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THE ROLE OF THE TEACHER IN THE ACQUISITION OF COUNTING SKILLS

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ABSTRACT

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The study is an action research project to improve the teaching of counting by focusing on three components. The first is the designing of materials and activities which may help children develop a greater understanding and confidence in their counting skills. The second is designing activities which will enable children to work as a class, as co-operative group members and as individuals within differing organisational frameworks. The third is finding ways of helping teachers effect the management of change within their classroom.

The collaborative study is based upon non-participant, non-judgemental observation of five teachers in different schools. It is a naturalistic investigation. The results of the observations were used to effect change within the classrooms through adaptation rather than through imposition of solutions. The foci of the observations were the role of the teacher and the range of counting experiences offered to six randomly chosen target children within each class. After nine observations over two school terms the target children undertook seven tests to assess their performance on various aspects of counting. The results showed that although there were significant differences between the teachers there was no significant difference between the test items. This is consistent with the view that counting skills are not independent entities.

Counting activities were designed by the researcher which would extend the counting experiences offered by each teacher. These formed part of a co-operative, school-based, teacher-researcher INSET programme. They involved the development of POSITIONAL concepts in counting, using numerals to represent number words, using ACTIVE and STATIC number lines and tracks, improving subitizing skills, using counting techniques in the solution of ACTIVE WORD PROBLEMS, using numbers as discrete labels and as points on a continuum. The design ensured children actively participated as co-operative class or group members and provided the opportunity for discussion between and with children. It also addressed the problem of matching activities to the teacher's organisational framework.

"So young children are faced with two important problems with respect to the counting words: there are a lot to learn; and they must be said in certain ways and not others."

Page 3; H.Ginsburg (1977)
"Children's Arithmetic, the Learning Process"
D.Van Nostrand:New York

"By ensuring the adequacy of children's counting as a foundation for arithmetic learning when children begin their schooling, educators may be able to forestall learning problems that would otherwise have a cumulative impact on children's progress through elementary school curriculum"

Page 12; C.Sophian (1986)
"Early Developments in Children's Use of Counting to Solve Quantitative Problems"
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CONTENTS

	Page
INTRODUCTION	1
LITERATURE REVIEW Counting	7
LITERATURE REVIEW Teacher's role	38
LITERATURE REVIEW Research Methodology	52
THE PRESENT STUDY METHODOLOGY	70
CASE STUDY Teacher M	79
CASE STUDY Teacher A	93
CASE STUDY Teacher J	115
CASE STUDY Teacher L	130
CASE STUDY Teacher H	145
INSET ACTIVITIES	161
RESULTS	179
CONCLUSION	201
GENERAL BIBLIOGRAPHY	215
APPENDICES	1

TABLES

	Page
Table 1-M Record of Teacher M contacts	84
Table 2-M Record of Teacher M-target children contacts	85
Table 3-M Teacher M counting tasks observed	89
Table 4-M Teacher M test results: Counting to 10 items	91
Table 1-A Teacher A test results: Counting to 10 items	104
Table 2-A Teacher A counting tasks observed	111
Table 1-J Teacher J counting tasks observed	124
Table 2-J Teacher J test results: Counting to 10 items	128
Table 1-L Teacher L counting tasks observed	139
Table 2-L Teacher L test results: Counting to 10 items	143
Table 1-H Teacher H counting tasks observed	151
Table 2-H Teacher H test results: Counting to 10 items	159
Table T-1 Chi-square test: all Teachers	183
Table T-2 Chi-square test: less Teacher L	183
Table T-3 Chi-square test: less teacher L and category H	184
Table T-4 Mean percentaged test scores	187
Table T-5 Ranking of test means	188

TABLES (Continued)

Page

Table T-6 188
Results of 2-way ANOVA on percentaged scores

Table T-7 189
Counting strategies: Tests 1-3

Table T-8 190
Silent or verbal counting: Tests 1-4

Table T-9 190
Response errors: Tests 1-4

FIGURES

	Page
Figure 1 Pie graph of time spent with different groupings (Using SISS 1)	185
Figure 2 Correct responses and pauses on numeral recognition test (Using Interchart)	192
Figure 3 Pauses and subsequent correct responses on numeral recognition test (Using Interchart)	193

PLATES

	Appendix-Page
PLATE 1 Desi-stick	57
PLATE 2 Desi-stick	57
PLATE 3 Holding Numbers	58
PLATE 4 Walking Numbers	59
PLATE 5 Floor Numbers and Action Cards	60
PLATE 6 Washing Line Numbers	61
PLATE 7 Washing Line Numbers	61
PLATE 8 Flap Jacks	62
PLATE 9 Numeral Cards	63

APPENDICES

	Appendix-Page
APPENDIX 1 Tasks observed each lesson	3
APPENDIX 2 Observational Records: Teacher M	11
APPENDIX 3 Observation of Teachers: 5 Minute Intervals	21
APPENDIX 4 Dates of Birth: Target Children	27
APPENDIX 5 Administration of Counting Tests	30
APPENDIX 6 Results of Counting Tests	39
APPENDIX 7 Analysis of Counting tests	49
APPENDIX 8 INSET activities: Counting materials	55
APPENDIX 9 Description of Active Word Problems	64

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INTRODUCTION

This study is concerned with the teaching of counting skills to young children. It has three points of foci. The first is in the design of materials and activities which may help children develop a greater understanding and confidence in their counting skills. The second is planning activities which will enable children to work as a class, as co-operative group members and as individuals within differing organisational frameworks. The third is helping teachers effect the management of change within their classroom.

Counting activities

A flexible use of counting provides an important foundation for much of the number work undertaken in Infant and First Schools. Sophian (1986) identified three aspects of elementary school arithmetic that depended upon flexible counting abilities:

a) Counting helps children learn the basic arithmetic facts.

b) Counting helps children discover fundamental properties of arithmetic operations, such as the commutativity of addition.

c) Counting helps children develop skills for solving arithmetic word problems.

The present study addresses the following areas related to the teaching of counting to children during their first year in school:

a) The limitations on young children's use of counting to solve quantitative problems.

b) Developing the restricted use of counting experiences in young children.

c) Developing children's informally learnt pre-school counting skills.

Organisational framework

The organisational frameworks which teachers employ need to ensure that children develop a positive attitude to their mathematics. Approaches to the teaching of a particular piece of mathematics need to be related to the topic itself and to the abilities and experience of both teacher and pupils (HMI 1982). Children need the opportunity to work both independently and co-operatively (HMI 1985). The organisational framework needs to allow for discussion and interaction between pupils themselves and between pupils and their teachers (Cockroft 1982; HMI 1985). There is no such thing as a definitive style for the teaching of mathematics (Cockroft 1982).

The design of the counting activities in the present study has three underlying principles. Firstly to ensure that children become actively involved in class and group lessons. Secondly to develop activities which will avoid the total individualisation of children's work. Thirdly to design the activities in such a way that they allow opportunity for discussion within the teaching situation, among the children themselves and between children and their teacher.

Management of change

It is the purpose of the study to effect change within the classroom through adaption rather than solution. It is to help teachers examine

their teaching in relation to their own constructions of their actions and their own aspirations (cf McIntyre 1980). It is a "study of singularities" (cf Bassey 1986) which recognises the centrality of the practitioner (cf Street 1986). The researcher's relationship with the teachers taking part in the research is as interested, non-judgemental observer (cf King 1984; Hartley 1985). The researcher acts as a collaborative colleague rather more than as an observer (cf Cummings and Hustler 1986).

Reason for the study

The researcher has been actively involved in INSET activities at both national and local levels over a period of seventeen years. This involvement has been primarily teacher centre based rather than school, or teacher, focused. He has found little evidence to suggest that non-school based INSET activity has a great success rate in effecting curriculum and management change within the classroom. He wished to be involved in an action-research study rather than a process-product study which treats teachers as subjects of research rather than participants in it (cf Elliott 1980, 1985). The study is not a comparative one. It is based on the belief that development of teachers (and children) is in allowing them to take one step on from where they consider themselves to be at any particular time. It is not the imposition of bench marks of achievement or imposition of "outsider" solutions to particular problems. A consequence of this is that the researcher needs to spend time with the teacher, to act as a mirror, in order to reflect her actions back to her so that she is in a position to decide which "further step" she wishes to take.

Many discussions with teachers by the researcher suggest that they

place emphasis upon sorting, matching and comparison activities in the early days of schooling for assessment purposes and to "develop language". Very rarely do they place emphasis upon assessing a child's counting ability and to develop the language of counting. Children's counting experiences tend to centre upon counting groups of real objects to develop ideas of cardinality. Cardinality is a vital concept in counting but there are others which also need developing. Ideas of ordinality and POSITION also have a role to play in the acquisition of counting skills. Most of the counting experiences offered to children witnessed by the researcher tend to promote the idea that numbers are "discrete entities". Little work seems to be undertaken to promote the idea of numbers as part of a continuum.

Much of the work seen by the researcher in classrooms implies that children are expected to work as individuals rather more than as group or class members. Even when working within a group the children operate as individuals (cf Galton et al 1980; HMI 1985). Participation in class or group oral activities, emphasises individual effort (Mehan 1986). There is a need for activities which encourage children to work co-operatively without emphasis on individualism.

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"The most important single factor influencing learning is what the learner already knows. Ascertain this and teach him accordingly". (preface: Ausubel, Novak and Hanesian 1978).

Piaget stated that counting was a skill in which young children could be trained, but would have little understanding of the process (Piaget 1952). Recent research seems to indicate that pre-school children can and do use counting strategies, with understanding, in order to solve simple problems and to develop ideas of conservation, order and cardinality.

Michie (1984) investigated the significance children attached to their counting and found children aged 4-6 used counting to compare number before performing on number conservation tasks. She found that children were significantly more accurate when they were putting counters into boxes than when placing them in rows on cards. They relied on information from counting when alternative perceptual cues were not present but when perceptual cues were present they were preferred. The probable reason for the preference being that the cues were visible and did not have to be remembered before they could be compared. She considered that either eliminating perceptual cues or aiding memory for number counted would reduce errors significantly. When both were combined performance was virtually error-free. Her opinion was that number counted could form the basis for 4-year-old's number judgments. She stated that the belief arising from Piaget's conclusions that counting by young children is a rote and meaningless task appeared to be wrong. Children could understand the significance of the numbers they recited even though they may, on some occasions,

counting might be played down in preference to other sources of information relevent to number (e.g. length of row). Children have been shown to count more frequently when feedback confirms that it is more reliable than length of row. Mitchie stated that if this was the explanation then teachers should be more concerned with training children how to assess situations to find those stategies (including counting) which were likely to be the more reliable. She thought that teaching the conceptual nature of numbers recited may be redundant.

Gelman and Gallistel (1978) stated that counting principles seem to have great significance in the development of conservation and order. Their research lead them to the view that initially children cannot reason about numbers without reference to representations of specific numerosities. These representations were obtained by counting. The judgement of equivalence or order, the application of the operations of addition, subtraction, and identity, and the process of solving all depended on counting.

Counting underwent a significant intellectual construction prior to the development of number conservation. Children used counting to discover the phenomenon of conservation but counting accuracy was not critical for the development of number-conservation concepts (Saxe 1979). Counting, and reading and writing number symbols, could enhance the understanding of conservation and order, provided children could reflect and recognise these aspects of number (Bell, Costello and Kuchemann 1983).

It had been observed that counting strategies would be used rather

than a pairing or matching strategy in comparing different sets and solving simple problems by children aged 4-6 years (Hudson 1983; Fuson, Secada, Hall 1983; Resnick 1983).

There was evidence that children entered school with a representation of number that could be characterised as a mental number line with numbers having a positional relationship along a string (Resnick 1983). Resnick considered that the individual positions of the numbers were linked by a "successor" or "next" relationship and that a directional marker on the string showed that later positions on the string were larger. She showed that this mental number line could be used to establish the quantity of a set and to directly compare the quantities of two sets.

Pre-school children were aware of numbers around them and the uses to which some of them were put (Sinclair and Sinclair 1984). The Sinclair's study on pre-school children in Geneva demonstrated that young children were able to differentiate between differing use of numerals in an environmental setting. They recognised for example: a sequencing context; a cardinal context; a convenience context (e.g. the number on the front of a bus). Pre-school children could also use counting strategies to solve simple problems (Groen and Resnick 1977; Starkey and Gelman 1982; Carpenter and Moser 1982; Hughes 1986). Pre-school children could and did use sophisticated counting principles (Baroody and Price 1983).

Some young children used fingers to represent objects, others counted aloud, apparently either imagining the objects or working directly off the sequence of number names. Other children could count forwards and

backwards. These counting strategies, which may not be totally reliable, were meaningful for young children and used to answer various types of mathematical problems (Gelman and Gallistel 1978; Saxe 1979; Hughes 1986). Some children counted without using the conventional count words or conventional count sequence. They made up their own lists, self corrected and spontaneously practiced (Gelman and Gallistel 1978).

Hughes's (1986) research showed that children entered school with a disparate understanding of number concepts and counting skills. He suggested that teachers should devise tasks which made sense to young children, so that it was possible to look at their strengths rather than their weaknesses, at what they could do rather than at what they could not. If teachers could get a clearer picture of what children actually knew about number when they first came to school then they would be one step nearer to understanding what was subsequently going wrong. His research also showed that there was a substantial difference between middle-class and working class pre-school children in carrying out simple additions and subtractions with small numbers. This difference being equivalent to about one year's age. He stated that the explanation usually given was that working-class parents offered less linguistic stimulation to their children, although his research suggested that this was not necessarily the case. He found for example, that important skills such as the ability to use "counting-on strategy" were used by children from both groups. His research showed that children's counting stategies were frequently untaught and were meaningful attempts by the children to solve the problems confronting them. These strategies, which made frequent use of fingers and counting up or down the number sequence may not have

been totally reliable, but were meaningful for young children and should be the basis from which mathematics education started.

Blatchford et al (1985) found evidence that girls entered school with higher numeracy skills than boys and that children's skills on entry to school had nothing to do with the ethnic origin of their parents.

Children invented original solutions and although mathematics may have been presented in a routine way this was not how they learnt it (Davis 1984). Children commonly ignored taught procedures and adopted others which fitted more easily into their conceptual systems (Bell 1983). Children often realised that counting would assist in the solution of problems but were let down by their limited ability to count (Hughes 1986).

> "So young children are faced with two important problems with respect to the counting words: there are a lot to learn; and they must be said in certain ways and not others."
> (pp 3 Ginsburg 1977)

The appeal of counting may be found in many stories and nursery rhymes (Cockroft 1982). Young children's counting should be extended and they should be encouraged to go on counting as far as they can (HMI 1979). Counting aloud was a measure of the difficulty children found in counting so considerable practice was required to make the process routine and so lessen the need for meticulous detail (Gelman and Gallistel 1978).

Von Glasersfeld, Steffe and Richards (1983) considered that counting was three intersecting, overlapping component activities. The first component was the ability to vocally (or sub-vocally) produce the

Standard Number Word Sequence (SNWS) when backward counting and counting on from any point. They stated that flexible use of SNWS facilitated a wider range of problem solving techniques. The second component was the ability to produce (perceptually or otherwise) a plurality of units that could be counted. Numerosity could only be attributed to pluralities if they were in a countable collection which placed them within spatial or temporal boundaries such as "beads in this jar". The third component was the co-ordination of number word and item to be counted. Although this was usually observed as some form of synchronisation of action or word with the item being counted this was not necessarily so because "correspondence" was the subjects focus of attention and could only be a matter of inference for the observer.

For accurate counting of items to establish cardinality children must use the number words in a stable order (Gelman and Gallistel 1978; Von Glasersfeld et al 1983). Children need to commit to memory the standard number word sequence, the sequence from "one" through "twenty". Von Glasersfeld et al (1983) considered that children must have the ability to use vocal and subvocal segments of SNWS and that the words for "one" through "twelve" must be fixed in a child's memory. After thirteen a preliminary composition procedure set in, after twenty-one a general one. The general composition procedure made it possible to extend SNWS indefinitely. Gelman and Gallistel (1978) considered that a five to fifteen item word sequence needed to be learned because after the word "sixteen" a generative rule emerged. They said that the count sequence needed a little rote learning but then could be continued indefinitely because of children's ability to develop generative rules. The acquisition of the sequence of count

words also involved discerning rules for generating counting tags beyond the base series. For some young children the SNWS seems to be an unstructured list until twenty (or twenty-nine) when the decade structure became evident (Fuson and Hall 1983). Fuson, Richards and Briars (1982) found evidence that children between 4.5 years and 6 years knew the repeating nines pattern in the decades but did not know the order of the decades. They also found little evidence to suggest that children understood the "teen" structure of the words. Ginsburg (1977) and Baroody and Ginsburg (1984) observed children verbalising rules and trying to generalise through words such as "tenny". These "rules" were not taught; the children generated them themselves. They also stated that children's mistakes frequently had a rational basis. Ginsburg (1977) and HMI (1979) considered that smaller numbers, to 13, are learned by rote, thereafter an underlining pattern emerged.

