	10
17	375min	27	29	370min	25	27	9	6	12
1	300min	27	22	330min	34	24	9	7	11
4	360min	28	27	330min	38	24	8	9	8
3	305min	31	22	285min	31	21	8	10	7

Table 7.5: Characteristics of schools recording an overall attainment gain of between eight per cent and ten per cent in mathematics assessments

Characteristics of school and locality					
School no.	**Size of school**	**School setting**	**General characteristics of population and school catchment area**		
8/9	250	Urban	Mostly middle-class but with some rented housing		Mainly modern estate housing
16	255+ Nursery	Urban	Mostly middle-class but with some rented housing		
6	375+ Nursery	Urban	Predominantly working-class, high unemployment	75% multi-ethnic: ESL support	35% pupil movement in/out
17	80	Rural	Mostly middle-class, semi-professional	SEN a priority: mostly language	
1	528+ Nursery	Urban	Social disadvantage, high unemployment, social housing		Inner city type culture with social problems
4	245	Urban	Very mixed catchment – high rise/mixed housing	Multi-ethnic: refugee groups: ESL	Inner city: 30–60% movement
3	405+ Nursery	Urban	Very mixed catchment – mixed housing	Multi-ethnic community: ESL	Inner city – stable population

Table 7.6: Mean for baseline of attainment and calculated pupil attainment profile for schools recording an overall attainment gain of between eight and ten per cent

School no.	Y1 mean for pupils' baseline attainment	Y1 attainment profile by calculated attainment band:			Y3 mean for pupils' baseline attainment	Y3 attainment profile by calculated attainment band:		
		Band 1	Band 2	Band 3		Band 1	Band 2	Band 3
8/9	50%	0	5	2	56%	3	1	3
16	47%	1	3	3	48%	0	5	2
6	49%	2	3	2	56%	1	5	1
17	57%	2	4	1	70%	2	5	0
1	57%	2	4	1	43%	0	2	4
4	49%	2	2	3	55%	2	2	3
3	53%	1	4	2	59%	3	2	2

The second group of schools comprises six schools teaching both infants and juniors and a separate infant and junior school situated on the same campus, School 8/9. Five Schools, 8/9, 16, 1, 4 and 3, teach an integrated curriculum in open plan teaching areas. Between a quarter and a third of mathematics in Year 1 is taught as part of an overall curriculum theme. The proportion of integrated mathematics teaching drops to a quarter or less for most Year 3 classes.

School 6 also taught a thematic curriculum, but as a matter of policy mathematics was taught as a discrete subject. Teachers worked in small teams and team teaching was used with one group of children. In School 6, the difference of over an hour per week in the time spent teaching mathematics, between Year 1 and Year 3 classes appeared out of step with otherwise fairly consistent provision between classes.

It was common practice, among this group of schools, for teachers to work in small teams, supported by the mathematics coordinator. Professional systems for planning the mathematics teaching were evident in each school, but there was tremendous variation in the detail recorded. Where there was agreement about teaching a scheme of work, differentiating materials and evaluating attainments, it appears schools were more likely to provide more systematic mathematics teaching. The link between a

school's mathematics policy and its teaching appeared tenuous in several schools. In half of the schools visited, the mathematics policy and teaching schemes were in the process of revision.

School 17 was different from others in the group. It was a village school with vertically grouped, mixed-age classes. Mathematics policy and planning for progression in teaching were less explicit. Evidence of planning for differentiation was weak and teaching resources were limited. Although teachers had produced a policy and scheme of work for mathematics in collaboration with a group of small schools, these did not appear to influence practice in the classroom.

The final group of three primary schools had the least well developed professional systems for planning mathematics teaching and providing professional support. All of the features of curricular organisation and professional activity previously described were evident to some degree in each school. However, there appeared to be a different set of priorities which caused these schools to be at an earlier stage of mathematics curriculum development compared with many other schools visited. Details of these schools are given in Tables 7.7–7.9. In School 12, it was not possible to administer the summer assessment for Y3.

Table 7.7: Schools recording an overall attainment gain of less than eight per cent in mathematics assessments for Year 1 and Year 3 pupils

School organisation and mathematics lesson time							Mean for attainment gain		
	Year 1			Year 3					
School no.	Time per week	Class size Y1	% total lessons	Time per week	Class size Y3	% total lessons	Overall % gain	% gain for Y1	% gain for Y3
5	300min 420min	30 31	32	295min	30	22	7.7	9	6
13	260min	29	20	360min	23	27	6.6	9	5
12	250min	28	26	240min	28	18	3.5	4	-

Table 7.8: Characteristics of schools recording an overall attainment gain of less than eight per cent in pupils' mathematics assessments

Characteristics of school and locality					
School no.	**Size of school**	**School setting**	**General characteristics of population and school catchment area**		
5	408	Urban	Very mixed catchment: private and rented housing	16% multi-ethnic: ESL support	
13	175	Urban	Mostly working-class: economic and social disadvantage	Multi-ethnic community: ESL support	35% pupil movement in/out
12	450+ Nursery	Urban	Mostly working-class: economic and social disadvantage: mixed housing	60% multi-ethnic community: ESL support	

Table 7.9: Mean for baseline of attainment and calculated pupil attainment profile for schools recording an overall attainment gain of less than eight per cent

School number	Y1 mean for pupils' baseline attainment	Y1 attainment profile by calculated attainment band:			Y3 mean for pupil's baseline attainment	Y3 attainment profile by calculated attainment band:		
		Band 1	Band 2	Band 3		Band 1	Band 2	Band 3
5	55%	2	4	1	55%	1	4	2
13	51%	1	5	1	55%	1	3	3
12	53%	3	1	3	-			

A feature of School 13 was a 35 per cent movement of pupils in or out of the school during the year. School 5 taught an integrated curriculum with a wide mathematics content, and School 12 showed the greatest variation in the quality of teaching between classes. Where the teaching was well planned and organised, it was the equal of that in other schools. The attainment profile for the pupils in these schools, given in Table 7.9, shows a strong weighting towards the lower end of the attainment scale. In that context, the pupils have made a creditable gain in attainment.

Schools are complex organisations and the ethos of teaching and learning established within a school appears to develop over time. The differing strengths and interests of

teachers were self-evident in the practice observed. The extent to which school systems build upon these attributes is a precursor of good mathematics teaching. Innovation and change are constant features of curricular development and school organisation, but the increased rate of curricular and organisational change over recent years has placed different demands on teachers. The range of curriculum-related activities in response to change showed considerable variation between the schools studied. It appeared all schools were working towards similar goals. Each was defining a mathematics curriculum, but the strategies adopted, and the outcomes, were quite different.

Analysis of information supplied by schools and gathered from fieldwork notes identified ten areas of professional activity which enabled teachers to develop the mathematics curriculum as a group in a school. The ten areas of activity were:

- Mathematics curriculum development which is inclusive

The degree to which a school staff develops an inclusive or associative view of what to teach, how to teach it, and to what age group appears to be the single most important factor underpinning consistent quality in mathematics teaching. Where teachers are involved and take responsibility for planning and resourcing mathematics teaching, it appears the overall quality of teaching is enhanced and the level of expectation raised.