Whether children should learn the sequence words and the counting words as separate entities which eventually merged or whether both should be developed together (the words being given meaning) has been the cause of much debate. Ginsburg (1977) was of the view that number words did not necessarily convey correct number ideas. Von Glasersfeld et al (1983) suggested that recitation of SNWS had a rythmic activity and that this underlied the ability to use number word utterances as countables. When a segment of SNWS had been memorized, the child was able to use positional relationships without necessarily understanding numeric relationships. Fuson and Hall (1983) thought that reciting the number sequence would contribute to the acquisition of the sequence and to its eventual fluent production but probably did not contribute substantially to any further knowledge regarding the number words. Von Glasersfeld, Steffe and Richards

(1983) stated that a child's acquisition of the initial word sequence did not depend upon an awareness of countable items, although this awareness provided the opportunity to practice the sequence. They went on to say that as concepts, cardinality and ordinality had no part in a child's ability to recite a standard number word sequence; they were logically independent. As the child's extension of the standard number word sequence occurred there was usually a progression to more abstract units. In their model the "conception of cardinal/ordinal number" implied awareness of the possiblity of substituting for the given number word a collection of countable items, each of which could be made to coincide, in a counting action, with the number words preceding the given one. They thought that children could count by the coordination of number words and unitary items long before they had any conceptual structure that could be called a "set". They also asserted that children could correctly provide answers to the question "How many?" without understanding cardinality or ordinality. Saxe (1983) stated that number words, just as units, must be understood to have cardinal and ordinal values. He went on to say that construction of the number string and the construction of the unit was such that both could serve to represent one another. This argued against memorising a number string which was co-ordinated with the gradual conceptual construction of the unit. Sinclair (1983) expressed doubt that words and co-ordination with countables developed separately then fused at a certain point. She also doubted the value of backward recitation. She agreed with Skemp (1983) over the importance of number words not being names of separate items but of what they summed.

Using the sequence of number words in order to answer problems could

facilitate the realisation that addition and subtraction were inverse operations. This would contribute to children being able to select more efficient or convenient solution strategies to solving problems (Fuson, Richards and Briars 1982; Steffe, Cobb and Richards 1983). The sequence of number words could become a representational tool enabling children to solve number problems in cardinal contexts. Children used solution procedures of counting on in addition, and counting back x, or counting back to x in subtractions (Fuson, Richards and Briars 1982; Carpenter and Moser 1982; Fuson 1982; Steffe, Thompson and Richards 1982; Resnick 1983; Fuson and Hall 1983). The Davydov and Andronov (1981) research showed that some children indulged in "imaginary" counting on. They found that children used their mastery of counting to immediately count 'onward' from a given number word. Whilst this looked like counting on, when the children were asked to correlate the number word with the set of objects they reverted back to counting all or related the number word to only one element of the addend, not the whole group of items. They also reported on the contradiction between the cardinal and ordinal aspects of counting causing counting errors in young children's early addition techniques. The contradiction arose because the children related a certain number word both to the entire group and to one of its elements. They demonstrated that close observation of children's strategies for solving simple addition problems gave an insight into children's conceptual understanding of cardinality. They suggested that a sweeping movement of the hand over a group representing the first addend in an addition problem and stating a number name without counting, demonstrated an understanding of the cardinality of that group.

Children were more successful with addition than with subtraction when faced with the problem of adding (and removing) bricks from a quantity in a box (Hughes 1986). Hughes suggested that if the strategy on these problems was to count up and down the number scale starting from the initial contents of the box then, because children had more experience of counting up than of counting down, the results were to be expected.

Experiences should always precede the formalization so that later the words, the formalizations, would enable the mind to re-collect the experiences and the meanings (Dawson 1982; Leibeck 1986). Pimm (1986) referred to the two ways the verb "to count" was used; transitively and intransitively. He stated that intransitive counting (saying the number words in order) as well as transitive counting (learning ways to apply this system to the material world) both contributed to a child's experience of number. Intransitive counting was a solely linguistic experience. He believed that "rehearsal of a system independent of its application" was a familiar activity for children and that intransitive counting provided but one instance of exploring and getting a system right in production before approaching the harder task of figuring out what it had to do with the outside world. He emphasised the need for SNWS to be known for transitive counting to be successful.

Burton (1980) wrote that mathematics could embrace linguistic experiences as well as concrete experiences with manipulatives. Cobb (1986) observed during Melissa's Case Study that undue reliance on manipulatives could have unfortunate consequences. He did not advocate the banishment of manipulatives from the classroom, but

highlighted that other counting techniques could develop appropriate and efficient solution strategies. Davydov and Andronov (1981) found that a 'count all' procedure could be imposed upon children by the choice of manipulatives and the strategy of combining sets. When two sets were joined they lost their individual numerical identity and children had to obtain the result of the addition by counting one by one all the elements of the sum.

Siegel (1982) found that in early number development, perceptual non quantitative factors appeared to precede the use of language. As the child developed, the movement was away from a perceptual matching strategy to a conceptual numerically based one. Counting, audible or silent, was tied to language and a child's estimation errors were perhaps a failure to employ language skillfully, or not at all.

> "Counting is the production of a number word sequence, such that each number word is accompanied by the production of a unit item".
> (pp 83, Steffe, Thompson and Richards 1982)

Different types of counting could be based upon counting "unit items" (Steffe, Thompson and Richards 1982; Von Glasersfeld and Richards 1983). Von Glasersfeld and Richards (1983) considered that counting experiences required moments (or foci) of attention. They stated that, for example, "fourness" was the abstraction of this particular attentional pattern and that countable items which were obviously unitary and discrete had to be "isolated" and perceived as units or as pluralities. Their analysis showed that the attentional operations that created unitary items were in essence the same as number being units of units and there was no contradiction between the unity of the object and the plurality of the elements that constituted and

characterised it. Unity in the context of numbers was a collection of individuals taken together, that was to say, in both cases, there was a unitary item composed of a plurality of parts. "Number" was the abstraction of operations on units so that they were considered composite wholes. Gelman and Gallistel's (1978) understanding of how children counted contradicted the belief that an investigation into a child's counting skills could be done apart from questions as to what the countable items were and where they came from. Steffe, Thompson and Richards (1982) outlined five types of unit item: perceptual; figural; motor; verbal; abstract.

Von Glasersfeld, Steffe and Richards (1983) thought that the indispensability of perceptual signals for a child warranted the classification "counter of perceptual items". When dependence upon perceptual items lessened there had to be an internal re-representation of the perceptual signals. That was to say, the child had a figural representation of the perceptual item and became a "counter of figural items. Counting perceptual or figural items always involved a motor act such as pointing or tapping and when a child became aware that these motor acts could be substituted for the countables then the child became a "counter of motor items". Like motor acts the utterances of number words could become subtitutes of countable items of the perceptual or motor kind and this lead the way to the eventual abstraction of units and the concept of number. Hughes (1986) recorded children counting "hidden" items during his research (cf figural unit items).

Herscovics (1983) considered counting units to be comprised of four concepts: a physical one, such as a bag of candy; a component; an

aggregate, and a counting component, such as counting in fives.

Von Glasersfeld and Richards (1983) stated that children found difficulty in counting a succession of items, such as in two's, three's or ten's. When counting in two's the children could place two fingers on two items and remove the items from the original lot (sensory-motor "joining"). This technique obviously only worked with small numbers so the "taking together" became a "purely conceptual operation" i.e. several items which were visually separate and discrete were considered as if they were "one ". This mental act created the unitary composite to which a single number could be assigned in counting. This "taking together", a plurality of sensory signals (visual, tactual, auditory, kinesthetic) must not be confused with "summation" or forming a "set". It was logically and developmentally prior to any operation with objects. Von Glasersfeld, Steffe and Richards (1983), held the constructivist view of hierarchically developed experiences, and considered counting to be the result of a progressive abstraction in which, necessarily, the less abstract preceeded the more abstract. The final steps in the progression, the creation of wholly abstract units, acquired its operational power precisely because having been abstracted from sensory-motor material, it came to imply its potential application to any sensory-motor material. They accepted that there could be some children who would skip over some of these steps, especially on the sensory-motor level, but they believed in the absolute necessity that all types of sensory material should be cut from the children's experiences by the attentional pattern that created discrete items or "things". Progress in counting was marked by decreasing dependence on perceptual material, that was to say, the ability to count figural

representations. Head nods were common to many counters but did not necessarily infer a motor counter.

Children were able to subitize very small sets by being able to produce the number name without any counting. They had the ability to recognise the number pattern (Schaeffer, Eggleston and Scott 1974; Ginsburg 1977; Saxe 1979; Resnick 1983; Fuson and Hall 1983; Von Glasersfeld, Steffe and Richards 1983; Cooper, Campbell and Blevins 1983; Baroody and Ginsburg 1984; Hughes 1986). Gelman and Gallistel (1978) argued that counting preceded subitizing and rejected the notion that subititizing was a numerical abstraction method that acted independently of the counting procedure. They considered the development of rapid counting strategies for small sets began when counting of small sets had become largely subvocal. A contrary stance was taken by Cooper, Campbell and Blevins (1983) who suggested that the counting estimator (cf numerosity) developed subsequent to subitizing.

> "Determining a set's number is a formidable task for young children. Perhaps the most frequent difficulty is the tendency to get different results on repeated countings of the same set. First children get 10; then they carefully count again and get 11. Not only is their counting unreliable; they also see nothing wrong in it! There is no contradiction in counting ten fingers one time, and eleven the next". (pp12, Ginsburg 1977)

This contradiction was also reported by Siegel(1983). Children obtaining different totals as a result of counting a set of objects may be the result of counting accuracy, counting strategy or the choice of objects to be counted. Counting accuracy and counting strategy although correlated were partially independent from each other; counting accuracy could break down as a result of sensori-motor

impairment whereas counting strategy was not so vulnerable to impairments (Saxe 1977,1979).

Children relied heavily on counting techniques in order to solve problems (Hughes 1986). He reported on Juliette seeming to place more reliance on her faulty counting procedure than on her initial, and correct representation of bricks with fingers. In the same study he found that Andrew knew his number word sequence thoroughly from one to ten and could state correctly the total of two quantities of bricks placed in a box. When he checked by actually counting the bricks he miscounted through incorrect matching of word and touch.

Procedural strategies in counting have been much researched (Schaeffer, Eggleston and Scott 1974; Ginsburg 1977; Gelman and Gallistel 1978; Wagner and Walters 1982; Steffe, et al 1983; Fuson and Hall 1983; Baroody and Price 1983; McConkey and McEvoy 1986; Hughes 1986). McConkey and McEvoy (1986) studied how children with severe learning difficulties learned to count. They considered the basic number skills to be:

a) The ability to rote count from 1 to 20 without omissions.

b) The ability to recognise the numerals 0-9.

c) The ability to count out a quantity of objects from 1 to 20.

They considered these three skills as being independent with competence in one not meaning ability in another. They identified the following steps to be involved in counting a pre-determined set of objects:

a) Identify the items making up the set.

b) Recall the number names in the proper order.

c) Give each item in the set one, and only one, number name.

d) Remember the objects which had been counted and those which remained.

e) Realise that the last number named was the total for the set.

They outlined four different mental checks that had to be made for each object as a child counted: "What number am I at now?"; "What is the next number in the sequence?"; "Have I counted this object or not?"; "Are there any more objects to be counted?". They discussed some of the difficulties a child and teacher might have in deciding where a procedural counting error had occurred, quoting two examples of a child making an error of execution in counting an array of four objects:

X X X X...1,2,3,5

Wrong even though the rule of only touching each object once was kept.

X X X X...1,2,3,4,5

Wrong, even though the rule of number words was correct, one object was touched twice; one-to-one correspondence word and touch were correct.

They observed that the child was unlikely to realise that an error had been made for different reasons and may as a consequence have resorted to guessing. Here lay the problem for teachers because there was no easy way of explaining the errors. Correct counting demanded perfect rule keeping on all points. If a student could not process information simultaneously, he or she would not be able to count.

In counting for cardinality procedural accuracy was of vital importance, the larger the set to be counted the more likely errors were to arise (Schaeffer, Eggleston and Scott 1974; Gelman and Gallistel 1978). Accurate counting with smaller sets was, in part, due to subitizing (Ginsburg 1977; Fuson and Hall,1983). Counting could involve "sequence" (moving from item to item when direction was important) and "coordination" (moving from item to item when direction was not important) (Von Glasersfeld, Steffe and Richards 1983). In co-ordinating countable units to number words it did not matter whether the word or the unit came first, what did matter was if they became out of step (Von Glasersfeld, Steffe and Richards 1983).

Hughes (1986) conducting his "bricks in the box task" observed children relying on a direct visual image of bricks "hidden" in a box. They would tap at different places on the closed lid of the box whilst counting. Gelman and Gallistel (1978) noted that variation in colour or item type had little, if any, effect on counting accuracy. Fuson and Hall (1983) described the external behaviour of children whilst they were counting by matching successive sequence words to items in a well defined set. Objects not fixed were physically moved from the uncounted to the counted and pairing of countable to the sequence word was often observed with a pointing action.

Steffe et al (1983) were concerned with the internal representations that were involved in counting. They considered counting to be the production of a counting word and of a "counting unit item" (a mental construction). In perceptual counting the counter produced unit items from the concrete materials present.

Gelman and Gallistel (1978) outlined five "principles" necessary for accurate counting: one-one principle; stable order principle; cardinal principle; abstraction principle; order irrelevance principle. They found little evidence of children attempting to give the same "numberlog" to a particular item during re-counts. Contrary to this view Wagner and Walters (1982) found pre-schoolers tended to use a list exhaustion scheme. When a set was less than a child's known count sequence then double tagging would occur to use all the count sequence. When the set was greater than the count sequence then terms would be made up in order to exhaust all the set items. They also argued that their study suggested that Gelman and Gallistel's (1978) evidence for a stable-order principle was weak. Baroody and Price (1983) and Baroody and Ginsburg (1984) found little evidence of the list exhaustion scheme in their research. They found children tended to use stable nonconventional sequences across the counting tasks. Fuson, Richards and Briars (1982) and Baroody and Ginsburg (1984) found children counted in three portions: an initial conventional stable portion; a stable nonconventional portion; a final nonstable "spew" portion. Some children moved straight from the initial conventional stable portion to the nonstable "spew" portion (Baroody and Ginburg 1984). Repetition of terms during the stable nonconventional portion seemed to be inconsistent with the stable-order principle and with a "uniqueness scheme" which demonstrated the understanding for the need to generate a sequence of distinct terms (Baroody and Price 1983; Baroody and Ginsburg 1984). However, when counting, children who appreciated the stable-order principle would avoid repeating standard or non-standard terms that they remembered using previously. Consequently a spew or repeated term per se was not inconsistent with a stable-order principle

(Baroody and Ginsburg 1984).

HMI (1979) reported that restriction to one type of apparatus could restrict the child's understanding of number. Bologna (1982) stated the difficulty of teachers being able to recognise the strengths and weaknesses of the various types of apparatus in developing a child's understanding of number.

Children were able to use several basic counting stategies in solving addition and subtraction problems before they received formal instruction (Carpenter and Moser 1982). In solving addition problems they identified three types of solution strategies: direct modelling with fingers, or physical objects; using the counting sequence; using recalled number facts. In the counting strategies three distinct methods were observed:

a) "Counting all without models" - beginning the counting sequence with one and continuing until the answer was reached, without used physical representations.
b) "Counting on from first" - counting on from the first addend.
c) "Counting-on-from-larger" - counting on from the larger addend.

In solving subtraction problems using counting strategies Carpenter and Moser (1982) observed "Counting down from" which was a backwards counting sequence from the larger number and "Counting up from given", which was counting on from the smaller number to reach the larger. They found children were able to solve certain types of story problems using counting strategies although the solutions usually used only manipulatives and forward counting.

children had difficulty in counting on from numbers other than one (Resnick 1983). For problems involving larger numbers most children who succeeded used the "counting-on" from initial quantity (Hughes 1986). Children could move from the "count-all" strategy to the "count-on from initial quantity" to the "count-on from larger quantity" without any teaching of these strategies. This inferred that children "invented" them for themselves (Fuson 1982; Groen and Resnick 1977; Hughes 1986). Analysis of counting-on procedure showed that children would revert to a count all stategy after using a count on strategy under certain circumstances, such as when both addends were visible and capable of being counted (Davydov and Andronov 1981; Fuson 1982). The counting on strategy involved a cardinal-count transition. It involved the child in the transition from the cardinal value of of the first addend in an addition problem, to the counting meaning of that word and then counting on from this count word the second addend (Fuson 1982). An ability to count-on represented a use of abstract units because counting had become "reflective" (cf Piagetian) and as such, operative rather than figurative (Von Glasersfeld, Steffe and Richards 1983). Davydov and Andronov (1981) considered that the transition from counting all to counting on, based on the child's smooth movement of hand over an object group, took place when the child grasped the relationship between a group of objects and a number which was characteristic of mental adding. Mental adding occurred when the child became aware of the action of addition as distinct to the action of counting as demonstrated by the smooth hand movement over a set of objects. Only in this movement did the object group begin to appear to the child as a unit.

Research has shown that young children can count efficiently and

establish the cardinality of a set (Steffe,L.P., Thompson,P.W. and Richards 1982).

The last number word said in counting a set of items gave the cardinal word for that set; Cardinality Rule (Scaeffer Eggleston and Scott 1974); the Cardinality Principle (Gelman and Gallistel 1978); Count-Cardinal Transition (Fuson and Hall 1983). Gelman and Gallistel (1978) inferred that the Cardinality Principle had been understood:

a) when children correctly responded to the question "How many?" after a set had been counted.
b) emphasised, or stated more slowly, the last word when counting a set.
c) repeated the number word after counting a set.
d) remembered the correct cardinal word from a previously counted set.

They found that children's response to the question "How many?" with a recount of the items did not necessarily reflect a lack of understanding of the Cardinality Principle. For some children it was a "trigger" which had been interpreted as the command "Count them again". For other children, who were at the early stages of counting experiences, it might have been construed as a gentle way of telling them that they had miscounted and should recount a little more carefully. It was also quite possible that they could simply have forgotten the last number word they had used.