- Writing a mathematics policy

Framing schemes of work which were based on agreements about progression, consistency and entitlement in mathematics teaching was ongoing in every school visited. Staff meetings, working parties, training courses and school-based staff development all contributed to the process. Schools were at differing stages in this process but schools having established teaching schemes, subject to regular and rigorous review, enabled the pupils assessed to achieve comparable attainment gains across the ability range. It did appear in a number of schools that expectations of the Year 1 children were increasing as teachers focused their teaching on small steps in learning and differentiated both their teaching and materials more clearly.

- A proactive and knowledgeable mathematics coordinator

One-third of the schools participating in this study had a member of staff who had attended a 20-day course for the mathematics coordinator. In every case, aspects of the training were disseminated to colleagues, and initiatives taken to improve mathematics teaching.

The role of individual mathematics coordinators covered a variety of tasks. In four schools, the role lacked definition. Where the coordinator fulfilled an extended role, this covered resourcing, leading policy and planning groups, reviewing curriculum coverage and providing professional support. In three schools, the mathematics coordinator was working alongside colleagues as part of the school's INSET programme.

- A supportive mathematics INSET programme

A school may have copious documentation, but teaching schemes appear most effective where staff have debated teaching strategies, content and progression. In several schools studied, there was lively informal discussion of teaching, whilst in others, professional conversation was limited. Where teachers were involved in both internal and external INSET, there was usually a positive attitude to mathematics and initiatives were being developed.

- Detailed lesson plans in mathematics

Many of the teachers interviewed said that National Curriculum programmes of study had made them focus on the sequence of quite small steps in mathematics. The detail of lesson plans varied, but the most detailed planning was associated with structured teaching and progression.

- Evidence of differentiation and grouping children for mathematics

Classroom organisation and lesson plans which included details of pupil groups, resources, and teaching content were associated with school systems which supported a consistent approach among teachers in differentiating tasks for groups and individuals.

- Focused teaching sessions

Maximum communication between teacher and pupil supported high attainment. Teaching styles varied enormously, depending on context. There is no right or wrong approach, but where teachers focused time with groups or individuals, observed pupils at work, questioned their strategies, encouraged participation and acknowledged achievements, the quality of learning was enhanced.

- Record keeping

Where schools had managed the demands of record keeping as an integral part of the teaching process, it was likely records were used to inform decisions about teaching content and in providing enrichment activities, especially for the most able children.

- Reference made to a range of teaching schemes and materials

The majority of schools studied relied on one published mathematics scheme, but most teachers wanted more varied materials. A few schools had established resource banks, and this approach seemed to produce a broader coverage of mathematics.

- Range and availability of mathematics resources

The deployment of mathematics resources and the focus of mathematics teaching were strongly influenced by the culture and ethos of individual schools. Schools mostly reported an adequate level of practical resources, but their availability was variable. One-third of schools were planning to purchase new books as part of their development strategy.

The data collected about schools and their mathematics curriculum were analysed in relation to the ten features described above. Schools were rated on a four-point scale and the result is shown in Table 7.10.

Chapter 8

Conclusions

The following issues were identified in those schools contributing to this study and suggest pointers for primary schools to reflect upon when reviewing their provision and practices in planning, teaching and evaluating mathematics programmes.

- The overall level of pupils' attainment in the aspects of Number, and Shape and Space studied by the project appears to be influenced by a range of professional and contextual features. The overall pattern of attainment gain shown in this study suggests the mathematics curriculum is more clearly differentiated for pupils of average and below-average ability. This raises concerns about attainment in relation to pupils' capabilities.

- Teachers of Year 1 and Year 3 classes give a lot of attention to routine Number work. At key stage 2, this appears to be at the expense of breadth in mathematical content, particularly the skills associated with Using and Applying Mathematics and Handling Data.

- Many pupils, particularly at key stage 2, are allowed to work at their own rate through a scheme or text book. This imposes constraints on the quality and timing of what is taught.

- Year 1 pupils sometimes showed greater facility in tasks which involved the manipulation of practical apparatus than Y3 pupils. The curriculum experience of Year 3 pupils in this respect was more problematic.

- Greater evidence of planning for differentiation and identification of precise teaching objectives was observed at key stage 1. The match of work to the pupils' previous attainment was more variable at key stage 2, and strategies for monitoring progress showed considerable variation.

- In the majority of schools studied, teachers kept a record of pupils' attainment in mathematics. However, in planning further work, only limited use was made of such records.

- Classes which achieved the greatest overall gain in pupil attainment were invariably well managed. The professional practice and subject knowledge of the teacher were key factors. The influence of a mathematics coordinator in providing a structure for mathematics teaching resulted in greater consistency in mathematics teaching. However, few coordinators were allocated non-teaching time to develop their role.

- Most schools studied were adequately or well resourced with a comprehensive range of practical equipment and materials. Teachers used lesson materials from a variety of sources, but in one-third of the schools studied, teachers failed to make good use of the resources available because of poor overall school planning or lack of awareness of what was available.

- National programmes of study have raised teachers awareness of the content of mathematics teaching, and established clearer expectations, particularly at key stage 1. The varied patterns of teaching observed raised issues of the effective use of mathematics lesson time and of balance between content areas.

- The issues raised above have implications for the quality of mathematics teaching experienced by children. The strongest messages derived from the mathematical assessments suggest there is scope to improve pupils' level of attainment in Number, particularly at Year 3, and that the more able child requires activities to extend learning in most aspects of mathematics. In many classrooms the reward for success, particularly in Number activities, was more of the same type of work at a similar level.

- Whilst administering assessment tasks in a one-to-one situation, it was interesting observing Year 3, high- and middle-attaining pupils solving problems about Capacity and Fractions. Most pupils appeared confident in using practical apparatus and were enthusiastic in applying previous knowledge and skills to problem solving. The curriculum described by teachers of Year 3 offered limited opportunities to engage in similar tasks but, even with the emphasis given to Number skills, many pupils experienced difficulty in applying mental skills with accuracy. For example, many Year 3 pupils were unable to recall important Number facts or make calculations quickly.

- The assessment tasks used in this study were based on current teaching practices, but the wide variations in levels of attainment between tasks and between schools suggest the context and presentation of some aspects of mathematics teaching might be reconsidered. For example, the tasks involving spatial relationships and abstract Number concepts were challenging for children in each attainment band.

- The mathematics curriculum was systematically planned in most schools studied and levels of achievement were generally good. However, the challenge remains to raise expectations and levels of achievement in all areas of mathematics. Consideration of the issues raised in this study will assist teachers in developing mathematics teaching.

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Appendix 1: The MAPS Assessments

Copies of the assessments used in the MAPS project are reproduced in a reduced-size format in order to save space. In this reduced size they are in landscape format, but the originals were A4-size portrait. Page references for each task are given below.

	Page
Naming and Recognising 2D Shapes	85
Addition and Subtraction	85
Understanding Movement and Direction	87
Calculations with Money	89
Rotation of 2D Shapes	89
Understanding Words Associated with Number	91
Visualising 2D Representations of 3D Solids	92
Division and Multiplication	93
Mental Skills	93
Understanding and Writing of Fractions	94
Calculator Tasks	95
Making 2D Shapes	96
Capacity	97
Reflection of 2D Shapes	97
Area	98

Child's Name_____ Boy/Girl

SHAPE & SPACE: Naming and Recognising 2-D Shapes **YEAR 1**

'Shapes Picture' Activity

Present shapes picture to child.

'Here is a picture made from some different shapes.'

'What is the name of this shape (indicate shape A)?'

If child gives no response or incorrect response, say that it is a circle.

'Can you show me all the other circles in the picture?'

'What is the name of this shape (indicate shape B)?'

If child gives no response or incorrect response, say that it is a square.

'Can you show me all the other squares in the picture?'

'What is the name of this shape (indicate shape M)?'

If the child gives no response or incorrect response, say that it is a triangle.

'Can you show me all the other triangles in the picture?'

What is the name of this shape (indicate shape C)?'

If the child gives no response or incorrect response, say that it is a rectangle.

(NB rectangle or oblong is an acceptable response)

'Can you show me all the other rectangles (oblongs) in the picture?'

If there are any shapes in the picture that have not been classified as circle,

square, triangle, or rectangle, then continue as below.

Otherwise, activity is completed.

'Now we've got some shapes left over. Let's find out if they have names.'

Indicate shape on picture.

'Does this shape have a name?' If "yes", then continue, 'What is the name of the shape?'

Indicate shape on picture.

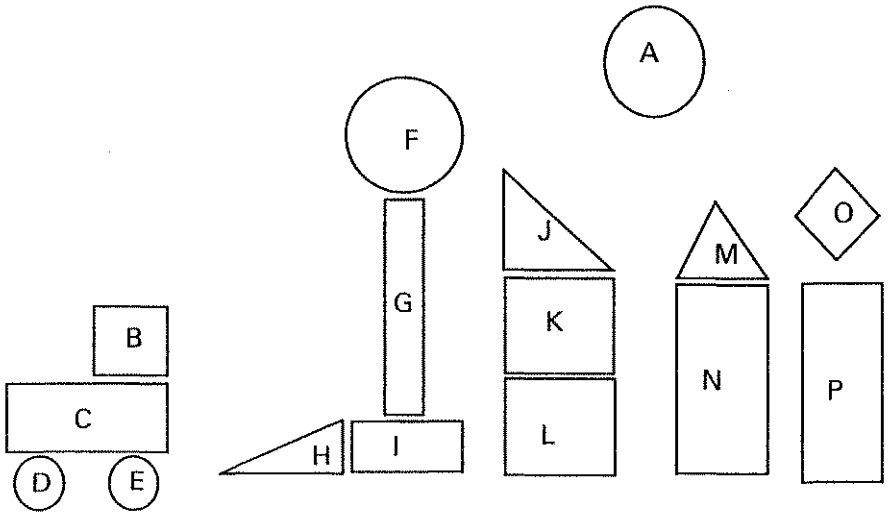
'Does this shape have a name?' If "yes", then continue, 'What is the name of the shape?'

Indicate shape on picture.

'Does this shape have a name?' If "yes", then continue, 'What is the name of the shape?'

Indicate shape on picture.

'Does this shape have a name?' If "yes", then continue, 'What is the name of the shape?'



Child's Name_____ Boy/Girl

NUMBER: Addition and Subtraction **YEAR 1**

'Cubes in Box' Activity

Place three cubes in one group and four cubes in another group on table in front of child.

'How many cubes are here (point to group of three cubes)?'

'How many cubes are here (point to group of four cubes)?'

'How many cubes are there altogether on the table?'

'How did you work that out?'

Place six cubes in one group and five cubes in another group on the table in front of child.

'How many cubes are here (point to group of six cubes)?'

'How many cubes are here (point to group of five cubes)?'

'How many cubes are there altogether on the table?'

'How did you work that out?'

Show child the box.

'Put two cubes in the box.'

Close lid of box.

'Now I've closed the box with two cubes inside. We can only open the box after you have worked out an answer.'

Give the child three more cubes.

'If you put these cubes in the box, how many cubes would be in the box altogether?'

'How did you work that out?'

'Open the box now. Show me if you are right.'

Empty the box.

'Put five cubes in the box.'

Close lid of the box.

'Now I've closed the box with five cubes inside. We can only open the box after you have worked out an answer.'

Give the child seven more cubes.

'If you put these cubes in the box, how many cubes would be in the box altogether?'

How did you work that out?'

'Open the box now. Show me if you are right.'

Empty the box.

'Put twelve cubes in the box.'

Close lid of the box.

'Now I've closed the box with twelve cubes inside. We can only open the box after you have worked out an answer.'

Give the child four more cubes.

'If you put these cubes in the box, how many cubes would be in the box altogether?'

How did you work that out?'

'Open the box now. Show me if you are right.'

Put box to one side.

'We'll do a different type of sum now.'

Place six cubes in a group on the table in front of child.

'How many cubes are here (point to the group)?'

'Take two cubes away, and tell me how many cubes are left'

'How did you work that out?'

Place twelve cubes in a group on the table in front of child.

'How many cubes are here (point to the group)?'

'Take three cubes away, and tell me how many cubes are left'

'How did you work that out?'

Show child the box.

'Put five cubes in the box.'

Put box in a position on the table so that the child cannot see directly into it.

Take three cubes out of the box and give them to the child.

Close lid of box.

'How many cubes are in the box now?'

If necessary, remind child that he/she put 5 cubes in the box.

Circle: Reminder necessary / Reminder not necessary

'How did you work that out?.

'Open the box now. Show me if you are right.'

Empty the box.

'Put six cubes in the box.'

Put box in a position on the table so that the child cannot see directly into it.

Take out six cubes from the box and give them to the child.

Close lid of box.

'How many cubes are in the box now?'

If necessary, remind child that he/she put 6 cubes in the box.

Circle: Reminder necessary / Reminder not necessary

'How did you work that out?.

'Open the box now. Show me if you are right.'

Empty the box.

'Put thirteen cubes in the box.'

Put box in a position on the table so that the child cannot see directly into it.

Take out five cubes from the box and give them to the child.

Close lid of box.

'How many cubes are in the box now?'

If necessary, remind child that he/she put 13 cubes in the box.

Circle: Reminder necessary / Reminder not necessary

'How did you work that out?.

'Open the box now. Show me if you are right.'

Child's Name_____ Boy/Girl

SHAPE & SPACE: Understanding of Movement and Direction **YEAR 1**

'Frog' Activity

'We are going to play a game in a little while, but before we get started, do you know which is your right hand?'

If child correctly indicates right hand, then reaffirm which is his/her right hand and which is his/her left hand.

If the child is incorrect or gives no response, then tell him/her which is right hand and which is left hand..

Indicate model frog.

'Can you show me which is the right side of this frog?'

Establish with child which is right and left sides of frog.

Place grid in front of child and place frog on square A, facing forwards in direction child is looking.

'I will read out some directions and you are going to move the frog and see which square it gets to.'

Read out the directions below, one at a time, and ask the child to move the frog each time. Note any errors made.

'MOVE FORWARD 2 SQUARES'

'TURN RIGHT'

'MOVE FORWARD 2 SQUARES, AND STOP'

Give child sufficient help so frog gets to the correct square.

'Well done. Show me which square you finished on.'

'Now I am going to read out some different directions, and we'll see which square the frog gets to.'

Place frog on square A, facing forwards in same direction child is looking.

Read out the directions below, one at a time, and ask the child to move the frog each time. Do not give the child any help.