In arriving at the cardinal value of a set the order in which the individual items were counted was irrelevant (Ginsburg 1977). Gelman and Gallistel (1978) referred to this as the order-irrelevance principle.

The cardinal context described the numerousness of a well defined and discrete set and there were special cardinal words such as: duet; trio; quartet; pair (Fuson and Hall 1983).

Markman (1979) stated that cardinal number applied to aggregates, not to individual items, and the labelling of an array of objects as a collection rather than a class, facilitated a child's numerical reasoning about discrete objects. Children were better able to conserve and appreciate cardinality when collection terms, such as army, were used in preference to class terms, such as soldier, because they focused on the whole set rather than on the individual components of the set.

There may be several paths to a child appreciating the concept of "two". There are: kinaesthetics (one in each hand); visual patterns (that one and that one); sensorimotor (one and then another) (Fuson and Hall 1983).

McConkey and McEvoy (1986) outlined the difficulty of grasping different number meanings:

a) Four cars and four matchboxes were "the same". This ignored the characteristics of the items but focused on group size.
b) A cake, when cut into four pieces, turned one item into four.
c) 1,2,3,4; where the last object counted was four, even though it was only one object. On a re-count the same object might be "two". Children needed to be able to see the group and not focus on individual items.

Children had grasped the "one-one Principle" once they realised that each item counted must only have one number word (Gelman and Gallistel 1978).

Von Glasersfeld, Steffe and Richards (1983) asserted that the semantic link between a number word and the concept of a summation of units could only be made on the level of abstract units. They also added that this semantic link need not be made in every context, since number words stood for different things in different contexts, especially for those children who were counters of abstract units. Each number word implied the sequence of number words which preceded it. Uttering a number word implied the counting activity which had used the standard number word sequence in one-to-one correspondence with countables items. When that implication was understood, (when the use of a number word brought with it the awareness of a potential count that lead to and ended with the given number word, implying a count of a collection), then, and only then, could the child be said to have an abstract conception of units and number.

Fuson and Hall (1983) distinguished between "ordinal" and "ordering". Entities could be ordered according to some criterion but only took on an ordinal word context when the relative magnitude, or relative position, of one of the entities was considered in relation to the other entities. They stated the importance of distiguishing in future research the difference between "order relations" (cardinal, measure, sequence and ordinal contexts) and "ordinal word contexts".

The order-irrelevance principle did not apply in an ordinal context because children order first, then count. In developing cardinality

the countables children experience usually had some "sameness" about them which did not necessarily lend themselves to consideration of ordinality. When considering ordering, leading to ordinality, each countable was intrinsically "different" to allow for an ordering criterion, an unusual counting experience for children (Gelman and Gallistel 1978).

Children's recognition and interpretation of the number symbols played an important part in their development of counting skills. The interpretation of number symbol meaning had not a uniform level of difficulty for children (Hughes 1982). Children were used to seeing the number symbols around them and showed an aptitude for understanding the different purposes to which they related (Sinclair and Sinclair 1984). Numeration was a process consisting of moving from the number (associated with a given collection) to the representation of that number (Bednarz and Janvier 1982). Numerals should be introduced as symbols denoting "absolute manynesses" (Brainerd 1979). Children should not use symbols until they could convey orally and pictorally what they meant (HMI 1979). Associating a numeral with its concrete meaning was easier when the meaning was ordinal rather than cardinal (Brainerd 1979). Even preschool children found representing cardinal numbers with written symbols remarkably easy when the numbers were small (Hughes 1982,1986; Sinclair, Siegrist and Sinclair 1983). Hughes (1986) distinguished between children's Idiosyncratic, Pictographic, Iconic and Symbolic representations of quantities. How children represented quantities, whether by number symbol, word, drawing or a combination of these depended upon the verbal instruction given to them. "How many?" lead most children to represent the quantity by numerals, whilst "What?" lead children to

represent the quantity by writing or drawing (Davis, Bridges and Brosgall 1985). There was a serious mismatch between symbols children had to learn and their own "spontaneous conceptualisations". When representing quantity, it seemed that children themselves tended to use methods based on one-to-one correspondence, but were required to use a symbolic system instead (Hughes 1986).

Instead of symbols only being introduced and used to represent a cardinal value the system of numerals could be worked upon, independent of their meaning, as part of mathematics being accessed directly as a linguistic phenomenon (Tahta 1985; Pimm 1986). Pimm (1986) suggested that experience with symbols was a necessary part of learning mathematics, even with the very youngest children. He wrote that mathematical signifiers formed part of a system whose properties could be explored, as signifiers per se, rather than signifiers of something. He tried to refine the notion of "experience" so as to move away from the automatic presumption that manipulation of physical objects formed both a necessary and sufficient route into arithmetic, or any other branch of mathematics.

This argument that symbols can be used and understood in a liguistic sense was in conflict with the view that symbols should represent the formalisation of some manipulative experiences (Liebeck 1986). Liebeck expressed the view that mathematics learning must be based on experience (activity with familiar objects) and that it could not take place as a result of linguistic experience. She used the mnemonic ELPS:

E - Experience where the teacher provided objects and did

L - Language where the teacher was asked to talk with the children

P - Picture where a picture was made of the activity

S - Symbols where the experience was translated into symbolic form.

Whatever the argument as to how symbolism was used, teachers were anxious to reach a symbolic stage so as to have tangible evidence of mathematical learning (Bologna 1982).

Davydov and Andronov (1981) considered that the transition of physical acts to ideas was closely connected with the use of symbols, in that only by transforming the object set into a symbol for any number was it possible for a child to reconcile the contradiction between the ordinal and cardinal aspects of number. The acceptance of symbols opened to the child the immense possibilities of using numbers in the logic of mental actions. They considered the smooth hand movement over a group of objects, without counting, matched to the utterance of a number word was equivalent to using a symbol for that group.

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The didactic class-teaching style prevalent in the 1960's was changed mainly as a result of the Plowden Report (1967) leading the vanguard action towards individualised learning in our schools and the enquiry-based discovery learning approach to teaching. Plowden (1967) envisaged the primary teacher as enjoying a guiding, questioning role, who tactfully intervened whilst children were engaged in discovery learning. The discovery method of learning was more appropriate in the pre-school and early elementary years because concept formation rather than concept assimilation was occurring (Ausubel et al 1978). Ausubel (1978) considered that expository teaching was "authoritarian" and that training in the "heuristics of discovery" was more important than training in subject matter because problem-solving ability must be the primary goal of education. Cockroft (1982) agreed that problem solving and practical activities were fundamental to the teaching of mathematics but considered 'exposition by the teacher' as a necessary ingredient of teaching style in the now famous paragraph 243. The paragraph also included reference to the necessity for: discussion between teacher and pupils and between pupils themselves; appropriate practical work; consolidation and practice of fundamental skills and routines; problem solving, including the application of mathematics to everyday situations; investigational work.

Ausubel et al (1978) stated that the individual student rather than the class as a whole must become the "working unit" in teaching and individualised teaching must constitute one of the primary goals of instruction because individual differences were too diverse to be

considered otherwise. These individual differences included: a child's mode of cognitive functioning; approach to problem solving; subject-matter sophistication; general level of intelligence; specific academic aptitude; motivation for learning; intellectual curiosity; self-critical ability; need for precise meanings and integrated knowledge; ability to think independently, critically and creatively.

Plowden (1967) did not differentiate between children working individually and teachers giving attention to individual children. Studies have shown that even when children were sat in groups they still tended to work as individuals (Galton et al 1980; HMI 1985). Effective learning in groups or as individuals depended partly on whether the child was working with rather than in the presence of other children (Ausubel et al 1978). 'Grouping' referred to an organisational feature whereby an average of four or five children were seated together working as individuals and 'Group Work' was a pedagogical feature whereby a small group of children worked collectively on a task (Tann 1981). Teachers concentrated on individualisation both as work and as attention on children and that in spatial and notational grouping, children worked as individuals and no convincing group work was encountered in the ORACLE study (Galton et al 1980).

For grouping to make any pedagogical sense it must be differential in nature, in accordance with subject-matter, aptitude or achievement. Obviously some form of group teaching was inevitable because total individualisation was not feasable economically, hence the need to find compromise between grouping and individualisation (Ausubel et al 1978).

Galton et al (1980) found that individualization, class teaching and didactic group work allowed the problems associated with co-operative group activities to be evaded. Children did not have the opportunity to develop pedagogic (explaining) skills, even though they worked as the member of a group, because individualisation was overwhelmingly factual and managerial. The wider pedagogical considerations were ignored in order to keep the whole class busy. Teacher-pupil interaction was asymetrical, in that the teacher was interacting for a large part of her time with the children whilst each individual child only received a small part of the teacher's time.

Because teachers seemed determined to be instantly available to any child at any time, they found it difficult to create a few minutes with an individual child in order to conduct diagnostic work (Desforges 1985). When teachers engaged in frequent, short interchanges with the children in their class, these interchanges were usually managerial and when the teacher became involved with a child for a longer period there would be interuptions from other children for reassurance and feedback. These interuptions were tolerated as necessary by the teachers (Resnick 1972).

The ORACLE study (Galton et al 1980) showed that the amount of attention individual pupils received was related to the distinctive type of pupil and that there was a link between teaching style and pupil behaviour. They broadly categorised teaching styles under four labels:

'INDIVIDUAL MONITORS' were teachers who moved rapidly from table to table. When they sat at their desks a queue formed of children asking

for instructions and reassurance. Most interactions were brief. They tended to be silent markers.

'CLASS ENQUIRERS' were teachers who placed emphasis on questions related to the task in hand and much of the learning was teacher managed. They tended to introduce a topic to a whole class, questioned and answered then moved among the children questioning and giving feedback.

'GROUP INSTRUCTORS' were teachers who made a high level of factual statements and received verbal feedback. They demonstrated by showing or gesture and structured the work of the group carefully before allowing them on task. Emphasis was on giving information i.e. a didactic approach. They expected children to work as individuals, even in group situations.

'STYLE CHANGERS' were teachers who used a mixture of the other styles.

The ORACLE study found that distinctive types of pupils could be categorised under the labels:

'ATTENTION SEEKERS' were those who were more likely to wait for the teacher, be out of their base area, move around the classroom and seek out the teacher.

'INTERMITTENT WORKERS' were those who initiated and responded to conversation in their own base area. They watched what other children were doing and engaged in brief conversations between the task activities.

'SOLITARY WORKERS' were those reluctant to interact with other children. They took a passive role and remained static in their base. They were listeners rather than conversationalists.

'QUIET COLLABORATORS' were those who waited for the teacher, were fairly static, relied heavily on teacher's support and rarely tried to

overcome problems themselves.

There was clear evidence that teachers adapted their organisation to provide satisfactorily for children of different attainments and abilities, to accommodate various types of work, including practical work, and to take advantage of resources and teaching strengths available within a particular school (HMI 1978; HMI 1982). When children were arranged into attainment groupings for mathematics there was still considerable differences between the children and this difference needed to be recognised by teachers (Cockroft 1982). HMI (1978) highlighted the serious problem of match and mismatch and stated that mismatching was a serious problem in primary classrooms. Concern about matching being seen as an isolated cognitive issue to be optimised by improving the character of the teacher as a transmitter was expressed by Desforges (1985). He wrote that assessments of the match between the demands of a task and a child's attainment must be inextricably linked to models of learning and attainment. Harlen (1982) proposed that the keynote of matching was finding the right challenge for a child.

Bennett et al (1984) and Desforges (1985) referred to matching children to four task demands:

'INCREMENTAL' - when the task introduced new ideas, procedures or skills and demanded recognition and discrimination.

'RESTRUCTURING' - when the task demanded the invention or discovery of an idea, process or pattern.

'ENRICHMENT' - when the task demanded application of familiar skills to new problems

'PRACTICE' - when the task demanded the tuning of new skills on

familiar problems.

Doyle (1983) illustrated general task demand on children under four headings:

'MEMORY TASKS' in which pupils were expected to reproduce information previously encountered.

'PROCEDURAL or ROUTINE TASKS' in which pupils were expected to apply standardized and predictable formula or algorithm to generate answers.

'COMPREHENSION or UNDERSTANDING TASKS' in which pupils were expected to apply procedures to new problems or decide from among several procedures those which were applicable to a particular problem.

'OPINION TASKS' in which pupils were expected to state a preference.

Bennett (1985) posited that an incentive system would seem more appropriate than group discussions when developing and practising basic skills with children.

Children's observed on-task error rates did not provide sufficient evidence on which to base a judgement of match or mismatch (Desforges 1985). Desforges went on to say that in sum, mismatching appeared to be initiated and sustained by:

a) demanding concrete rewards of procedures rather than evidence of thought.

b) rewarding effort to produce rather than effort to conceptualise.

c) adopting management techniques which permitted rapid response to each child's immediate problems but left the teacher ignorant of the child's confusions or potential.

d) teachers' inexperience with and lack of skill in diagnostic work and a taste for direct instruction, however informally put, rather than analysis.

Marriott (1985) was of the view that teachers operated on the basis of intuition rather than on careful intellectual analysis.

The most satisfactory indicator of a child's progress was the "active learning time" and had little to do with teaching behaviour (Harnischfeger and Wiley 1975). Formal teachers allowed children to have longer active learning time because of class teaching and working in silence (Bennett 1978). More teachers used higher order questioning with a class than with individuals because they did not have to focus on lots of different activities, only the one being undertaken with the whole class (Galton et al 1980; Doyle 1983).

Teachers often had to work without feedback as to how successful their efforts were. As a consequence, because of the difficulty of any individual working without knowing whether they were achieving very much, teachers replaced ultimate educational goals with ones that were more "proximate, immediate and attainable", and more easily related to the techniques that they were using (Marriott 1985). Marriott continued by stating that because long term goals were cloudy and difficult they were replaced with measurable short term successes.

Classroom activities were typically "episodic" and the duration, constituent activities, character and interrelationship of discernable episodes were greatly diversified. The stages could be broadly classified as "entry", "settling in", "down to business", "finishing up", "leaving". It was noticable in classroom activity that the parties to it were engaged not in discriminating episodes, as a cognitive or perceptual matter, but in segregating them, as an organisational or managerial matter (Sharrock and Anderson 1982).

Most infant teachers reserved the first part of the day for child-initiated talk. The pre-registration period was generally regarded as more informal and personal time than post-registration (Cummings 1982; Rawers 1984). The teacher maintained a tight control in informal child-initiated discussions with a group of children during pre-registration periods. These sessions were structured and tightly organised (Cummings 1982). Control was an important indicator of success and teachers believed learning could not occur in the absence of order and well behaved pupils were an indicator to colleagues that a teacher was competent (Marriott 1985). Studies of informal classroom layouts and children being taught through the integrated day showed that teachers maintained a tight control over pupil activities (Moran 1971). Teachers who established both a task, or work-oriented, atmosphere in the classroom and a warm, supportive environment provided children with a successful learning environment. These teachers established routines and procedures to guide and regulate pupil behavour while still maintaining a desirable degree of flexibility in the classroom (Griffin 1983). A quiet working atmosphere was established in nine out of ten of the classes whenever it was needed (HMI 1978). Activities at the experiential level in

infant schools were mostly controlled by the teacher and were therefore mainly the outcome of her actions (King 1979). King (1978,1979,1984) referred to oblique control through extraverbal meaning and voice tone:

'Now we are going to do something exciting' voice;

'Slightly aggrieved, sad' voice,

'I'm being very patient with you' voice,

'Oh, never mind don't let's have a fuss' voice,

'Listen to me I'm saying something important' voice.

Although infant teachers' 'styles' varied widely there was a certain amount of commonality in their control commands. They tended to mitigate their contol instructions by using: "please"; endearments; prosodic sofening; positive evaluations; proposed deferments; proposed redesigns or 'accounts' to justify the command (French and Peskett 1986). In giving control instructions inductive teachers used praise more freqently than sensitizing teachers and provided pupils with more extended praise, including the reasons for the praise (Smith 1983).

A central feature of teachers' talk was that they asked questions to which they already knew the answer (Maclure and French 1980; Marriott 1985; Mehan 1986) and that they used a common format of 'Initiation', 'Response' and 'Feedback' (IRF for short). Closed questioning was the norm; it was harder to find examples of open questioning, or those requiring exploratory or tentative responses from children (Marriott 1985). Closed questions were often factual whilst open questions usually involved reasoning and judgement. Closed questions were usually expected to have yes or no answers although occasionally questions which had yes, no answers could, and were elaborated on by

pupils. These could be considered 'half-open' questions (Hargreaves 1984). The IRF pattern was explained by the fact that teachers regarded their job as purveyers of knowledge to children and that such approaches made it easier for teachers to maintain control in terms of knowledge and discipline. The transmission model was basic to the whole educational system from nursery school to university. Pupils may do what the teacher asked for a variety of reasons among which "to learn" may not figure (Woods 1985).

During class or group oral activities, teachers sanctioned or elicited pupil responses by calling on specific pupils to respond, accepting 'volunteers' or 'call outs' (Griffin 1983; Mehan 1986). Participation in these activities emphasised individual rather than group effort. Answering was mandatory rather than voluntary and it was competitive rather than co-operative (Mehan 1986). How teachers effected the 'turn-allocation procedures' imposed constraints on interaction and had organisational implications in that children had to learn the important communicative skill of answering questions correctly within classroom discourse (Doyle 1983; Mehan 1986).

Teachers had the temptation to go for superficially quick progress in written work before the pupils conceptual understanding was sufficiently well established (HMI 1985). Most prescriptive models of teaching have been derived from the theories of learning and ignored the constraints upon a teacher (Desforges 1985).