'MOVE FORWARD 3 SQUARES'

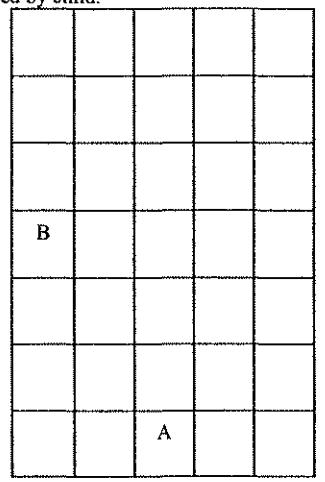
'TURN RIGHT'

'MOVE FORWARD 2 SQUARES'

'TURN LEFT'

'MOVE FORWARD 2 SQUARES, AND STOP'

Record journey of frog as moved by child.



'Well done. Show me which square you finished on.'

'Now I am going to read out some different directions, and we'll see which square the frog gets to.'

Place frog on square A, facing forwards in same direction child is looking.

Read out the directions below, one at a time, and ask the child to move the frog each time. Do not give the child any help.

'MOVE FORWARD 4 SQUARES'

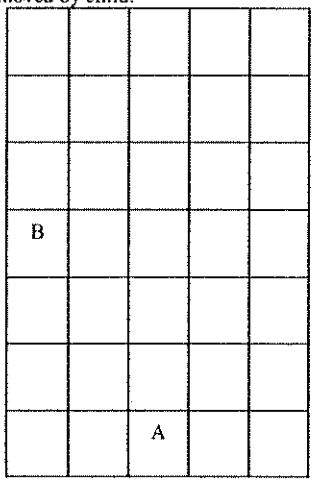
'TURN LEFT'

'MOVE FORWARD 1 SQUARE'

'TURN LEFT'

'MOVE FORWARD 1 SQUARE, AND STOP'

Record journey of frog as moved by child.



'Well done. Show me which square you finished on.'

"

'Now I am going to read out some different directions, and we'll see which square the frog gets to. The frog is going to start from a different square, facing a different direction.'

Place frog on square B, facing directly across the grid.

Read out the directions below, one at a time, and ask the child to move the frog each time. Do not give the child any help.

'MOVE FORWARD 2 SQUARES'

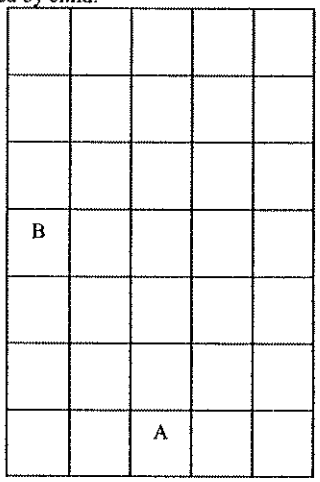
'TURN RIGHT'

'MOVE FORWARD 1 SQUARE'

'TURN RIGHT'

'MOVE FORWARD 1 SQUARE, AND STOP'

Record journey of frog as moved by child.



'Well done. Show me which square you finished on.'

"

'Now I am going to read out some different directions, and we'll see which square the frog gets to.'

"

Place frog on square B, facing directly across the grid.

Read out the directions below, one at a time, and ask the child to move the frog each time. Do not give the child any help.

'MOVE FORWARD 3 SQUARES'

'MOVE BACKWARDS 2 SQUARES'

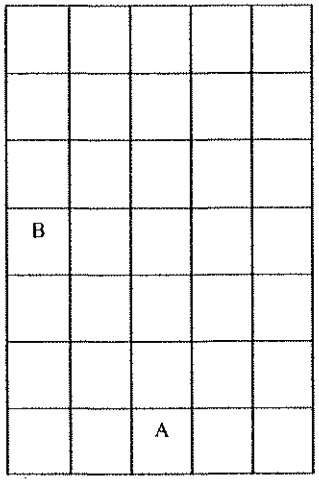
'TURN RIGHT'

'MOVE FORWARD 2 SQUARES'

'TURN LEFT'

'MOVE FORWARD 1 SQUARE, AND STOP'

Record journey of frog as moved by child.



'Well done. Show me which square you finished on.'

"

Child's Name_____ Boy/Girl

NUMBER: Calculations with Money **YEAR 1&3**

'Coins' Activity

Give child packet A containing three 2p coins and two 1p coins.

'Find out how much money is in this packet.'

'Give me five pence.'

2p 2p 2p 1p 1p

Collect coins back, put in packet, and put to one side.

Give child packet B containing two 5p coins, one 2p coin and three 1p coins.

'Find out how much money is in this packet.'

'Give me seven pence'

5p 5p 2p 1p 1p 1p

Give child back all the packet B coins.

'You want to buy something that costs this amount (show the child 10p label). Which coins will you give me? I can give you change if necessary.'

5p 5p 2p 1p 1p 1p

'Do I need to give you any change?' If "yes", then ask 'How much change do I need to give you?'

Collect coins back, put in packet, and put to one side.

Give child packet C containing one 10p coin and three 5p coins.

'Find out how much money is in this packet?'

'You want to buy something that costs this amount (show child 17p label). Which coins will you give me? I can give you change if necessary?'

10p 5p 5p 5p

'Do I need to give you any change? If "yes" the ask 'How much change do I need to give you?'

Collect coins back, put in packet.

'Now we've got three packets here (give child packets A, B and C). Find out how much money there is altogether.'

'You want to buy something that costs this amount (show child 33p label). Which coins will you give me? I can give you change if necessary.'

10p 5p 5p 5p 5p 5p 2p 2p 2p 2p 1p 1p 1p 1p 1p

'Do I need to give you any change? If "yes" then ask 'How much change do I need to give you?'

Child's Name_____ Boy/Girl

SHAPE & SPACE: Rotation of 2-D Shapes **YEAR 1**

'Badge' Activity

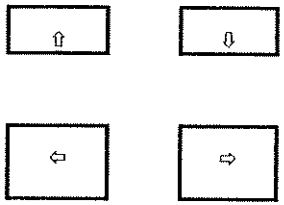
Put on badge 1

'Have a close look at my badge. It's made up of a card that is slid into a plastic holder.'

Demonstrate that the card can be slid in and out off the plastic holder, but do not remove the card completely.

'What I want you to do is to image that the card is taken out, turned upside down, and slid back into to the plastic holder. Which of these drawing would it look like?'

Show child sheet 1.

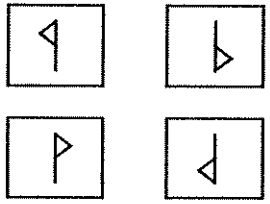


Take card out off holder, turn upside down, and put back.

'Does it look like the drawing you chose?'

Remove badge 1 and put on badge 2.

'Here is another badge, with a different drawing. What I want you to do is to image that the card is taken out, turned upside down, and slid back into the plastic holder. Which of these drawings would it look like?'

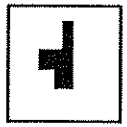


Show child sheet 2.

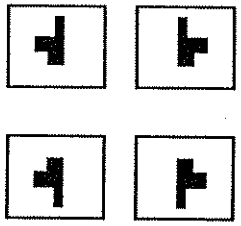
Take card out off holder, turn upside down, and put back.

'Does it look like the drawing you chose?'

Remove badge 2 and put on badge 3.



'Here is another badge, with a different drawing. What I want you to do is to image that the card is taken out, turned upside down, and slid back into the plastic holder. Which of these drawings would it look like?'



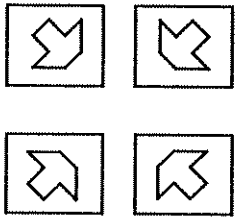
Show child sheet 3.