Galton et al (1980) discussed how teaching tactics had more than one function: dealing with class control; development of social and personal skills; concerned with a pupil's cognitive development. When

a set of tactics became consistent it was considered the teaching style. HMI (1978) and HMI (1982) thought it misleading to categorise teaching methods, they noted that teachers varied their approaches according to the circumstances and would vary their approach during the course of a lesson; although in the reports they postulated two broad approaches to teaching, the "mainly didactic" and the "mainly exploratory." Cockroft (1982) stated the impossibility of indicating a definitive teaching style for the teaching of mathematics.

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Case studies

Case studies were styles of inquiry particulary suited to the individual researcher (Nisbet and Watt 1978). Case studies raised the issue of the constraints which shaped the thinking and decision making of teachers, and of how these constraints operated (Calderhead 1985). In case studies the implicit was made explicit, the intuitive made self evident and the abstract made concrete. Once written the case study was "fixed" whilst the subjects of the case study moved on, consequently it could only capture an instant in time and space (Walker 1983). Typically case studies were single cases which served to identify and describe basic phenomena, as well as provide the basis for subsequent theory-development (Kenny and Grotelueschen 1984). Case studies were concerned essentially with the interaction of factors and events where the evidence was gathered systematically in such a way as to illuminate some general principle (Stenhouse 1978; Nisbet and Watt 1978). A case was an instance not like a sample, a representative of a class. Case study was a basis for generalisation (Stenhouse 1978, Atkinson and Delamont 1985).

Stake (1985) considered that a case study was the study of a single case, or bounded system, observed naturalistically where the results were generalizable and where the given information allowed the reader to decide whether the case was similar to his or her own. He stated that whereas experimental design had checks built into its methods, with case study the responsibilty lay more with the researcher. While other styles of research aimed to elicit general relationships, case

study explored the context of individual instances. The case study researcher anticipated and appreciated that critical understanding depended upon the interactions between the subject and his or her environment. It was important to contextualise the case study.

Researchers must operate within a clearly defined framework which makes case studies open to public validation (Bennett and Desforges 1985). Systematic case study data was considered as either timeless, hence replicable, or embedded in time; it was analytical rather than a narrative history (Stenhouse 1978). In case studies there were two evaluative concerns; that of description and interpretation, and that of judgement (Parlett 1980). These two concerns were paralleled by phenomenology, and hermeneutics. There was a third concern of tacit knowledge which dealt with that which could not be directly empirically verified in fact or principle; that was to say those issues of traditional quantitative and positivistic educational research (Kenny and Grotelueschen 1984).

Stake (1985) wrote that most evaluation designers relied on an inference model whereby samples, even of size one, could be studied in order to refine general rules in the hope of guiding the management of cases belonging to the same population. He considered that an alternative inference model was implicit in case literature whereby the researcher optimized reader opportunity to relate the case described directly to their own case, to infer particularistic understanding not necessarily mediated by general rules. He stated that the pursuit of contextuality in naturalistic generalizations was important not only for consideration of interactions but for clarification of possible use by "readers" in deciding the extent to

which the case was similar to their own.

The case study researcher attempted to produce information to fa cilitate a subject's own analysis more than to deliver statements on generalizations (Walker 1980). Research which attempted to generate "grand generalizations" increased the authority of and dependence upon the specialist (Stake 1985). Stake (1985) was of the opinion that case research aimed at enabling users to increase their understanding through naturalistic generalization offered a greater possibility of facilitating the autonomy and sense of responsibility of the practitioner.

Data in case studies

There is considerable debate over the advantages and disadvantages of qualitative and quantitative data gathered during case studies. Critics of empirical research in education pointed to the difficulties of implicit assumptions, uncontrollable variables and the problems of replicability in researching human behaviour whether for explanation or description (Jonathan 1981). There appeared to be an unbridgeable gap between empiricists and those researchers who gave equal weighting to emic and etic accounts. In principle empiricists placed reliance on high statistical reliability which confirmed or refuted existing hypotheses whilst interpretive research claimed validity through careful description and analysis (Adelman and Young 1985; Stake 1985). The uniqueness and contextuality of case data was lost when converting qualitative data into quantitative data during content analysis (Stake 1985).

The term "qualitative methods" referred to: fieldwork; field research;

ethnography; case study; and interpretive procedures. Fieldwork usually signified the collection of observational material (although it might include results of surveys). Field research tended to signify participant observation and unstructured interviews. Ethnography referred to investigations that principally used observational methods. Case studies were carried out within a particular theoretical framework the most common of which used interpretive procedures and was known as symbolic interactionism (Burgess 1985; Tranter 1986).

Qualitative research involved an ecological study of individuals in their natural setting (Parsons et al 1983; Burgess 1985). It was very flexible in that it did not operate within a rigid framework but could be modified as the collection and anaysis of data progressed (Burgess 1985).

Ethnomethodological research was concerned with other people's methods and considered that which routinely went unnoticed (King 1978; McIntyre 1980; Payne and Cuff 1982; Street 1986). The successful unravelling and explication of mundane beliefs and actions demanded that common sense was suspended and not uncritically endorsed (Atkinson and Delamont 1985). Whilst statistical generalizations required the study of many situations which had to be simplified to make them numerically manipulative ethnomethodological analysis could provide generalizations from single instances because any individual member had, through his or her membership, a repertoire of methods for making that membership observable to others. How these methods were displayed and put together in any one particular occasion would of course be contingent to that occasion. It was assumed that the

appropriateness of activities so produced would be recognised by others through similarly organised methodic practices and procedures. It was the methodic procedures which were generalizable (Payne and Cuff 1982).

Bennett (1976) used questionnaires to decide a teacher's style. He was critical of the technique of systematic analysis to obtain the raw data for analysing teaching methods, critisising the small sample of teachers used and the narrow range of behaviours observed. He was concerned that categorisation was not afforded sufficient theoretical perspective. Galton et al (1980) questioned the quality or usefulness of the questionnaire approach in which teachers had to select one response from a limited number of mutually exclusive categories. In their ORACLE study they relied upon observational techniques on fifty-eight teachers over a three year period to research teaching style.

Classroom observation

Observational case studies could involve quantitative as well as qualitative data (Hargreaves 1984; Hammersley 1985). Classroom events were very complex and both systematic researchers and participant observers tried to look at too much at once (Dunkerton 1981; Good and Brophy 1984). Observation within a case study was a task which required a category system and needed to develop a hypothesis otherwise it became a formless, uninformative collection of observations (Nisbet and Watt 1978). Observation of a complicated situation like a classroom required a lot more than the simple categorisation of events (Dunkerton 1981) otherwise observational science served the observer rather than the "actor" (Stenhouse 1978).

Observational research often under estimated the significance of what people said and made too much of what the researcher claimed to have observed (McNamara 1980; Walker 1983). There was nothing to stop an informal observer offering unambiguous observational categories either before or after the observation since systematic observations could lack objectivity owing to the classifications being decided beforehand. There was the problem of unambiguously coding these classifications (Barrow 1984). Systematic observation did not necessarily produce 'atomistic' data through 'de-contextualizing' the phenomena being observed. The context of the individual observations could be incorporated into the observation schedules to avoid rendering the recording of individual isolated bits of behaviour meaningless (Croll 1986). A study of classrooms which was to be useful in formulating research questions could not, in the first instance, be through systematic observation (McIntyre 1980). Techniques of systematic observation were of little help in helping a teacher monitor which types of questions (cognitive tatics) and which topics (curriculum strategies) enabled pupils to think in "productive ways" (Galton et al 1980). Unstructured observation was unlikely to yield quantitative data on classroom behaviour whilst time sampled systematic observation would distort the collected data so severely that it could not accurately reflect what happened in the classroom (Dunkerton 1981). There was a problem of ambiguity in the classification of coding categories during systematic observation distorting the interpretation of the data (Scarth and Hammersley 1986a, 1986b).

Observer bias

Systematic observation through time-sampling attempted to overcome subjectivity in initial judgements and let the facts speak for themselves. Low-inference observation directed what the observer should focus his attention on at any given time, to the exclusion of all else. Time sampling did not permit the observer to make his own discriminations but entailed faithful coding on predecided categories (Flanders 1970; Jonathan 1981; Boydell and Jarman 1983; Croll 1986). One of the problems associated with timed point sampling was that every instance of a specified behaviour within a timed interval was not recorded, instead the occurrence of activities were recorded at regular points in time. This conflated frequency and duration of types of activity (Scarth and Hammersley 1986). Classroom observation through point sampling was preferable to instantaneous time sampling whenever the observations needed were too complex for a true continuous recording system. Point sampling gave an estimate of the total time devoted to particular categories of activities (Croll and Galton 1986). Coding on predecided categories assisted in overcoming observer bias (McIntyre 1980; Good and Brophy 1984; Powell 1984; Croll 1986). Reducing the multitude of variables to more manageable numbers by combining categories which appeared similar could place different interpretations upon the observed events (Griffin 1983; Scarth and Hammersley 1986b). Powell (1984) argued that inference could be controlled within acceptable limits and that objectivity and subjectivity were very complex. He suggested that observer bias could be reduced by concentrating on 43 separate variables believed to part of teaching style or teaching strategy. Using his SCOTS schedule the observer had to place the teacher under observation on a defined continuum for each variable. Each continuum consisted of five points,

thus making each variable a multiple-choice item for the observer.

In non-randomised observational studies, many sources of potential bias were present (McIntyre 1980; Aitkin, Bennett and Hesketh 1981; McNamara 1980). Observers past experiences, biases and prejudices could lead to misinterpretation rather than an objective account of collected data (McIntyre 1980; Good and Brophy 1984; Tranter 1986; Hammersley 1986). A problem associated with participant unstructured observation was observer bias (Dunkerton 1981). A difficulty in compiling a case record was to attenuate and expose to criticism possible bias of the researcher (Stenhouse 1978). The researcher should attempt to be impartial in the selection of data and in the writing up of the research document (Elliott and Whitehead 1980; McNamara 1980). The case report was a 'constructed' reality rather than a veridical representation of reality; a meaningful, useful and rich interaction between observer and observed (Stake 1985). Phenomenology was interpretation by "telling it as it felt to be in it" rather than "telling it as it was" (Stenhouse 1978). Used in the scientific sense phenomenology contributed a strong and concerted effort to avoid, or minimise, interpretation bias by the observer (Kenny and Grotelueschen 1984).

Non-participant observation

Research could be based upon non-participant observation rather than participant observation (King 1978, 1979, 1984; McIntyre 1980). King (1984) considered that it would not be ethnographic because the interest would be in the teachers as teachers and not their whole way of life which ethnographic research tended to imply (King 1984). Non-participant observation reduced the effect the researcher had on

the events he was trying to observe (King 1978; Good and Brophy 1984; Merrett and Wheldall 1986; Croll 1986). The relationship with the teacher could be as interested, non-judgemental observer (King 1984; Hartley 1985) although the researcher could be as much a collaborative colleague as observer (Cummings and Hustler 1986).

Action research

Action research did not assume that its findings were generalizable because teaching acts which constituted particular forms of constraint varied from classroom to classroom. However, through the comparatative study of cases it was possible to identify similar cases, and therefore teaching problems shared by teachers (Elliott 1980).

Action research was "The study of a social situation with a view to improving the quality of action within it" (pp 1; Elliott 1982). Elliott and Whitehead (1980) considered that the action researcher should:

a) be concerned with the deepening of understanding of the classroom and school situation through adopting a critical, questioning stance.
b) present the research in ordinary everyday language possibly the form of a case study.
c) be reflective.
d) place emphasis on description and diagnosis, although recommendations may emerge.
e) ensure that those involved have free access to all the data, in an atmosphere of mutual trust and loyalty, with regard to its release.
f) make clear his intended audience and his relationship to the

group, as this may later affect the value of his work.

Action research involved a spiral of activities namely: identifying a general idea; reconnaissance; general planning; developing the first action step; implementing the first action step; evaluation; revising the general plan. This basic cycle should spiral into the development of the second action steps. Ideally case studies were written at the end of a particular spiral of action and research. After collection of the information it was crucial that time was taken to reflect and consider the implications of the research (Elliott 1982).

A key methodological problem in Action Research was the achievement of contradictory aims; that of how to research a situation and that of how to act upon it. That there should be some form of dialogue between the teacher and an "outsider" was not only desirable for action research but was almost one of its defining characteristics (Hustler et al 1986).

There was a distinction between educational policy and educational action. "Educational policy" was the deliberative planning which occurred outside the action situation on the basis of judgements of likelihood and predictions about the possible effects of alternative courses of action. "Educational action" was the carrying out of the consequences of that decision in practice (Stenhouse 1978).

The process-product paradigm involved a radically different view of the nature of teaching and learning from the action research paradigm. Process-product methodology treated the teacher as a subject of research and assumed her professional development to be an independent

activity. Action research entailed dialogue with the teacher hence involved her as a participant in the research process (Elliott 1980; Elliott 1985). The advantages of collaborative research would seem to be dependent on the extent of teacher participation and the extent to which the research questions posed reflect teachers' concerns and priorities (Bennett and Desforges 1985). Action research started with attempts to uncover "matters of concern" as perceived by the teachers not by those not involved in the day to day running of a classroom (Cummings and Hustler 1986). There were two kinds of pedagogic research. One type produced general statements about teaching and learning based on large scale research into teachers and pupils. This produced little of practical help to the individual teacher in her classroom. The other was a "study of singularities" which was based on studies of single classrooms and no attempt was made to generalise beyond the particular classroom (Bassey 1986). The emphasis of action research should be on the centrality of the practitioner (Street 1986). Action research related to any teacher concerned with her own teaching; to improve her understanding of a particular problem rather than trying to impose an immediate solution upon the problem. There should be an end product or practical effect to the research and it must be based on an increased awareness of what happened in the classroom (Elliott 1978; Elliott and Whitehead 1980; Elliott 1980, 1985).

The interrelation between observational research and a teacher wishing to effect change within her classroom by adaption rather than solution was discussed by McIntyre (1980). He stated that in the past it had been assumed that this help could best be given by establishing general laws and by enabling teachers to examine their own teaching in

relation to these laws. He thought a more productive approach would be to help teachers to examine their teaching in relation to their own constructions of their activities and their own aspirations. It was from teachers who wanted to try new approaches that co-operation in new ventures would be most likely. It was in collaborating with teachers in their efforts to change what happened in classrooms, that such research could be most valuable. Systematic observation was a technique which was relevant and important for this type of research. Attempts to bring about change implied that hypotheses were being formulated and tested about what would be possible and about how it could be achieved. Knowledge of what changes proved possible, by what means, and in what circumstances, was likely to be valued by teachers. But of even greater value to teachers and others would be increased understanding of what changes did not prove possible and of why they proved impossible. It was perhaps by contributing to our understanding of the constaints which existing patterns of schooling imposed on teacher's efforts to facilitate their pupils' education that research involving systematic observation could be most useful.

Classroom studies

Hammersley (1986) outlined several types of evidence found in classroom studies on teaching style:

a) Information about the teachers and classes presumably derived from documents, interviews or observation.
b) Time-generalized observer description.
c) Frequency-specified time generalised observer description.
d) Time-specific observer description.
e) Quotations from participants' accounts either to document perspectives or as a source of description of events.

He considered three distinct things in evaluating any such study:

a) Whether the descriptions and explanations provided were correct.

b) Whether the researcher had taken the best precautions and made the best checks so as to maximise the chances of the validity of descriptive and expanatory claims, given available methodology.

c) Whether the researcher provided the reader with the necessary information about the precautions taken and the checks made for an assessment to be made of their effectiveness.

The case researcher should indicate the validity of the report by giving an elaborate account of how he or she carried out the study (Stake 1985). Stake (1985) highlighted the danger of vignettes threatening the validy of the study. He considered that they were powerful explanatory devices, essential to reports, but that they overstated and as a consequence could constitute a threat to validity unless carefully used.

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The present study is a report of action research with five reception infant teachers in Derbyshire primary and infant schools over four terms. It is a naturalistic enquiry studying the teachers in their own environment with a design relatively free from intervention or control (cf Stake 1985). The research is a "study of singularities" rather than a comparative investigation (cf Bassey 1986).

The information is produced to fa cilitate each teacher's own analysis rather than to deliver statements on generalisations (cf Walker 1980). It is not the intention to generate hypotheses out of the cases. The researcher's role is to act as a 'focusing agent' for the observed teachers on issues of concern to them. The centrality of the teacher's role in wishing to effect change by adaption rather than solution is fully recognised (cf McIntyre 1980).

The time-table was:

Term 1

Informal visits to several schools to talk to headteachers and teachers of the oppropriate age group.
The five teachers around whom the research would be based were decided and further discussions and informal visits to their classrooms undertaken when the method of data gathering, style of observation, format of information-feedback and broad parameters of the research were discussed and agreed.

Term 2

Non-participant observation within each classroom involving both

Each teacher was observed along with six of their pupils who attained their fifth birthday during the course of the term (Appendix 4).
The main focus of the research emerged during this period.

Term 3

Non-participant observation within each classroom involving both systematic timed sampling and continuous case note recording of each teacher and continuous case note recording focusing upon children's counting activities.
At the end of the term each child was given a series of counting tests based on ordinal, cardinal, and numeral recognition (Appendix 5).

Term 4

Qualitative analysis of the case records.
Quantitative analysis of test results and observation schedules.
The 'Microtab' statistical package for a BBC microcomputer was used in the analysis of test and observation results (Appendix 7).
Preparation of materials and activities to widen and develop the teaching of counting for each teacher (Appendix 8 and Appendix 9).
School based INSET activities with the teachers.