Take card out off holder, turn upside down, and put back.

'Does it look like the drawing you chose?'

Remove badge 3 and put on badge 4.

'Here is another badge, with a different drawing. What I want you to do is to image that the card is taken out, turned upside down, and slid back into the plastic holder. Which of these drawings would it look like?'



Show child sheet 4.

Take card out off holder, turn upside down, and put back.

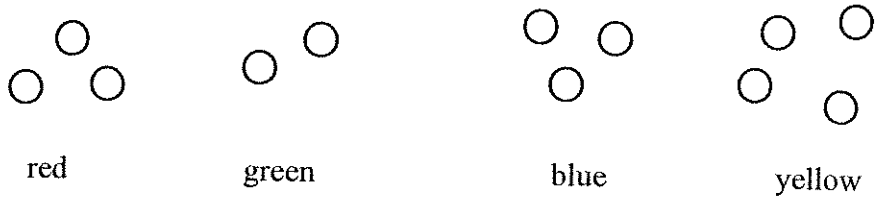
'Does it look like the drawing you chose?'

Child's Name_____ Boy/Girl

NUMBER: Understanding of Words Associated with Number **YEAR 1**

'Number Words' Activity

Put counters into four groups on table as shown:

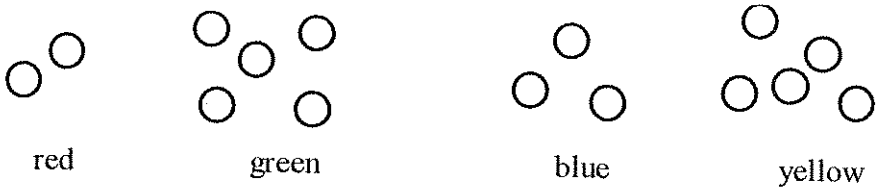


'We've got some groups of counters here. There's a red group, a green group, a blue group and a yellow group. Which colours have the same number of counters?'

'Which colour has the most counters?'

'Which colour has the fewest counters?'

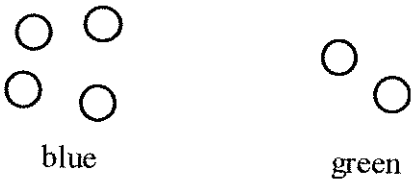
Put counters into four groups on table as shown:



'There's some different groups here. Which colours have the same number of counters?'

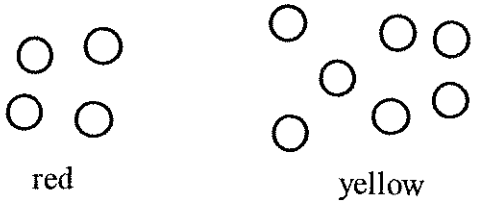
'Which colour has the fewest counters?'

Put counters into two groups on table as shown:



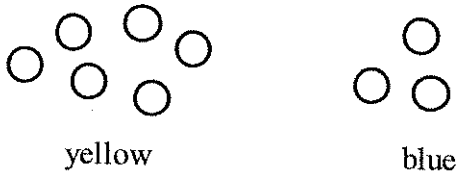
'We've only got two groups here; a blue group and a green group. Which colour has fewer counters?'

Put counters into two groups on table as shown:



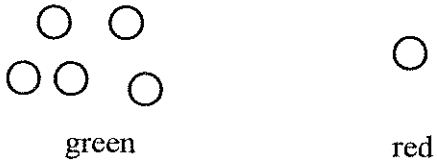
'We've only got two groups here; a red group and a yellow group. Which colour has more counters?'

Put counters into two groups on table as shown:



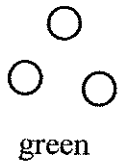
'We've only got two groups here; a yellow group and a blue group. Which colour has fewer counters?'

Put counters into two groups on the table as shown:



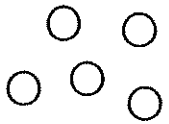
'We've only got two groups here; a green group and a red group. Which colour has more counters?'

Put counters into one group on the table as shown:



'We've only got one group here; a green group. Can you make a blue group so that there are twice the number of counters in the blue group as there are in the green group?'

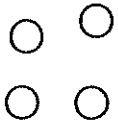
Put counters into one group on the table as shown:



yellow

'We've only got one group here; a yellow group. Can you make a red group so that there are twice as many counters in the red group as there are in the yellow group?'

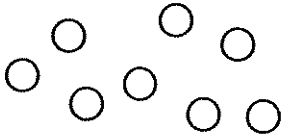
Put counters into one group on table as shown:



blue

'We've only got one group here; a blue group. Can you make a yellow group so that there is half the number of counters in the yellow group as there are in the blue group?'

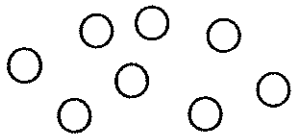
Put counters into one group on table as shown:



green

'We've only got one group here; a green group. Can you make a red group so that there is half the number of counters in the red group as there are in the green group?'

Put counters into one group on the table as shown:



blue

'We've only got one group here; a blue group. Can you make a yellow group so that there is quarter the number of counters in the yellow group as there are in the blue group?'

Child's Name_____ Boy/Girl

SHAPE & SPACE: Visualising 2-D Representations of 3-D solids **YEAR 1&3**

(A sheet with diagrams of the 3-D shapes accompanies this activity)

'Making Solids' Activity

Place all the cubes, unconnected, on the table.

'Here is a picture of a shape made out of cubes (present picture A). The shape can be made by putting cubes together.'

Demonstrate by making the shape. Then let child compare shape with the picture. Then put picture to one side, break up shape into four cubes, and put these back with other cubes.

'Here is a picture of another shape (present picture B). Make the shape with some of the cubes.'

If child has correctly made the shape, write CORRECT below. Otherwise, draw a diagram of the shape made. Write brief notes on how the child made the shape, whether correct or incorrect.

Put shape and picture to one side.

'Here is a picture of another shape (present picture C). Make the shape with some of the cubes.'

If child has correctly made the shape, write CORRECT below. Otherwise, draw a diagram of the shape made. Write brief notes on how the child made the shape, whether correct or incorrect.

If both shapes B and C made correctly, then put these shapes next to each other and ask 'How are these shapes different from each other?' Otherwise, go on to shape D.

Put shapes and pictures to one side.

'Here is a picture of another shape (present picture D). Make the shape with some of the cubes.'

If child has correctly made the shape, write CORRECT below. Otherwise, draw a diagram of the shape made. Write brief notes on how the child made the shape, whether correct or incorrect.

Put shape and picture to one side.

'Here is a picture of another shape (present picture E). Make the shape with some of the cubes.'

If child has correctly made the shape, write CORRECT below. Otherwise, draw a diagram of the shape made. Write brief notes on how the child made the shape, whether correct or incorrect.

If shape E is not made correctly, then make the base of the shape and give it to the child.

'You've nearly got it right. Can you add another cube to this to make the shape complete shape?'

If child has now correctly made the shape, write CORRECT below. Otherwise draw a diagram showing where the child added the cube to the base.

Child's Name_____ Boy/Girl

NUMBER: Division and Multiplication **YEAR 1**

'Bears' Activity

Place two pictures of bears on the table in front of the child.

Give child 14 cubes.

'Share these cubes equally between the bears.'