The teachers and schools used for the research were not a random choice. Every school and head visited during Term 1 was known to the researcher, although he had not worked alongside any of the teachers previously. The reseacher was well known to all the schools because of his INSET activities within the County. This allowed for an atmosphere of mutual respect to develop between the researcher and the researched. The five teachers were selected because they were

They were experienced teachers of infants having taught that age range for longer than five years. They would also be involved with teaching the appropriate age group for at least a two year period during the research programme. All the teachers were anxious to be involved in research which would enable them to reflect, analyse and improve their teaching through interaction with a interested, non-judgemental, collaborative colleague acting as an observer (cf McIntyre 1980; King 1984; Hartley 1985; Cummings and Hustler 1986). The six target children to be closely observed were a random choice of three boys and three girls, with the exception of one school where four boys and two girls were chosen because of the nature of that school's intake for the term. All the observed children were born between 1.1.80 and 30.4.80 (Appendix 4). After discussions with the teachers and the informal visits into the classroom it was decided that the research would be based upon non-participant observation within the classroom in order to reduce the effect the researcher might have had upon the events he was trying to observe (cf King 1978; Good and Brophy 1984; Merrett and Wheldall 1986; Croll 1986). One teacher wanted to monitor the time spent with the children as part of the research so it was decided to employ a 25 second timed sampling technique in that instance (cf Boydell and Jasman 1983). Before starting the observation period there was a semi-structured interview with each teacher to ascertain her intentions with regard to organisation, mathematical curriculum content and general objectives for the target children over the subsequent two terms.

The early observations in each classroom formed the "open phase" (cf Nisbet and Watt 1978). This allowed the teachers and researcher to

importance to the teacher. It was less formal and qualitative so allowing the researcher to get a feel for those aspects of the classroom he and the teacher wished to investigate (cf Croll 1986). During the observation the effect of the observer on the children seemed minimal, they seemed to ignore his presence very swiftly (cf McIntyre 1980; Tizard and Hughes 1984). The researcher did make a positive effort to avoid being treated as an "added resource" in the classroom by avoiding direct eye contact with the observed children (cf Cummings and Hustler 1986). He sat quietly near the observed children writing case notes about what the children were doing; the interaction they had with each other and with the teacher; the materials which were being used during the activity; the task demands being placed on the children. A five minute interval record was kept of what each teacher was doing at that particular time. There was also a record of her interactions with the observed group. There were occasions when the nature of the lesson was such that it was impossible to monitor each of the target children because some may have been working in other parts of the room or out of the room. In these cases the focus was on those children who were to be the centre of the teacher attention during the observational period. When the timed systematic observations were being undertaken with Teacher M a pre-recorded 25 second impulse was fed into the researcher's ear via a small recorder and an entry made on the teacher record sheet according to a specific category. Completed record sheets can be found in Appendix 2. Alongside this sampling a record was kept of the observed children's activities. The nature of the classroom organisation and task demand on the children enabled this type of observation to be viable. After each observation of a lesson the case notes were

annotated and immediately written up into a case record and fed back to and discussed with the teacher at the time of the next visit. A particular concern here was in the condensing of the raw data into a case record trying to ensure "methodological violence" was not committed on the data (cf Walker 1983). The observational recordings were intended to reflect teacher activities rather than test any particular theoretical position concerning appropriate or inappropriate teacher behaviour (cf Resnick 1972). The teachers were always regarded as authoritative professionals and not research "subjects". The issues discussed were those which were of concern to the teacher and it was fundamental to the research that the programme would prove to be worthwhile to the teachers concerned (cf Stenhouse 1978; Elliott 1980; McNamara 1980; McIntyre 1980). During this first phase of the programme several issues of concern were raised by the teachers but there was one common factor which kept occurring, that of children's ability or inability to count and how it could be monitored and improved upon. Because of the commonality of this issue it became the focus of attention for the researcher and the teachers during the latter part of Term 2, Term 3 and for the INSET activities.

The observations were continued throughout Term 2, each teacher being seen for nine occasions. At the end of the term the target children were given a series of tests to assess their counting ability (Appendix 5). Each child was given the tests over a three day period.

The tests were designed to assess ability to:

a) count items which could be touched and moved.

b) count items which could be touched but not moved.

c) count items which could not be touched or moved.

d) count items which can only be heard.

e) recognise numerals.

f) order numerals.

g) match numerals to quantities.

The results of the tests were reported back to the appropriate teacher, discussed and analysed along with the results of the observations in order to prepare for INSET activites which would improve their quality of teaching counting to children.

The format and content of the INSET activities varied from teacher to teacher. It was school based (cf Biggs 1983) and included:

a) a workshop for parents with the teacher, her pupils and the researcher taking part.

b) researcher working with pupils and the teacher observing.

c) researcher and teacher working in unison with some children.

d) teacher trying new materials and ideas with her pupils with and without researcher being present.

At this point the case records were written up as case studies (cf Stenhouse 1978). Information is provided in the case studies to assist readers in deciding whether the cases are similar to their own. This information includes reference to catchment area, physical attributes of the classroom, resources and enrolment procedure for reception aged children. The case study is contextualized (cf Stake 1985)

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CASE STUDY: Teacher M

Ms M was a Scale III teacher, aged between 30 and 40, with experience of teaching at two previous schools. She had overall responsiblity for the infant department of a Primary school with 325 children on role. The school, built in 1981 to replace two separate Infant and Junior Schools, was of open plan design and had as its catchment area a village which served a predominantly mining community. Ms M had regular meetings with the headteacher to discuss both organisation and curriculum matters. The school was committed to curriculum development where the staff, under the guidance of a curriculum leader and the headteacher, considered school policy and practice for a particular curriculum area each year.

Ms M's teaching space was a large shared working area with a small work bay which was used for creative activities and for reading and listening skills. The working area was shared with one other teacher and her class of thirty children. A closed classroom was strictly time-tabled for the four teachers in the Infant Department. Although the children were being taught in an Open Plan designed room, each class was treated as if it were being taught in a closed box classroom. There was no evidence of team teaching or different working areas appropriate to an integrated day. The children had fixed working bases and were not 'mobile'. The apparatus children were allowed to use was stored in trolleys which had plastic trays. It was well labelled and visually appealing. A high standard of display was in evidence which was extremely imaginative, creative and

stimulating. For the most part the displays were large collages of children's work labelled with a rich use of text. The displays were constantly being changed to provide an enriched visual stimulus for the children. There was one co-operating adult working alongside the teacher, a Nursery assistant, who came to help for two sessions per week. A session was half the morning or afternoon period.

In the September there were 20 rising fives in the class. The children who were to be five during the Spring Term went to Teacher P before transferring to Teacher M in January. January saw the 20 September starters joined by 10 rising fives from Teacher P making a class size of 30 children. No more children joined the class for that academic year.

During an interview with the researcher about her classroom organisation and expectations of the children over the next two terms Ms M stated that the new intake would work as a group until she had assessed them. The remaining children would be grouped loosely on ability for organisational convenience, although in reality they would be moved within groups to be taught as their needs dictated. The children would have their own base at which they would work and have their own pencils and materials. Shared resources were not the norm. She considered that her integrated day was hampered by having to withdraw to the closed classroom on a regular time-tabled basis and would rather not have to avail herself of the facility. It was usual for her to teach mathematics as a sessional activity in the morning or afternoon with integration, as and when applicable, in the other curriculum areas. In effect her integrated day was similar to that described by Moran (1971) as Type C, the "integrated half-day." She

stated that she kept a very flexible approach to her organisation with a careful eye on the balance of activities the children undertook during the week. Various activities were usually set out on the tables for the children to work at whilst she would move from child to child assessing, monitoring and enabling. She kept a termly plan of content and the general direction she had taken for each curriculum area. A weekly plan was prepared in detail, outlining the groups, organisation and activities. At the end of each day she made an assessment of what had been satisfactorily covered in order to plan for the following day's activities. She considered that she kept very careful and thorough predictions and records of each child's progress and the content covered. The television was not used to supplement her mathematics. A computer was used on a weekly time-tabled basis. She informally assessed the mathematical level of the new intake children whilst they were working on sorting activities and anticipated that the areas of number understanding the children would grasp during their first two terms to be:

Easter - Counting up to 10; "Knowing" numbers to 5; Wide language development would occur through sorting, matching and comparison activities.

Summer - Associating symbols with quantities to 10; Writing the number symbols.

During the observed lessons the children would enter the classroom from the playground and sit down in the small bay where Ms M would spend about five minutes calming them down with a short song, usually related to the topic they were studying. The tables had all the

materials the children would require for their mathematics lesson placed on them by the teacher during the breaktime. The children had a specific place to sit, with their own pencil, ruler and working materials. The tables were typically set for small groups of about six children, as observed by Bennett et al (1984). After the short session in the bay the children would move to their allotted place and begin their tasks. It was usual for all the children to be doing mathematics at the same time and those children who were working together on a table were all doing the same sort of activity at the same level. It was observed that they worked in the presence of the other children rather than with them (cf Ausubel et al 1978).
The target pupils had a simple, clearly defined procedural task (cf Bennett et al 1984) to complete during each lesson (Appendix 1). The mean length of time they were expected to be on task during the nine observed lessons was 47 minutes. The tasks involved: colouring; drawing; cutting out; gluing. With the exception of logic blocks in Lesson 1 no other materials were used other than in the supplementary activities. Those tasks which required some form of recording were either pre-drawn in each child's book by the teacher (e.g. mapping symbols to drawn quantities) or were copied from published mathematics cards. When the teacher-allotted task, was finished the children were either given teacher directed supplementary activities or they chose some activity to play with until the end of the lesson. Each observed lesson was similar to those reported by Sharrock and Anderson (1982) in that they were episodic both in an organisational and managerial sense; the children entered, settled in, got down to business, finished off and left .

Ms M would quickly circulate the various groups of children monitoring

what was happening and spending a similar amount of time with each child (Appendix 2). She was an Individual Monitor (cf Galton et al 1980), her style was rather like that of a butterfly, moving quickly from table to table, hardly pausing at each place before swiftly moving elsewhere. She would treat the children as individuals. No group discussion was observed with the target pupils during the nine lessons (Appendix 3). She visited the target table between four and fifteen times each lesson (Table 1-M), the longest visit lasting five minutes (Appendix 2).

Table 1-M (Record of teacher contacts - every 25 seconds)

LESSON	1	2	3	4	5	7	9
Visits to bases	51	26	49	54	23	24	40
Visits to observed base	11	5	10	15	4	8	5
Observations of all children seen out of base	14	28	27	29	14	13	28
Total observations	106	96	108	123	126	108	127
Number of bases	7	7	7	7	6	6	8

The observations were at 25 second intervals
The bases were: 6 tables plus the bay (lessons 1-4)
5 tables plus the bay (lessons 5-8)
7 tables plus the bay (lesson 9)

Her statements and questions tended to be instructional, routine or focused on subject matters (cf Elliott 1975), "Now do the next card". "Write a little more neatly". "Is that all you've done?". "That's good". The frequent short visits allowed her to see the products of the children's work but not the processes by which they were obtained

(cf Bennett et al 1984). Children were allowed to leave their table to see her if they had problems. Target pupils saw her between two and eight occasions each observed lesson whilst they were out of base, this usually represented several visits by Daniel, (Table 2-M).

Table 2-M (Number of target children's teacher-contacts)

LESSON	1	2	3	4	5	7	9
Robert	7(2)	2(1)	1	4	3(1)	1	3(2)
Daniel	3(1)	5(3)	7(4)	6(2)	4(1)	7(2)	5(3)
Leanne	3(1)	2(1)	Abs	7(1)	3	2(1)	2(1)
Claire	Abs	5(3)	3(3)	7(1)	1	2(1)	1
Clare	Abs	Abs	1	3	4	2(1)	1
Neal	Abs	0	2(1)	2	1	2	1

Figure in brackets indicates teacher-contact which was out of child's base and is included in the totals.

When she sat at one of the tables to hear children read there would soon be a line of children queuing to see her (cf Resnick 1972). She always responded to a child who came out to see her (cf Bennett et al 1984; Desforges 1985). If she was sitting at a table for any length of time she would call different children out from their table to show her what they had been doing. Children were encouraged to work on their own and talking or helping each other was actively discouraged (cf Elliott and Adelman 1975a; Adelman 1975). During Lesson 5 Daniel asked Leanne to help him write his number five properly which she did until Ms M instucted her to stop.

TEACHER : You get on with your work Leanne, I will help Daniel if he needs it.

There was always a very quiet working atmosphere in the classroom as frequently observed in primary classrooms by HMI (1978). She maintained control by reference to the specific child who was misbehaving.

TEACHER : Daniel, get on with your work.

There was usually a quiet working atmosphere within the room during the observed lessons therefore these control instructions happened infrequently.

The six target pupils usually worked together at the same table. Leanne was typical of Galton et al's (1980) Solitary Worker in that she very rarely spoke and was not observed initiating conversation. She worked with a quiet confidence and did not appear to find any difficulty with most of the tasks being undertaken, she gave only occasional glances around. Leanne did not seem to be easily distracted and would not move from her place to visit the teacher for help or to have her work corrected unless she was called upon to do so by the teacher.

Robert would work in short bursts of activity with very frequent looking around the room at what was happening elsewhere. He was an intermittent worker and an attention seeker. He would occasionally visit the teacher for reassurance on, and correction of, his work. He liked to visit the bay to look at the books and would occasionally

chose to do this before he had completed his alotted task. This would result in him having to remain behind at playtime to complete the unfinished work. During the first few observation lessons he tended to follow the lead set by Daniel but as the term developed he became rather more dominant and acted single mindedly.

Daniel would spent his time looking around the room, visiting some of the other tables and going into the bay, but would then undertake bursts of activity in order to complete his task on time. He would make frequent visits to the teacher to question her and to seek reassurance. He would also ask the other children what to do when he did not understand. He was an attention seeker. Daniel was normally the most lively and spirited child on the table although on occasions was prone to fits of moodiness. He did not appear to unduly distract other children around him.

Clare rarely initiated conversation but would respond when given the oportunity to do so. She would occasionally visit the teacher for help but tended to wait for the teacher to come to the table before raising her query or showing her work. She was friendly with Claire and tried to offer her as much help as she could.

Claire was a lively, popular little girl who found some of the tasks rather difficult. She received help and advice from Clare, Robert and Daniel along with several other children from an adjoining table who seemed to maintain an interest in her work. She tended to receive praise from other children and adults when she had completed something satisfactorily. She would chatter away cheerfully even though there was often little response from the other children on the table and

would often seek attention. The teacher would occasionally give her a different task to her peer group.

Neal was a quiet boy who would sit for periods of time doing nothing before slowly continuing his work. He would inevitably be one of the last to finish and would often not have completed the task by the end of the lesson. He was observed working very intermittently and rarely initiated conversation although would respond when spoken to. Neal was very friendly with Clare, he was observed quickly kissing her and passing her little notes with 'kisses' on them.

During the observed lessons involving the target pupils in counting tasks all the activities were clearly defined (Table 3-M).

Each lesson was TASK focused rather than TIME focused. All the children, with the exception of Claire during Lesson 5, undertook the same activities. There was very little task related discussion observed among the children and no materials were used in the counting activities even though apparatus was clearly labelled and stored around the room. Materials were seen to be used during the post-task supplementary activities. The difficulties observed in completing counting tasks during the observed lessons were :

Lesson 5

Daniel needed help to form his numerals properly and to recognise them. He asked Leanne "What number is that? Eight?" and she responded by correctly stating it was a ten. His counting was insecure and often incorrect. Leanne helped him on several occasions at his request.

Table 3-M (Counting tasks observed)

LESSON	RANGE	TYPE	APPARATUS	ACTIVITY
2	5	matching	pictures	Making five paper eggs to stick onto five drawn egg-cups, by 1-1 correspondence.
3	2	matching	pictures	Cutting out two pictures and matching them to the symbol 2.
4	3	one more	none	Three pictures were drawn, one more had to be drawn.
	4	cardinal	none	Drawing sets of four pictures.
	4	grouping	none	Grouping sets of four together within groups of eight and twelve.
5	6-10	matching	none	Mapping a drawn quantity to the appropriate written symbol.
	5	cardinal	none	Claire had to draw and label sets of 5 items.
8	0-10	cardinal	none	A symbol appeared on the computer screen the space bar had to be touched the appropriate number of times.
	1-10	cardinal	none	Drawing a stated number of pictures.
	1-10	partitioning	none	Drawing a stated number of pictures and colouring two nominated subsets.
	1-10	cardinal	none	Counting subsets of a group according to some attribute (eg. How many thick books?)
9	1-10	cardinal	none	Drawing a stated number of pictures.
	1-10	partitioning	none	Drawing a stated number of pictures and colouring two nominated subsets.
	1-10	cardinal	none	Counting subsets of a group according to some attribute (eg. How many thick books?)

Claire was observed to have difficulty in counting up to five.

Leanne miscounted one of her groups.

Counting problems appeared when the children had to count immovable

objects (drawn pictures) because they lost track of what had been counted and what needed to be counted.

Lesson 8

Robert had to draw ten birds, after he had drawn eight he had frequent recounts to see how many he had drawn.

Lesson 9

Leanne seemed confused when counting photographs of long and short pencils as to whether each group should be counted separately or whether she should write the overall total.

Clare had drawn eight pigs on her page, she checked with the workcard (ten were needed) and said, to no-one in particular, "The other two won't fit on." She did not draw any more pigs.

The results of the test items for counting to ten (Table 4-M) show that:

a) Neal made no errors on any of the test items.

b) Daniel had difficulty with counting a number of sounds.

c) In the matching of a numeral to a quantity no errors were recorded. Claire seemed to guess because she immediately placed the numeral on the quantity then checked by touching and counting.

d) For visual counting Daniel stated the number shown without hesitation, there was no apparent counting.

Table 4-M (Test items analysed)

NAME	MOVE			FIXED			VISUAL					AURAL				MATCHING		
	4	9	7	2	10	6	5	3	7	9	8	3	8	5	10	4	7	9
LEANNE	I	Ex	E	I	E	E	E	I	E	E	E		x			I	T	T
CLARE	M	M	M	I	E	E	E	I	E	Ex	E		x	x		I	I	T
CLAIRE	I	T	T	I	Tx	Px	Px	I	P	P	P					I/TI/TI/T		
ROBERT	M	M	M	I	T	T	E	E	Ex	E	E			x		T	T	T
NEAL	M	M	M	I	T	T	E	I	P	P	P					T	T	T
DANIEL	I	T	T	I	T	Tx	I	I	I	I	I	x	x	x	x	T	T	T

1. The counting test included:
   - MOVE - counting moveable objects
   - FIXED - counting immoveable objects which could be touched
   - VISUAL - counting immoveable objects which could not be touched
   - AURAL - counting sounds
   - MATCHING - matching a numeral card to a card showing plastic counters.

2. An error is signified by x

3. I= Immediate response M= The item was moved
   T= The item was touched P= The item was pointed at
   E= Eye or head movement

4. Numbers at the top of the columns show the appropriate response

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CASE STUDY: Teacher A

Ms A was a scale II teacher, aged between 40 and 50, with experience of teaching at one previous school. She had responsiblity for the mathematics in an infant school with 130 children on roll. The school was church aided and housed in a 1900 building with several wooden annexes. It served a catchment area of predominantly private housing in a small rural town.

Ms A's classroom was a large wooden annex with attached cloakroom and toilets. The room was divided by furniture into three parts: Wendy House, shop, bed and dressing area; carpet and audio area; main teaching area with tables. The classroom was well equipped with commercially purchased apparatus as well as home-made apparatus and teaching aids which had been made by the teacher. There was a long wall for display which showed some examples of children's work and an information display of words and pictures. Each display was changed at half-termly intervals. Large collages and extensive displays of children's work was not encouraged by the head teacher.

A Welfare Assistant operated within the classroom for 10 hours per week as part of the County Education Committee's rising, rising fives policy and extra welfare hours were granted to support the education of two children with severe medical problems.

The September admissions procedure at the school was for the children who were rising fives to have full time education with Reception Teacher T. Twenty-nine children, who would reach their fifth birthday

during the Spring Term, went to Ms A each day until 11.00am; after which they went home. At 11 o'clock, for the rest of the day, Ms A taught sixteen children who had reached their sixth birthdays (between May and August), withdrawn from two Middle Infant classes. During the Spring Term ten of the twenty-nine children who had been receiving part-time education with Ms A joined the September starters with Reception Teacher T. The remaining nineteen children were taught full time by Ms A. Fourteen children, who were to be five during the Summer Term, joined these nineteen children until 11.00am each day after which they went home. During the Summer Term there were thirty-four children in the class receiving full time education, one extra child entered the class during the previous term.

Ms A organised her day so that during the early morning (until 10.00am), whilst the part-time children were present, creative activities, such as clay modelling, water play and dressing up were undertaken. At 10.00am children had a drink which they had brought from home. At 10.15am the full-time children went to school assembly, then to playtime, rejoining the class at 10.45am. The remaining part-time children sat on the carpet with the teacher and were involved in discussion activities to develop their language skills. Their play time was at a different time to that of the main school. At 10.45am all the class joined together for singing or a story. For the first two terms, at 11.00am, the part-time children went home. From 11.00am to 12 noon either number or language activities were done and one day each week there was dance during this time. The afternoon periods were a mixture of number, language, watching TV, music, PE, creative activities and free choice. Children worked in friendship groups, although they were grouped together by ability when deemed

necessary by the teacher.

The children did not have a fixed base but would move to various tables where activities would be set out for them. Each group were, during the course of a few days, expected to experience each of the activities. The teacher stated that some of the table activities occasionally had graded difficulties within them to cater for the brighter child. A computer was available for the whole of each Wednesday. The "Lets Go Maths" ITV programme was watched live twice weekly, the repeat also being watched.

During an interview with the researcher Ms A stated that she thought there was a certain amount of parental pressure to see written recording for mathematics from the early days of schooling and that her method of teaching mathematics did not lead itself to formalised recording at this early age. The children's mathematical education would be started by giving them an overall assessment on language development which she considered would be lacking in most children. Assessment would be made from this point on. She anticipated that the children's area of number understanding during their first two terms would be: counting to 20; recognising the number symbols; attempting some simple workcards in order to produce written recording. She thought that by the end of the Summer Term they should be combining groups to obtain a total.

All the observations in Ms A's class took place in the period between morning breaktime and lunchtime. The children would enter the classroom and settle down on a large carpet in front of the teacher for a range of oral activities. The mean length of time for these

oral activities over the nine observations was 39.3 minutes. She was a TIME focused teacher rather than a TASK focused one in that she covered many mathematical ideas within a period of time (Appendix 1). From the carpet activities the children would move to table activities either in friendship groups or as directed by the teacher who would then do one of three things; monitor the activities; sit down with one particular group to play a game with them; be involved in routine matters around the classroom. Ms A did not appear to undertake any directed teaching during the group activities. The children worked in pairs or small groups of three or four and co-operated in the activities. No child was observed working as an individual. The mean length of time for the group activities was 10.4 minutes.

During the oral sessions the language input by the teacher was via quick questioning and instructions and the children either responded 'in unison' or were 'nominated' to reply by name. The responses tended to be short, one word replies. There would be the occasional 'call out' response, or contribution, from a child after a 'unison' response or a 'nominated ' response.

TEACHER : What does ten mean? (Holding a numeral card showing 10).
UNISON : A set of ten with none left over.
TEACHER : What does eleven mean? (Holding the 11 card).
UNISON : A set of ten with one left over.
TEACHER : What about nine? (Holding the 9 card).
UNISON : You need one more.
CHILD : Then you will have ten. A set of ten with none left over.
The 0-12 numeral cards were given out in a random order and the children told to stand in line.
TEACHER : Emma, are they right?
EMMA : Yes.
TEACHER : Say your number.
The children holding cards said their number in turn.
TEACHER : Rachel, can you see anything wrong?
RACHEL : Yes. Three and six are upsidedown.
(LESSON 3)

Although many of the oral activities resulted in closed questioning in the sense that they had but one correct response, there were some oral activities which were more open involving a range of appropriate responses. During Lesson 4 the children were engaged in 'Behind the Wall' activities whereby one of the children faced his classmates with a cardboard wall between him and the children. He slowly raised a numeral card up from behind the wall and stopped when only a little of the numeral was showing over the top of the wall. The children had to state which number it could possibly be. This was done by 'calling out'. A little more of the number was shown and the children then restated the options. Eventually it became obvious which number was being used. As a variation the child told the class that he would show them upsidedown numbers and slowly raised an inverted numeral card up from over the wall. During the activity no inappropriate 'called out' responses were heard. The teacher remained silent and allowed the child to conduct the activity. Activities which were more 'open' involved the children in stating a fact about a nominated number chosen by the teacher. She usually nominated children to answer in turn, either by name or by a look.

TEACHER : We've had five and six, now let's have seven. What can we say about seven?
CHILD : Seven is before six.
CHILD : It's after six. (This was called out).
CHILD : It's on my door.
CHILD : Six and one make seven.
CHILD : Seven is less than ten.
CHILD : Three and four make seven.
CHILD : Seven is less than nine.
MATTHEW : It's more than five.
DAVID : Four and two make seven.
TEACHER : Do they?
CHILD : Five and two make seven. (This was called out)
MICHELLE : My sister is seven.
KATE : Seven is on my door.
HELEN : One and six make seven.

(LESSON 7)

It was interesting to note during these 'What can you tell me about a number?' sessions that the children's responses always included a cardinal meaning, positional meaning, convenience meaning (e.g. numbers on doors) and results of an operation.

During the oral lessons Ms A appeared to overcome the difficult problem of ensuring that there was some evidence of group effort instead of emphasising individual effort and she managed to create a feeling of co-operation rather than competition among the children (cf Mehan 1986). During many of the oral activities all the children would be taking part in an active way rather than sitting passively responding to questions and statements. Perhaps the best example of this was the "Holding Numbers" activities (Appendix 8). Children holding numeral cards would be holding up their numbers or changing places with another numeral holder and the children sat on the carpet would be touching or changing places with the numeral holders. Children would offer help and advice to each other and there was a feeling of 'taking part' in the activity

Some children were holding numeral cards, the rest were sat on the carpet.
TEACHER : David, show me a number not as many as six.
DAVID : None.
TEACHER : Joanne, show me another number not as many as six. (Joanne went and touched four).
TEACHER : Karen, show me a number more than six. (Karen touched ten).
TEACHER : People holding numbers, if your number is more than six step forward.
(This was done correctly).
TEACHER : If your number is less than six step forward.
Zero to five stepped forward, except two, held by Tim, he was told to move by his neighbour.
CHILD : You are less than six Tim.
TEACHER : Why hasn't six moved?
Several children replied that six wasn't more than six and it wasn't less than six, it was just six.
(LESSON 3)

During this, and other activities, it appeared that children were expected to appreciate cardinal meaning of numbers from their relative position to each other in the standard number sequence. The idea of

children holding cards showing numerals and moving into various positions was also used to develop ideas of ordinal numbers. During Lesson 7 the children were sitting on the carpet facing the teacher and she showed them flash cards on which were ordinal numbers in words, she highlighted the sound at the end of the word; it made a "Th" sound. She then gave some ordinal word cards to six children, showing the words 'first', 'second', 'third', 'fourth', 'fifth' and 'last', telling them to stand in line, which they did with no help from anyone. The children stated their positions correctly although Adam, who was fourth, was unsure. They were told to turn and face the wall in a line, one behind each other, and state their positions. After this had been done they were then instructed to about turn.

TEACHER : What's happened?
CHILD : Debbie is first, William is last.
TEACHER : Change places. (Which Debbie and William did).
TEACHER : Are they right now?
CHILD : No, second goes behind William.
The 'second' child moved and the consensus was that this was now the correct order.
The children were instructed to face the carpet, side by side.
TEACHER : Debbie is last, what else could she be?
CHILD : Sixth.
Debbie changed her card from 'last' to 'sixth'.
TEACHER : What comes next?
UNISON : Seventh.
Kate took the 'seventh' card and stood in position.
TEACHER : Who has the 'last' card?
Kate took the 'last' card as well as the 'seventh' card.
TEACHER : Hide the cards behind your back. Emma, change places with 'third'.
Elizabeth, change places with 'fifth'. Andrew, change places with 'second'.
Richard, change places with 'last'.
This was correctly done. Kate kept her 'seventh' card, because she had had two, and Richard stood beside her. The teacher then repeated the 'changing places activity' with some other children.
TEACHER : Peter, what comes next to third?
PETER : Fourth.
TEACHER : Is there another number next to third?
PETER : Second.
TEACHER : Tammy, what is next to first?
TAMMY : Second.
TEACHER : Matthew, what is next to fifth?
MATTHEW : Second.
The teacher checked that he could read the 'sixth' and 'second' cards. He had the words confused, he had got the position correct but the word wrong.

(LESSON 7)

The various number line activities Ms A involved the children in were ACTIVE rather than INACTIVE in that the children held numbers, moved numbers, touched numbers and walked along numbers. The numerals on the number lines themselves were either fixed or moveable. The "Holding Numbers" (Appendix 8) was an example of an active number line in that the numbers could be moved about. "Walking Numbers" (Appendix 8) was an example of a static number line on which children were active. During Lesson 1 a vinyl strip, on which were written numerals 0 to 10, was rolled out on the floor. Children were nominated to stand on a specific number and to move forward and backward along the line according to teacher instructions.

TEACHER : Stand on four. Which number is in front of you? Which number is behind you?

TEACHER : Stand on six. Which numbers are you between?

TEACHER : Stand on two, then walk forward three. Tell me the numbers you are walking on.

TEACHER : Stand on six, then walk back three. Tell me the numbers you are walking on.
(LESSON 1)

This activity was extended and developed during Lesson 7 when children were walking along a 0 to 20 number line

TEACHER : Helen, stand on zero, go all the way to the top saying the numbers.
Helen did so.
TEACHER : We don't usually go as high as twenty. Tamsin, stand on fifteen.
Tamsin walked to fifteen counting.
TEACHER : What is fifteen?
CHILD : It's a one and a five.
TEACHER : Anything else?
HELEN : A set a ten and five left over.
TEACHER : William, stop at number eleven.
He walked to eleven.
TEACHER : Tell me some thing about eleven. (He paused and the teacher prompted him).
TEACHER : What comes before eleven?
WILLIAM : Ten.

TEACHER : What comes after eleven?
WILLIAM : Twelve.
TEACHER : Take three paces forward. Where are you?
WILLIAM : Fourteen.
The teacher then asked which number was before and after fourteen which William answered correctly.
TEACHER : Go back four. Where are you?.
WILLIAM : Ten.
TEACHER : Tell me about it.
WILLIAM : It's one set of ten and none over.
TEACHER : Tom, stand on zero. What are you standing on?
TOM : Zero.
TEACHER : Can you go along seven steps.
He did so, counting in unison with the teacher.
TEACHER : What number are you standing on?
TOM : Five
TEACHER : Look under your feet. That number is seven. What's the highest number on our line?
TOM : Twenty.
(LESSON 7)

Ms A enjoyed using a Flap Jack (Appendix 8) to develop quick counting and number recognition skills. She would fold the Flap Jack in such ways so as to show various arrangements of pictures to the children. The design of the Flap Jacks were such that each number could be shown by at least two arrangements of pictures. Her questions fell into two categories: "How many can you see?" and "How many can I see?". She would always show the children her side of the Flap Jack so that they could check their response to the question "How many can I see?". Each Flap Jack was based on sixteen card squares fastened in a square array, some of the sixteen cards had pictures drawn on them, usually within the range 6 to 10. During Lesson 5 she used 'five' and 'six' Flap Jacks, which had been used previously, before moving onto a 'seven' Flap Jack for the first time. She counted the pictures with the children then showed them the back of the Flap Jack to demonstrate that there were no pictures there. Ms A referred to the post Easter intake as "Little ones" and the pre Easter intake as "Big ones".

TEACHER : How many altogether?
UNISON : Seven.
TEACHER : How many can I see? (Showing three).
There were several answers of "four", "two" and "five" called out before she showed them how many she could see. She then used a ten Flap Jack.
TEACHER : Let's count for the little ones.
This was done with her pointing to the pictures and all the children counting with her.
TEACHER : How many can you see? (Showing seven).
UNISON : Seven.
TEACHER : How many can you see? (Showing five).
UNISON : Five.
TEACHER : How many can I see?
UNISON : Five.
TEACHER : How many are there? (Showing seven).
UNISON : Seven.
TEACHER : How many can I see?
UNISON : Three.
TEACHER : Big ones you're good at it. Let's see how the little ones do.
(She then used a five Flap Jack).
TEACHER : Little ones, you can see five. How many can you see? (Folding the Flap Jack).
UNISON : Four.
TEACHER : How many can I see?
A mixture of "two" and "one" could be heard. The children who said "two" changed their call to "one."
TEACHER : How many can you see? (Folding the Flap Jack to show three).
A mixture of "three", "four" and "two" could be heard.
(LESSON 5)

The children's responses were very quick indeed, they either subitized or developed the ability to count very quickly. When the researcher conducted a test item using a Flap Jack with individual children most responses were much slower and there was was evidence that they counted for quantities greater than three, using rapid eye movement or by pointing (Table 1-A). During the lessons there was no evidence of pointing, or other outward signs of systematic counting.

Some of the activities involved developing prepositional language, conservation of number and counting. A container which was either upside down or open side up would be used in conjunction with a specific number of objects which would be partitioned. The subsets were placed in various positions relative to the container, (e.g. behind, under, on top of).

Table 1-A (Test items analysed)

NAME	MOVE			FIXED			VISUAL					AURAL				MATCHING		
	4	9	7	2	10	6	5	3	7	9	8	3	8	5	10	4	7	9
KATE	I	E	E	I	T	E	E	I	E	E	E			x		I	I	E
MICHELLE	I	E	I	I	E	E	E	I	Ex	E	E					I	E	E
HELEN	I	Ex	E	I	Ex	Ex	E	I	E	E	E		x	x	x	I	E	T
PETER	T	T	T	I	Tx	T	E	I	I	P	P			x		E	I	E
MATTHEW	M	M	M	I	T	T	P	I	P	P	P	x	x	x	x	I	I/TT	
DAVID	I	P	P	I	P	P	I	I	I	E	I					I	I	T

1. The counting test included:
   - MOVE - counting moveable objects
   - FIXED - counting immoveable objects which could be touched
   - VISUAL - counting immoveable objects which could not be touched
   - AURAL - counting sounds
   - MATCHING - matching of a numeral card to a card showing plastic counters.

2. An error is signified by x

3. I= Immediate response M= The item was moved
   T= The item was touched P= The item was pointed at
   E= Eye or head movement

4. Numbers at the top of the columns show the appropriate response

During Lesson 6 six cubes and half a cardboard Easter Egg shell were used. The questions were asked in sets to help the children realise that six cubes were always present. Some of the positions used by Ms A meant that occasionally cubes would be 'hidden'.