'How many cubes does each bear get?'

Give child 9 cubes.

'Share these cubes equally between the bears.'

'How many cubes does each bear get?'

Place three pictures of bears on the table in front of the child.

Give child 15 cubes.

'Share these cubes equally between the bears.'

'How many cubes does each bear get?'

Give child 8 cubes.

'Share these cubes equally between the bears.'

'How many cubes does each bear get?'

Place two pictures of bears on the table in front of child. Leave cubes on table for child to use.

'You can use these cubes if you like. Each bear gets 3 cubes. How many cubes is this altogether?'

'We can only use some of these cubes now.'

Put eight cubes in front of picture of one of the bears, and put all the other cubes away.

'Each bear gets 8 cubes. How many cubes is this altogether?'

'How did you work that out?'

Put all the cubes away.

'Now we can't use any of the cubes. Each bear gets 5 cubes. How many cubes is this altogether?'

'How did you work that out?'

Place three pictures of bears on the table in front of child. Put all the cubes back on the table.

'You can use these cubes if you like. Each bear gets 4 cubes. How many cubes is this altogether?'

'We can only use some of the cubes now.'

Put six cubes in front of the picture of one of the bears, and put all the other cubes away.

'Each bear gets 6 cubes. How many cubes is this altogether?'

'How did you work that out?'

Put all the cubes away.

'Now we can't use any of the cubes. Each bear gets 3 cubes. How many cubes is this altogether?'

'How did you work that out?'

Child's Name_____ Boy/Girl

NUMBER: Mental Skills **YEAR 1&3**

'Mental Skills' Activity

'I'm going to ask you to do some sums in your head, and I want you to tell me the answers.'

If necessary, repeat each sum.

'Five add two.'

'Nine take away three.'

'Four times four.'

'How many lots of three make eighteen?.

'I have four 2p coins in my pocket. How much money have I got?'

'How did you work that out?'

'I have ten pence. I spend seven pence on sweets. How much money have I got left?.

'How did you work that out?'

'I have five pence in one pocket and fourteen pence in another pocket. How much money have I got?'

'How did you work that out?'

'Toffees cost 4p each. I have twenty pence. How many toffees can I buy?'

'How did you work that out?'

'Now I'm going to show you a picture for just a few seconds. In the picture, there are some pink counters and some blue counters. I want you to tell me which colour there is more of.' *(A picture with 15 pink spots and 10 blue spots mixed accompanies this activity)*

Show the picture for four seconds.

'Which colour is there more of?'

'I'm going to show you the picture again for just a few seconds. I want you to make a good guess at how many counters there are altogether.'

Show the picture again for four seconds.

'How many counters are there altogether?'

'How many pink counters do you think there are?'

'How many blue counters do you think there are?'

Child's Name_____ Boy/Girl

NUMBER: Understanding and Writing Fractions **YEAR 3**

'Fractions' Activity

Give child 6 counters.

'Here are some counters. Can you give me back one half of the counters?'

'How did you work that out?'

Give child 8 counters.

'Here is a different number of counters. Can you give me back one quarter of the counters?'

'How did you work that out?'

Give child 12 counters.

'Here is a different number of counters. Can you give me back one third of the counters?'

'How did you work that out?'

Give child 12 counters.

'Give me back three quarters of the counters?'

'How did you work that out?'

Present sheet of strips to child.

'Here is a strip made up of a number of equal parts (indicate first strip). If I wanted to colour in one half of the strip, this is what I would do (colour in five parts). Now I've coloured in one half of the strip.

'This is another strip made up of a number of equal parts (indicate second strip). Colour in one quarter of the strip.'

'How did you work that out?'

'This is another strip made up of a number of equal parts (indicate third strip). Colour in two thirds of the strip.'

'How did you work that out?'

'This is another strip made up of a number of equal parts (indicate fourth strip). Colour in one fifth of the strip.'

'How did you work that out?'

'This is another strip made up of a number of equal parts (indicate fifth strip). Colour in three quarters of the strip.'

'How did you work that out?'

'These are three empty glasses. Can you show this glass (indicate glass on the left) half full of orange juice (give child orange crayon)?'

'Write half as a number in the box above the glass.'

'Show this glass (indicate glass in the middle) three quarters full of orange juice.'

'Write three quarters as a number in the box above the glass.'

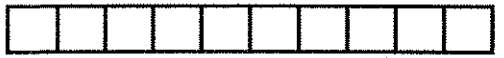
'Show this glass two thirds (indicate glass on the right) full of orange juice.'

'Write two thirds as a number in the box above the glass.'

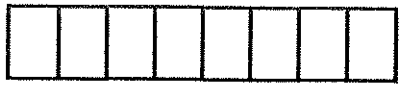
'Of the fractions, one half, three quarters and two thirds, which is the largest?.

Which of them is the smallest fraction?'

Child's Name_____



Colour in one half



Colour in one quarter

Colour in two thirds

Colour in one fifth

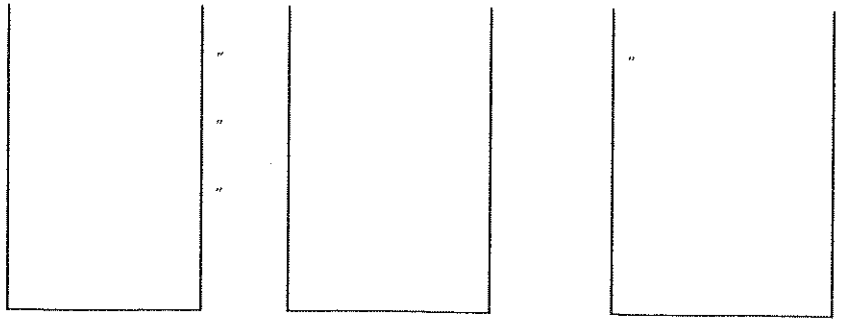
Colour in three quarters

Child's Name_____

One half

Three quarters

Two thirds



Child's Name_____ Boy/Girl

NUMBER: Calculator Tasks **YEAR 3**

'Using a Calculator' Activity

Provide child with the calculator they are most used to working with.

Ask the child to say what he/she calls the signs +, -, x and ÷ on the calculator.

\+ _____

\- _____

× _____

÷ _____

If child gives an incorrect response, or no response, say that they are add, subtract, times and divide, as appropriate.

Present child with sheet of sums.

'I want you to use the calculator to work out the answers to these sums.'

For each sum, record the answer on the calculator display and ask the child to read it out. If necessary, help child clear the display, and use the equals sing.

1. On calculator display _____

   Read out by child: as separate digits (eg "eight two")

   as complete number (eg "eighty two")

If the child reads out the number as separate digits, then say 'The number is eighty two.' (or whatever)

2. On calculator display _____

   Read out by child: as separate digits

   as complete number

If the child reads out the number as separate digits, then read it out as a whole number.

3. On calculator display _____

Read out by child as separate digits

as complete number

4. On calculator display _____

Read out by child: as separate digits

as complete number

5. On calculator display _____

Read out by child: as separate digits

as complete number

6. On calculator display _____

Read out by child: as "thirty two point five"

as "three hundred and twenty five"

as other _____

'Now I'm going to give you a sum, but before you do it on the calculator, I want you to tell me what type of sum it is. Is it an add, a subtract, a times, or a divide?' (or use child's words for signs if they are different)

Present child with sheet of sums in context.

Read out question 1 to child.

'What type of sum is it?' Circle + − × ÷

'Now work out the answer'

Record the keys pressed and answer on the display.

Read out question 2 to child.

'What type of sum is it?' Circle + − × ÷

'Now work out the answer'

Record the keys pressed and answer on the display.

Read out question 3 to child.

'What type of sum is it?' Circle + − × ÷

Record the keys pressed and answer on the display.

Read out question 4 to child.

'What type of sum is it?' Circle + − × ÷

Record the keys pressed and answer on the display.

Child's Name_____ Boy/Girl

SHAPE & SPACE: Making 2-D Shapes **YEAR 3**

'Making Shapes' Activity

Present child with ruler, pencil and pair of compasses.

'Have you ever used one of these (indicate pair of compasses)?'

Circle: Yes No Other.....

Demonstrate to child how to use the pair of compasses by drawing a circle on rough paper. (DO NOT use words 'radius' or diameter')

'Using any of this equipment I want you to draw, as best you can, the shapes described on this sheet (give child sheet).'

Record what child does, especially errors made. (If child wants to draw a shape again, use the reverse side of sheet).

Square

Rectangle

Triangle

Circle

If child draws a circle of radius 4cm, then say 'Is that four centimetres from one side to the other?'

If the child is aware of error, then encourage child to draw a circle of the correct size on the reverse side of sheet.

Child's Name.....

In the spaces shown, draw these shapes:

A square with sides 4 centimetres.

A rectangle 7½ centimetres long, 3 centimetres wide.

A triangle with sides 6 centimetres, 5 centimetres, 5 centimetres.

A circle that is 4 centimetres from one side to the other.

square	rectangle
triangle	circle

Child's Name_____ Boy/Girl

SHAPE & SPACE: Capacity **YEAR 3**

'Boxes to Fill' Activity

Present child with green box [2 x 2 x 2] and four cm cubes.

'Can you work out how many cubes like this would completely fill this box?'

'How did you work that out?'

If necessary, show the child how to fill the bottom of the box with a layer of four cubes. Explain that there are two layers, then eight cubes would completely fill the box.

'Here is another box (give child pink box [5 x 2 x 3]). Work out how many cubes would completely fill the box. Here is some paper if you want to write anything down to work it out (give child a piece of paper).'

'How did you work that out?'

If child gives the answer 30, go on to the yellow box. Otherwise continue as below.

'If you filled the bottom of the box with one layer of cubes, how many cubes would that be?'

If necessary, help child to see that layer would have 10 cubes. 'So how many cubes would completely fill the box?'

'Here is another box (give child yellow box [3 x 3 x 4]). Work out how many cubes would completely fill this box.'

'How did you work that out?'

'Here is another box (give child blue box [2 x 3 x 5]). Work out how many cubes would completely fill this box.'

'How did you work that out?'

If child has answered 30 for both pink and blue boxes, then ask: 'Why do these two boxes hold the same number of cubes?' (give child pink and blue boxes)

Place the four boxes in a line and ask the following questions:

'Which box holds the most?' .....

'Which box is the highest?' .....

'Which box has the largest base?' .....

'How large is the base?' .....

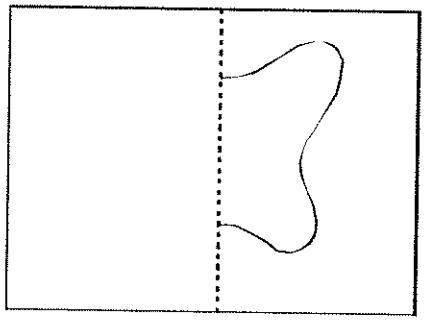
Child's Name_____ Boy/Girl

SHAPE & SPACE: Reflection of 2-D Shapes **YEAR 3**

'Folding Picture Over' Activity

'Have you ever made pictures by painting on one side of a piece of paper, folding the paper over, pressing it down, and making a copy on the other side?' (Demonstrate this using a piece of plain A4 paper by scribbling on the right side, folding it over, opening it out again, and then scribbling on the left hand side).

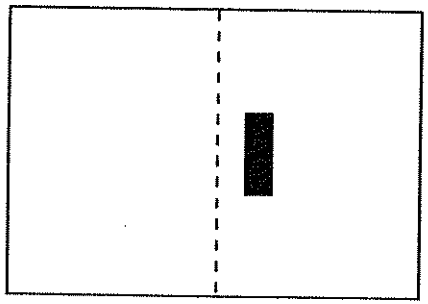
Show child card



'If this shape was painted in (indicate half butterfly shape) and the card folded along the dotted line (indicate dotted line) and pressed down to make a picture on the other side, this is what it would look like.'

Draw with reasonable accuracy the reflection of the shape on the left hand side of the card. (NB do not fold the card at any stage)

Give child card

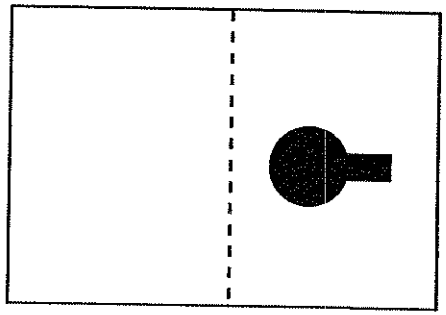


and a pencil.

'What I want you to do is to imagine that this shape has been painted in, and the card folded along the dotted line to make a picture on the other side. Draw, as best you can, what you think it would look like on this side.' (indicate left hand side of card)

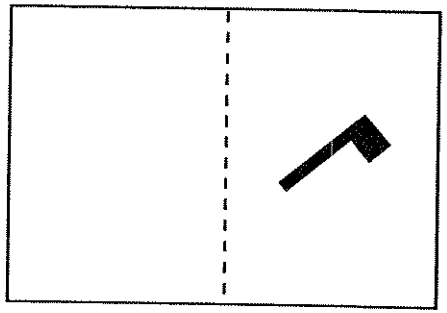
'Here is another shape. Again I want you to imagine that it has been painted in, and the card folded along the dotted line to make a picture on the other side. Draw, as best you can, what you think it would look like.'

Give child card



'Here is another shape. Again I want you to imagine that it has been painted in, and the card folded along the dotted line to make a picture on the other side. Draw, as best you can, what you think it would look like.'

Give child card



MAKE SURE CHILD'S NAME IS WRITTEN ONTHE BACK OF EACH CARD

Child's Name_____ Boy/Girl

SHAPE & SPACE: Area **YEAR 1 & 3**

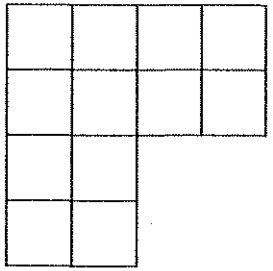
'Working Out Areas' Activity

'We are going to do some problems on working out the area of the shapes on this sheet (show the child the sheet showing four shapes). Before we get started, do you know what 'area' means?'

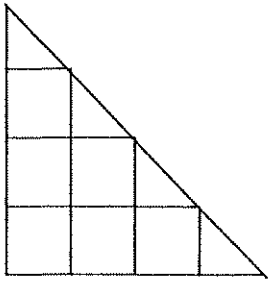
'Area is the amount of space covered by a shape. For these shapes (place sheet in front of child), you can find the area by working out how many squares are in each shape.'