Ms A placed four cubes inside the egg and two outside.
TEACHER : How many are inside the egg?
UNISON : Four.
TEACHER : How many are ouside the egg?
UNISON : Two.
TEACHER : How many cubes are there?
UNISON : Six.
She then inverted the egg, placed two cubes on top, two behind and two in front.
TEACHER : How many cubes are on top of the egg?
UNISON : Two.
TEACHER : How many cubes are in front of the egg?
UNISON : Two.
TEACHER : How many cubes behind the egg?
UNISON : Two.
TEACHER : How many cubes are there altogether?
UNISON : Six.

(LESSON 6)

Children were allowed to count objects to develop ideas of cardinality as well as considering the positional relationship between numbers. During Lesson 2 the children sat in a circle whilst the teacher moved round them with a bag of plastic numerals, 0 to 9. The children had their eyes closed and their hands behind their backs whilst the teacher placed a plastic numeral in their hand and they had to guess which was their numeral. The teacher stated each number in turn and the children had to show her if they had the appropriate numeral. There was some confusion with Matthew, who had a nine, as he did not show his numeral to the teacher until some children quickly informed him that it was a nine not a six. Three trays were placed in the centre of the carpet containing sticks, animal shapes and various plastic shapes and the children had to match quantities to their plastic numerals. They each placed their objects in a line with the numeral alongside and checked by counting then took turns to count their objects whilst the other children watched. They were asked whether their objects were the same colour or of the same things. Each child had a "sameness" collection except one who had a mixture of

shapes and sticks. The teacher joined in the counting activity. She had the numeral ten beside her with nine objects beside it. The children counted with her and exclaimed that she needed one more. She added one more then deliberately recounted incorrectly, whereupon the children quickly informed her which object she had forgotten to count. Ms A used the technique of making deliberate errors for the children to correct, she would also 'lose' or 'hide' things. During Lesson 3 the children were shown random numeral cards, in the 0 to 12 range, and the numeral names were called out by the children. When all the cards had been through they stated that number eight was missing and that teacher had hidden it, that it must be on the table. David jumped up and found it hidden under a tray. She would occasionally use a "whispering" technique, (also observed with Teacher L and Teacher H).

TEACHER : I'm going to call you and whisper something.
Tim, I'm going to whisper how many toys to get.
The teacher called each child out by name and whispered in his/her ear. The children then moved to a large tray of small plastic toys and took a number of them out.
TEACHER : Don't tell any one your number. Put them in front of you. (Pause).
Count them for me. (Pause).
Hands up if you've got eight.
Everyone's hands went up.
(LESSON 3)

Occasionally Ms A would take a situation and develop some mathematics from it, during Lesson 8 she used a large Grow-bag of mushrooms for this purpose.

TEACHER : We're going to take some out and weigh them and then count them.
We're going to pick the large ones.
She picked some and placed them in a line.
TEACHER : How many do you think there are?
"Twenty", "ten" and "sixteen" were shouted out, the consensus seems to settle on sixteen, there were in fact seventeen.
TEACHER : Let's have a look and count them. Richard come and count them.
He came and began to count.

TEACHER : As you count move them.
He did so to seventeen.
TEACHER : How many more are needed to make nineteen?
Most children called out "three" although there was the individual call out of "two" and "four".
The child who stated "two" was given two more mushrooms.
TEACHER : How many now?".
CHILD : Twenty.
He was made to count and reached nineteen.
TEACHER : Helen pick the biggest mushroom.
She chose a mushroom.
TEACHER : Daniel see if you can find a bigger one.
He chose a mushroom. They showed the rest of the children their two mushrooms; some of them stated one was taller, some thought one was bigger across the top.
TEACHER : How can we tell which is bigger?
CHILD : We could weigh them.
The mushrooms were balanced and Helen's was the heavier.
TEACHER : Can we make them balance? Will we need a big one or a little one to balance?
Tom picked the smallest mushroom and put it with Daniel's making these now heavier. Another child picked a small one and placed it with Helen's, making this side the heavier then Peter picked a large one and placed with Daniel's, now making this the heavier side. At this point the teacher stated she would choose some good children to balance the mushrooms later on.
(LESSON 8)

After the new intake of children into the class at Easter Ms A would occasionally use an organisational stategem of parallel grouping. The two groups would consist of 'big ones' and 'little ones'. The new intake were the little ones. The parallel groups would undertake a similar activity with slightly different demands being placed on each group. During Lesson 9 the 'little ones' and 'big ones' were sat in two circles with a tray of various counting objects in the centre of each circle. The 'big ones' were told to take eleven objects each and the 'little ones' five objects each.

TEACHER : Count to check you have eleven. Has any one too many? (To the 'big ones').
UNISON : No.
TEACHER : Has any one not got enough?
UNISON : No.
TEACHER : Has any one got a set where everything is the same colour?
Three children stated that they had. The teacher then asked similar questions to the 'little ones' before moving back to the 'big ones'.
TEACHER : Who has a group of the same things?

KATE : All beads.
ELIZABETH: All rabbits.
MICHELLE : All beads.
JOANNE : All prickly things.
HANNAH : Beads.
TIM : Spikey things.
DANIEL : Oh no! You've got an odd one. (This was said to Tim).
The teacher then instructed both circles to make two sets with the same number in each set. Some children said they had an odd one out and held it up.
TEACHER : Anyone not got an odd one?
UNISON : No.
TEACHER : How many in each set? (To the 'little ones').
UNISON : Two.
TEACHER : Put the odd one in the tray.
TEACHER : How many in each set? (To the 'big ones').
UNISON : Five.
CHILD : Five in each set.
The teacher moved round the circles and checked what they had done. She stopped by Peter.
TEACHER : Tell me about yours.
PETER : I've got two and two and two and two and two and one.
TEACHER : What has he done?
KATE : He's not done two sets but sets of two.
Peter then rearranged his objects into two groups.
TEACHER : Count them.
He counted one to six and one to five.
TEACHER : Are they the same?
PETER : No.
TEACHER : What are you going to do then?
PETER : Take one out. (Which he did).
TEACHER : Make me a set of six. (To the 'big ones').
TEACHER : Make me a set of three. (To the 'little ones').
TEACHER : If one set has six in it, what is in the other?
UNISON : Four.
TEACHER : Six and four make ten.
TEACHER : You had three in one set how many in the other? (To the 'little ones').
UNISON : One.
TEACHER : So three and one make four.
TEACHER : Remove one from the four into the other set. (To the 'big ones').
TEACHER : Make me a set with four thing in it. (To the 'little ones).
If we have two sets, how many in that set (Pointed to an empty space).
UNISON : Nothing.
TEACHER : Four and nought make four.
TEACHER : Has every one a set with three in it? (To the 'big ones').
Who hasn't? (Two hands went up, Matthew and Rachel).
Take one from your set of four and put it with the six. How many in this set? (Pointing).
MATTHEW : Three.
TEACHER : How many in this set (Pointing).
RACHEL : Seven.

(LESSON 9)

When children moved from the directed class activities to the more informal group activities the materials would be in place on the tables for the children to move to as directed, or as a free choice. A fairly typical set of activities were those observed during Lesson 1, when there were six groups:

Group 1

Worked on a bobbin number line with bobbins in sets of 10 in different colours, 50 bobbins were on the line. The children hung hooked numeral cards showing the numerals 1 to 6 on the line.

Group 2

Worked on a numeral board showing numerals 1 to 10. Each numeral had a hook above it and children hung an appropriate number of formica pieces onto each hook.

Group 3

Worked with stand up numeral cards showing textured numerals 1 to 10 which the children arranged in order. They felt the shape of the numerals, each texture was different, ribbon, flannel, sandpaper and seeds.

Group 4

Worked with a large flannel board on which were felt picture of 10 houses, each house was different. There were hooks above the houses and children had to hang house numbers above the houses in numerical order.

Group 5

Worked with sorting and matching cards. Each card showed an quantity from 1 to 10, there were several cards for each quantity but the arrangement and shapes used to show the quantities differed. The children matched and sorted for colour, shape or quantity.

Group 6

Worked with beads, sorting and matching them using pattern cards.

The criteria for the grouping was friendship and the groups were of different sizes. There was little interaction from the teacher other than in a monitoring role or as a co-operating group member playing one of the games.

There were very few direct control commands given to the children over the observation period. The children were very co-operative and gave the appearance of enjoying playing with numbers. Ms A's style of class activities allowed children the opportunity to work with their peers rather than in the presence of them (cf Ausubel et al 1978). This class-teaching style (Appendix 3) ensured that the teacher-pupil interaction was not asymetric (cf Galton et al 1980) and that there was ample "active learning time" (cf Harnischfeger and Wiley 1975). Although there was evidence of teacher talk following the IRF format (cf Marriott 1985) she did allow opportunity for more open and tentative responses from the children. Children operated on numerals independently to their cardinal meaning as part of a linguistic experience (cf Tahta 1985; Pimm 1986). During each lesson the children were actively engaged in a wide range of different acivities (Appendix 1) and covered a wide range of counting experiences (Table 2-A).

The results of the test items for numbers in the 0-10 range (Appendix 6) show that all the observed children were error free in numeral recognition and numeral order reflecting the importance the teacher placed upon transitive counting (cf Pimm 1986). Errors were observed

when children had to count actual "items", only David was error free. Matthew and Helen experienced some difficulty in the aural counting of "items".

Table 2-A (Counting tasks observed)

LESSON	RANGE	TYPE	APPARATUS	ACTIVITY
1	0-6	numeral recognition	numeral cards	Flash card activity stating numeral names.
	0-6	sequencing	numeral cards	Holding numeral cards. Standing in sequence.
	0-6	positioning	numeral cards	Questioning about the relative positions and values of numerals.
	0-10	position	floor line	Walking to nominated numerals on a floor number line.
	0-10	count on	floor line	Walking on from one number to another.
	0-10	count back	floor line	Walking back on a floor number line.
	1-50	counting	bobbin line	Counting bobbins on a line.
	1-10	cardinal	bobbin line numeral cards	Hanging numeral cards on a bobbin line.
	1-10	cardinal	squares	Hanging an appropriate number of plastic squares on a numbered board.
	1-10	ordering	textured numerals	Placing textured numeral cards in order.
	1-10	ordering	flannel board	Hanging numerals over a line of houses.
	1-10	cardinal	picture cards	Sorting picture cards according to quantity.
2	0-12	numeral recognition	numeral cards	Flash card activity stating numeral names.
	0-12	sequencing	numeral cards	Holding numeral cards. Standing in sequence.
	0-12	positioning	numeral cards	Questioning about the relative positions and values of numerals.
	0-12	pattern	numeral cards	Counting in two's from zero and one.
	5	conservation cardinal	cubes, bucket	Cubes partitioned and placed in various positions relative to the bucket. Questioning based on "How many?"
	0-9	numeral recognition	plastic numerals	Guessing a numeral which was 'hidden'.
	1-9	cardinal	objects	Matching a plastic numeral to an appropriate number of objects.
	10	counting	objects	Counting objects and matching them to the numeral.
	1-9	partitioning	objects	Partitioning and stating the value of each subset.
3	0-12	numeral recognition	numeral cards	Flash card activity stating numeral names.
	0-12	sequencing	numeral cards	Holding numeral cards. Standing in sequence.
	0-12	positioning	numeral cards	Questioning about the relative positions and values of numerals.
	0-12	place value	numeral cards	Stating the tens and units value of numbers greater than nine.
	0-10	ordering	numeral cards	Sorting numeral cards into order.
	8	partitioning	objects	Counting and partitioning objects.
	8	taking away	objects	Removing a subset. Counting the remainder.

Table 2-A (Continued)

LESSON	RANGE	TYPE	APPARATUS	ACTIVITY
4	0-14	numeral recognition	numeral cards	Flash card activity stating numeral names.
	0-14	sequencing	numeral cards	Holding numeral cards. Standing in sequence.
	0-14	positioning	numeral cards	Questioning about the relative positions and values of numerals.
	0-14	place value	numeral cards	Stating the tens and units value of numbers greater than nine.
	0-10	numeral recognition	numeral cards	A numeral was slowly raised from behind a wall and stating the possible numerals it could be.
5	1-7	number recognition	Flap-jacks	Quick counting.
	1-7	"subtraction"	Flap-jacks	Stating the number of 'hidden' pictures on a folded Flap-jack.
	12-20	numeral recognition	numeral cards	Flash card activity stating numeral names.
	0-10	numeral recognition	numeral cards	Flash card activity stating numeral names.
	0-10	number pattern	numeral cards	Counting in two's.
	0-20	sequencing	numeral cards	Holding numeral cards. Standing in sequence.
	0-20	positioning	numeral cards	Questioning about the relative positions and values of numerals.
	0-20	position	floor line	Walking to nominated numerals on a floor number line.
	0-20	count on	floor line	Walking on from one number to another.
	0-20	count back	floor line	Walking back on a floor number line.
	1-10	ordering	flannel board	Hanging numerals over a line of houses.
	0-10	cardinal	number strips	Placing cards showing spots onto a number strip.
	0-10	cardinal	published game	Playing a published counting game.
6	1-10	number recognition	Flap-jacks	Quick counting.
	6	conservation cardinal	cubes container	Partitioning cubes, placing them in various positions relative to the container. Questioning based on "How many?"
	0-17	counting	children	Counting how many children were in groups.
	0-17	cardinal	children	Groups of boys and girls compared by 1-1 correspondence to find which had most.
	0-18	counting	shoes	Shoes were put into groups. Counting the number of laces and buckles.
	0-18	cardinal	shoes	Shoes were compared by laces and buckles to find which group had most.
	0-18	difference	shoes	Groups of laced and buckled shoes were compared by counting to find how many more laces there were.

Table 2-A (Continued)

LESSON	RANGE	TYPE	APPARATUS	ACTIVITY
7	1-7	ordinal	word cards	Holding ordinal word cards. Standing in sequence. Questioning about the relative position of ordinal cards.
	6	conservation cardinal	cubes, bucket	Partitioning cubes, placing them in various positions relative to the bucket. Questions based on "How many?"
	7 & 9	facts		Stating facts about seven and nine.
	0-20	position	floor line	Walking to nominated numerals on a floor number line.
	0-20	count on	floor line	Walking on from one number to another.
	0-20	count back	floor line	Walking back on a floor number line.
	0-10	numeral recognition	numeral cards	Raising a numeral from behind a wall, stating the possible numerals.
	0-20	numeral recognition	numeral cards	Playing with numeral cards.
	0-20	cardinal	published games	Playing a variety of counting games.
	0-9	numeral recognition	plastic numerals feely bag	Feely bag activity with numerals.
8	0-20	numeral recognition	numeral cards	Flash card activity stating numeral names.
	0-20	sequencing	numeral cards	Holding numeral cards. Standing in sequence.
	0-20	positioning	numeral cards	Questioning about relative positions and values of numerals.
	20	facts		Stating facts about twenty.
	1-17	cardinal	mushrooms	Counting mushrooms.
	1-19	count on	mushrooms	'Counting on' with mushrooms.
	1-5	cardinal	leaves	Counting leaves.
	1-12	sequencing	clockface	Placing numerals on a clock face.
	1-10	number recognition	Flap-jacks	Playing with Flap-jacks. Quick counting.
	0-20	numeral recognition	numeral cards	Playing with numeral cards, asking "What does this number say?"
9	0-20	numeral recognition	numeral cards	Flash card activity stating numeral names
	7 & 8	facts		Stating facts about seven and eight.
	8	fact	children	Pairings for even numbers.
	7	fact	children	Pairings for odd numbers.
	0-10	sequencing	numeral cards	Holding numeral cards. Standing in sequence.
	0-10	positioning	numeral cards	Questioning regarding relative positions, values and facts of numeral cards.
	11	partitioning	various objects	Partitioning a set of eleven according to various criteria.
	1-11	taking away	various objects	Partitioning sets and removing a subset.

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CASE STUDY: Teacher J

Ms J was a Scale III teacher, aged between 30 and 40, who had taught in two previous schools. She had overall responsibility for the mathematics through an Infant School with 200 children on roll. The school was built in 1976 and had large teaching rooms, each room housed one class of children with their teacher. During the period of the observation the reception classroom was in the process of being altered from a single room into a large open plan area for both reception children and nursery children. Temporary wooden screens were in place to separate the workmen and noise from the ongoing teaching. The classroom was a large open area with a bay containing dressing up materials. Extra bays were created by the arrangement of cupboards. There was a carpeted area. The children's tables were grouped in small working units. Apparatus was easily accessible and visually appealing. A high standard of display was in evidence showing large collages and mobiles of children's work each with a wide use of language labels. The displays were changed at half termly intervals. The co-operating adults working in the room with the teacher and children during the observed period were: students from a local College of Further Education who were on a NNEB Course for block periods of 4 to 5 weeks; the Welfare assistant who helped daily for 30 minute periods (just before and just after morning breaktime); two parents helping on a regular weekly basis with baking activities; a teacher colleague (Teacher E) every afternoon. Teacher E came with eight children and a co-operative teaching situation occurred.

The school's admissions policy was that for the Autumn Term all those children who would attain their fifth birthday during the Spring Term went to Teacher E for half day sessions during the mornings only. For the Spring Term a number of these children transferred to Teacher J, the remainder staying with Teacher E to be joined by those children who would be five during the Summer Term. No more transfers took place for the rest of the year. At the start of the Autumn Term Ms J's class comprised of eighteen children who were rising fives plus two younger children who has been granted early admission to the school for special social reasons. For the Spring Term eight new children who were rising fives joined the class and there were no more intakes for the rest of the year.