'Let's look at the first shape together. This shape has (count the squares) one, two, three, four, five, six squares in it. So the area of the shape is six.' (write 6 next to the equals sign)

'Work out the area of this shape?'



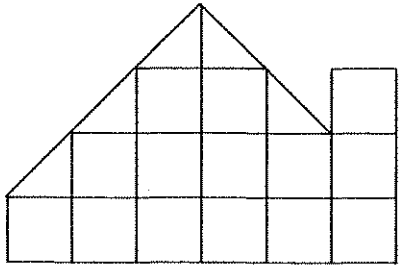
If necessary, for each shape, ask child to write the answer next to equals sign.

'In this shape (point to shape ),there are some half squares (point to the half squares).

So you will have to decide what to do with them.'

'Work out the area of the shape.'

'Work out the area of this shape.'



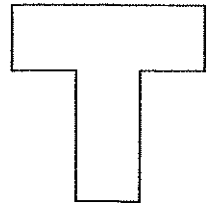
'Now on this sheet (give child sheet showing two grids), draw a shape that has an area of 17 squares.'

"

'Draw a shape that has an area of 13½ squares.'

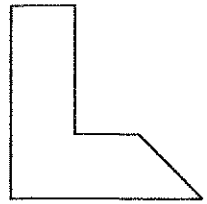
Present child with cm squares transparent grid.

'Using this grid, find the area of this shape.' (give child shape)



If child places shape on top of grid, so making the task more difficult, after several seconds say 'It's easier if you have the grid on top of the shape.'

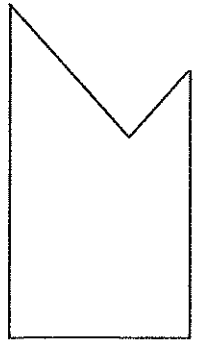
'Find the area of this shape.' (give child shape)



"

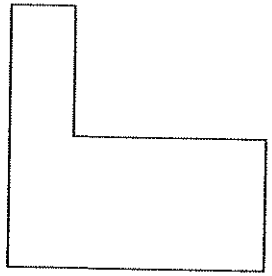
"

'Find the area of this shape.' (give child shape)



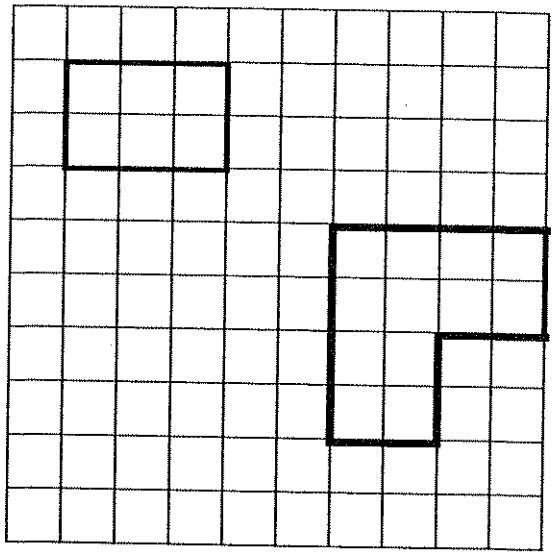
"

'Find the area of this shape.' (give child shape)



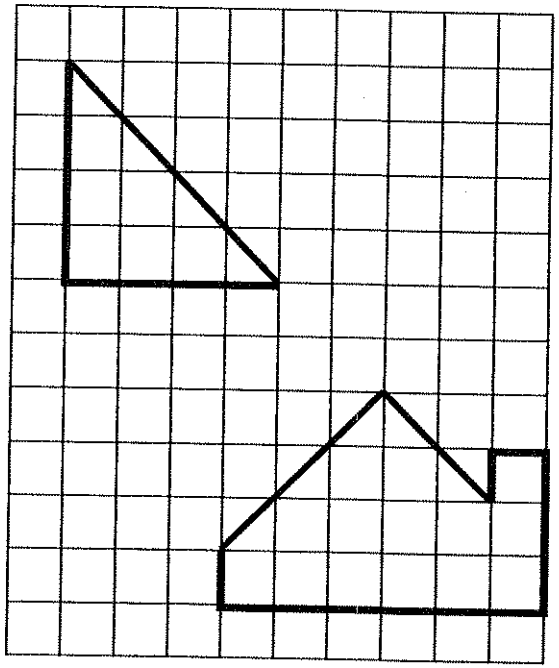
Child's Name.....

Area =



Area =

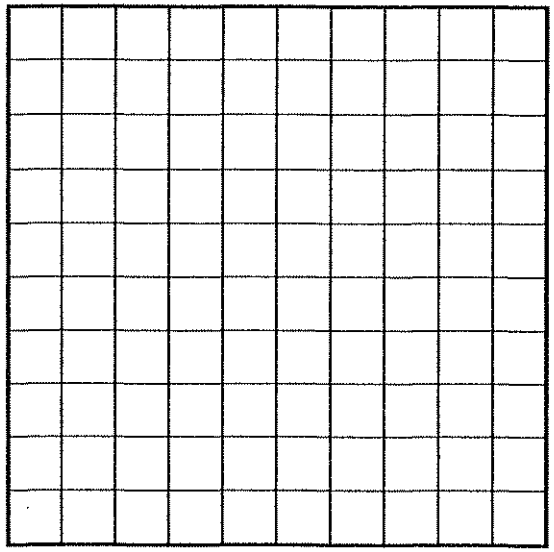
Area =



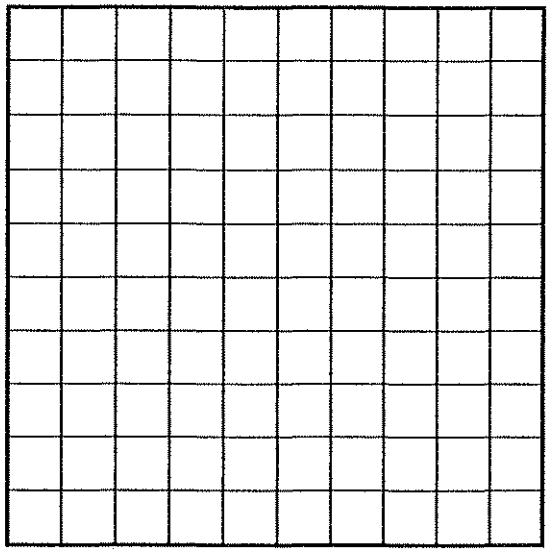
Area =

Child's Name.....

Area = 17



Area = 13½



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mathematics attainment in primary schools

Levels of attainment in mathematics have been the subject of controversy in recent years. The Mathematics Attainment in Primary Schools Project assessed the performance of a group of key stage 1 pupils at the beginning and at the end of Year 1 and that of a similar group of key stage 2 pupils at the beginning and end of Year 3. The assessments covered two important and contrasting areas of mathematics, Number and Shape and Space. Aspects of the schools and classrooms concerned were also examined.

Performance on the assessments suggested that above average pupils were often not making progress at the rate which might be expected compared to their average and below average peers. The match between the work and pupil's previous attainment in the Year 3 classes was more variable than in the Year 1 classes. When the results of individual classes were compared, the crucial factors associated with higher gains in performance over the years were identified as good classroom management and the subject knowledge of the teacher.

The report contains a wealth of detail on performance in both Number and Shape and Space, and on effective classroom practice in mathematics teaching.

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