Ms J began her day with the whole class sitting on the carpet for some language activity. The pre-registration language activities were usually child-initiated discussions followed by more directed teaching situations (cf Cummings 1982). The children then moved as directed to the activities which had previously been set out on the tables. They did not have a fixed base at which to work. Individual children did not have their own pencils and rubbers, the teacher preferred a group sharing system where materials were used from a central pool on the table. The organisation was such that children realised what to do when in difficulties and what to do when they had finished their particular tasks. Ms J was a TASK-FOCUSED teacher rather than a TIME-FOCUSED teacher. The children completed a defined task, or set of tasks, then moved onto something different rather than working on tasks for the period of a lesson. The children were placed into five colour groups for organisational purposes. There was frequent movement in and out of the various groups for specific teaching

points. The target children were in Green Group. The teacher worked with one of the groups for a specific teaching point, after which they had to complete some consolidation or practice activities. Ms J would then undertake a quick monitoring of the rest of the class before moving to new group for a teaching input. She tended to work with the groups in 10 to 15 minute blocks of time. Each afternoon Ms J's class was joined by Teacher E with some of her children. Teacher E taught her own children within the room but they were joined by differing groups from Teacher J. A measure of co-operative-teaching rather than team-teaching took place whereby there was agreement over content and the selection of children for the groupings. Each teacher would then be responsible for her own set of children.

During an interview with the researcher Ms J stated that she planned her activities so that she could monitor, assess, teach, consolidate, reassure and try to ensure there was no repeated failure on the children's part. She tried to plan a "major" mathematical topic for the week and this would take place for one day or it may be part of the daily activities. Some topics would be introduced to the whole class. All the activities would follow a predetermined path of skills and concepts decided by herself. She carried out her overall curriculum planning a half term ahead. Weekly planning took account of the organisation necessary to impliment each curriculum area. An assessment was made on each child at the end of the day so that groups could be organised for the following day. Regular use was made of the computer, almost on a daily basis, and the ITV programme "Lets Go Maths" was followed each week. A Language Master and tape recorder were used as an integral part of many activities. Her assessment of the new intake reception children was to be made as a result of their

responses to sorting, matching and comparison activities. She anticipated that the children's area of number understanding at the end of the Spring Term would be: an appropriate understanding of number language; conservation of number; partitioning. By the end of the Summer Term they would be able to associate a number symbol with a quantity up to ten.

During the nine observations each target child worked as a class member, as a group member and as an individual (cf Principle 12(c) HMI 1985). During Lesson 2 the class activity centred around the ITV programme "Let's Go Maths". All the children were sitting on the carpet having a discussion about the programmes. They knew that the programme for the week was about the number eight and they talked about the numbers which had already been used. The television characters and the stories in which they had been involved were recounted by the children. The teacher tried to ensure that all the children contributed to the discussion and that no-one interrupted them whilst they were talking, time was given for children to collect their thoughts and to comment. The teacher then read a "Let's Go Maths" booklet about eight, discussing various points as she went along, before the whole class sang a song about the number eight. Programme eight of "Lets Go Maths" was then watched.

The group activity in Lesson 8 centred around five of the target children working with the teacher sitting together on the carpet. She was using Floor Numbers and Action Cards (Appendix 8). The Floor Numbers showed the numerals 0 to 10 and the Action Cards had a range of language statements and questions which used cardinal, positional, operational and factual language. The Action cards included:

How many fingers have you?
One more than three.
Two less than five.
* * * * * *
Five
A number before 6.
The number before 8.
A number between 5 and 10.

The children read an Action Card in unison with the teacher and then discussed on which Number Card to place it. They stated whether only one Number Card could be used or whether there was a choice of several numbers. Each Number Card eventually had several Action Cards on it. Most of the Action Cards resulted in confident responses from the children, only the cards containing the language of "less than" appeared to create problems. There were several different responses to the card "What is 4 less than 5?". To help clarify the meaning of the card the teacher used Unifix cubes to model the the question.

TEACHER : These are smarties. Emma has five, I have four less than her.
She removed four cubes.
TEACHER : How many have I got?
UNISON : One.
The children were given Unifix cubes.
TEACHER : Nathan has six, I have two less. How many do I have?
The children worked this out using cubes.
UNISON : Four.
TEACHER : Emma has ten. I have five less.
The cubes were used by the children.
UNISON : Five.

Lesson 8

This activity was repeated several more times for different quantities before the teacher and children returned to placing the remaining Action Cards. The children were then directed to a table to complete some published work cards containing "more than" , "less than" and addition questions, James had buttons to help him, Emma a card number track and Nathan used Stern rods. Ms J encouraged children to use a

range of aids and structured apparatus in order to help them solve their problems.

When individualised activities were observed not all the class would be doing them at the same time, some would be involved in group activities. During Lesson 5 five of the target children moved from a class activity based on developing the language of time to individualised activities. Nathan and David were independently measuring lengths with arbitrary units, whilst Peter, James and Elizabeth worked from published workcards on Number. Emma was involved in a co-operative task working with another child on a balancing objects with arbitrary units.

Ms J would act as a co-operating member of the group during some of the activities, this technique was also observed with teachers in other schools, Ms A and Ms L. During Lesson 4 she was working with David, Peter, Nathan and James on matching and equivalence activities using Unifix Inset Boards, Unifix cubes and Stern rods. Each child and the teacher had two Inset Boards in front of them, some cubes were placed in the centre of the table and these had to be matched to an appropriate Inset Board.

Eight cubes were placed on the table.
TEACHER : See if you have the one which will fit all the cubes
NATHAN : I have. (He took the cubes and placed them in his board without counting).
TEACHER : What about these?
Six cubes were placed on the table. James counted them then placed them in his board.
A handful of cubes were put down. David took them without counting and tried to place them in his board.

DAVID : Oops. There's one too many. (He placed them back in the centre of the table).
They must be for Nathan 'cos he's got the one for ten cubes.
Nathan took the cubes. Five, three and one cubes were used, Peter, James and David correctly claiming them without counting. Seven cubes were claimed by David without a count and he tried to put them on his board.
DAVID : They do not fit. I need two more.
JAMES : They are not for you, they're for Miss, she's got the one for seven.
Ms J took the cubes and placed them in her board.
Lesson 4

It was noticable that Ms J allowed the children opportunity to lead discussion and to ask each other questions, she would allow children time to answer without the feeling of being rushed. Many of her questions, a mix of open and closed, had the 'feel' of "I wonder what the answer is?"

TEACHER : I wonder which other numbers this card can go on?
Lesson 2

TEACHER : See if you can find rods to match
Lesson 4

TEACHER : Can you find me some heavier things?
Lesson 5

JAMES : Eight is five and three. (Using eight buttons in two sets).
TEACHER : Can you find any more ways?
Lesson 8

James and Peter were observed using self questioning techniques to good effect during Lesson 7. They were working with Elizabeth and another child using published workcards which posed problems based on "more than" questions. They were expected to use Stern rods to help them. The teacher asked James to read the workcard to her, which he did reeling off all the answers at the same time. Only "4 more than 5" caused him to pause and quickly refer to a number track before answering. He made no attempt to use the rods. The teacher asked Elizabeth to read the card to her and checked that she knew what to

very slowly to copy a question off the card and write the answer. After one example had been completed he began to play with Peter using the Stern rods. He would state an addition for for them both to answer. The additions were pairs of numbers whose total was twenty or less. Peter tended to use the Stern rods whilst James quickly answered without reference to aids. Only "five add four" caused him to use the rods. Peter would answer some of the additions using the rods as single countable items rather than as representations of quantities. For "three add two" he used three different rods combined to two different rods to obtain the total of five rods. He found it quicker to count rods rather than the individual markings on the rods. They eventually returned to the task in hand At the end of the lesson Peter had completed seven examples whilst James had completed only two.

Her organisation and teaching style allowed Ms J to spend some time with all the children, including those children who were apparently not experiencing difficulties. Although children would move from their working base to see her with any particular problem no obvious queues were observed.

During the observed lessons the target children were engaged in a broad selection of mathematical experiences (Appendix 1). These mathematical experiences included a range of counting experiences using a variety of structured materials (Table 1-J). They were involved in counting moveable objects, counting items which could not be moved, counting on number lines, making count-measure transitions (cf Fuson and Hall 1983) and the equivalence of number.

Table 1-J (Counting tasks observed)

LESSON	RANGE	TYPE	APPARATUS	ACTIVITY
1	2	Cardinal	Crayons	Drawing two tall/short trees.
2	8	Cardinal	Plastic objects	Sorting sets of eight objects and matching them to numeral eight.
	1-5	Cardinal	Cards	Matching cards with cardinal meaning to numerals.
	1-5	Ordinal	Cards	Matching cards with ordinal meaning to numerals.
	8	Cardinal	Crayons	Drawing four tall and four short items.
	8	Writing numeral	Crayons	Tracing 'dotted' numeral eight.
3	10	Partitioning	Plastic ducks	Partitioning ten items into subsets.
	1-10	Totalling	Crayons	Finding a total number of pictures by counting all.
4	1-10	Cardinal	Cubes, Inset boards	Counting cubes and matching to inset boards.
	1-13	Totalling	Cubes	Finding a total by counting two groups.
	1-10	Equivalence	Cubes & rods	Matching Unifix cubes to equivalent Stern rods.
	1-10	Ordering	Rods	Placing Stern rods in ascending and descending stairs.
5	1-10	Totalling	Workcard, Cubes	Totalling two sets of pictures.
	1-22	Measure	Matchboxes	Counting how many matchboxes were 'as long as'.
6	1-10	Equivalence	Stern rods	Matching two rods with an equivalent third rod.
7	1-10	Count on	Number line	Counting on from one number a given number.
8	1-10	Cardinal	Cards	Matching cards with cardinal meaning to numerals.
	1-10	Ordinal	Cards	Matching cards with ordinal meaning to numerals.
	1-10	Totalling	Buttons, Number track, Stern rods, Number line	Finding the total of two sets.
9	1-10	Measure	Straws	Counting how many straws were 'as long as'.
	1-10	Totalling	Stern rods, Number track	Finding the total of two rods in a track.

The teacher used counting moveable objects to improve children's counting accuracy through appropriate strategies. During Lesson 3 four of the target children were working with Daniel on partitioning moveable objects whereby ten plastic ducks were placed in the centre of the table. Daniel was told to split the ducks down the middle. He divided them into a group of two and a group of eight. Nathan was told to count each group. He miscounted the group of eight and was encouraged to touch and move as he counted, which he did correctly. David was asked to split the ducks another way so he divided them into groups of six and four. Elizabeth counted each group by touching. She then split the ducks into groups of five and five. Emma counted one group to five and then announced "Five and six". The teacher suggested that she had guessed the second group and to check by counting. She did so and obtained the correct result. Emma divided the ducks into groups of four and six and Daniel counted them correctly by touching. Counting moveables through partitioning activities was subsequently developed into counting two groups and combining them to form a single group. In Lesson 5 James was observed using Unifix cubes to total two groups by combining them into a single group.

During the course of Lesson 5 David and Nathan had their counting experiences extended by being involved in count-measure transitions. Ms J showed Nathan how to end match and leave no spaces when measuring with matchboxes. At one point David had seventeen matchboxes as long as a shelf and did not know how to write this number. The teacher gave him a number line to help, whereupon he counted along the line

As part of the counting experiences Ms J involved the children in equivalence activities. During Lesson 6 Nathan, Elizabeth, David and Emma were working with Carmen in considering the equivalences involved by using Stern rods. The children had in front of them: published workcards; trays of Stern rods; a number track into which Stern rods would fit. The teacher showed the children the published workcards that they were to complete and explained how she wanted them to attempt the cards using Stern rods. She went through an example with them.

TEACHER : We get a three rod out and then a seven rod. (She end matched them).
TEACHER : Which one will match?
Some children pointed to the nine rod.
ELIZABETH: The ten rod.
Another example was done with them.
TEACHER : Which is the red one?
UNISON : Eight.
TEACHER : Which is the blue one?
UNISON : Two.
TEACHER : Which will match?
Carmen picked up the nine rod, the teacher end matched the rods.
ELIZABETH: It's the ten rod again.
Lesson 6

Although the children had experience of matching two rods with an equivalent rod and that this was the object of the workcard exercise they reverted to other, more familiar, strategies of finding solutions given the opportunity. Emma was observed counting the individual units on the rods, as pictured on the workcard, and just wrote the answer. The teacher stopped her and told her to use the rods and match them as she had been shown. Emma took two rods and counted the units until she was stopped and told to find the equal rod which matched them. The teacher left to work with another group. Emma and

placing two rods end-to-end and finding the equivalent one by estimation or by trial and error. He did not appear to count. David counted the individual units on his two rods then obtained the equivalent rod by counting the units on that one. Emma returned to counting from the pictures on the card, making several procedural counting errors in the process. The teacher returned and corrected Emma's work with her, using the rods. David was now visually matching, he did not appear to count. He had written six as the result of one of his examples although the correct answer was nine, he had copied the number from the number track by counting on and as the track was upside down to him he had inverted the number. The teacher showed him how to write the numeral nine. When she had moved away David continued the equivalence activity either by estimation or by guess work as there were several attempts at each matching. This 'guessing' strategy also showed up during the testing when he was counting items which could not be touched, the 'visual test', no attempt was made to count the items (Table 2-J). The teacher had not involved the target children in counting 'sounds' however in the testing, apart from Nathan, the children were error free (Table 2-J).

Table 2-J (Test Results: Counting numbers to ten)

NAME	MOVE			FIXED			VISUAL					AURAL				MATCHING		
	4	9	7	2	10	6	5	3	7	9	8	3	8	5	10	4	7	9
Peter	T	T	T	I	Tx	T	I	I	I	P	P					I	T	T
David	T	T	T	I	Tx	Ix	Ix	I	Ix	Ix	Ix					T	T	T
Nathan	I	Tx	Ex	I	T	E	I	I	E	E	E	x	x	x	x	T	E	E
Elizabeth	E	T	T	I	T	T	P	I	P	P	P					T	T	T
Emma	I	M	E	I	T	T	I	I	P	P	P					I	T	T
James	P	M	P	I	Tx	P	E	I	E	E	E					I	I	T

1. The counting test included:
   - MOVE - counting moveable objects
   - FIXED - counting immoveable objects which could be touched
   - VISUAL - counting immoveable objects which could not be touched
   - AURAL - counting sounds
   - MATCHING - matching a numeral card to a card showing plastic counters.

2. An error is signified by x

3. I= Immediate response M= The item was moved
   T= The item was touched P= The item was pointed at
   E= Eye or head movement

4. Numbers at the top of the columns show the appropriate response

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CASE STUDY: Teacher L

Ms L was a Scale II teacher, aged between 30 and 40 who had not taught in any previous schools. She had responsibility for the Reception class in an Infant school with 90 children on roll. The school was built in 1978 to serve an estate of predominently private housing on the edge of a medium sized town. Although the school was of open plan design the three classes were treated as separate entities and taught as classes. During the time of the research permanent screens were being built inside the school to remove the openess of the design.

Ms L had a large 'L' shaped room with the 'L' completed by a work bay containing a wet area. There was a large space off the main room containing: a Wendy House; bed; toy kitchen; rocking horse; large apparatus for creative activities. Toilets led directly off the classroom. The apparatus was very well labelled, easily accessible and visually appealing. Displays of work were very stimulating, creative and informative. They were a mixture of children's work and teacher produced stimuli.

Two parents came each day, one in the morning the other in the afternoon, to work with children and undertake tasks connected with classroom routine. Two of the helper parents were trained infant teachers.

The admissions procedure for the Autumn Term was that the rising fives joined those children who had begun their full time education the previous Easter. Those children who were to be five during the coming

Spring Term undertook half-time schooling for the afternoon sessions. The Spring Term saw the September intake and those children who had been attending half-time (now attending full time) joined by a new intake from a local nursery school. Children who were to be five during the Summer Term joined the class half-time whilst the previous Easter starters left to move to a middle infants class. For the Summer Term the class comprised of the September intake, the Christmas intake, the Easter intake who had been attending half-time (now full-time) and an intake from the local nursery school. At January 1985 there was an intake of nine children to join the ten already in the class.

Ms L stated that she started her day by setting out different activities on the tables and deciding which groups of children would work at each table. She would then move among the groups working mainly with the group but with individuals when she deemed it appropriate. The children began the day with a teacher-directed worksheet or workcard, to get them used to working on a task without fussing, and to allow her time to start off a small group or talk to an individual child. The task was based upon pre-taught skills, concepts or processes. It was consolidation, revision, practice or putting known "knowledge" into a different setting. After the "teacher task" children were directed to a range of activities which she had previously placed on tables. On completion of the activity children were directed to "activity trays". Each tray contained apparatus and games and was used to develop new concepts, language, processes or to consolidate previously taught skills. The contents of the trays allowed for several activities to be undertaken, each of which would allow the same concepts, language or process to develop.

The children were therefore allowed some freedom of choice in the activity. On finishing the "activity tray" to the teacher's satisfaction the children were allowed a free-choice activity. Some "topics" were introduced to the whole class then followed up with workcard or worksheets and activity trays. Children were encouraged to follow a "flexible" routine, to be self sufficent in obtaining and replacing the materials they needed. They knew which task was to be completed, what to do next, what was free choice and what was mandatory. This organisation allowed the teacher time to work with groups of children on specific teaching points with minimal interruptions. Mathematics was integrated into other activities wherever appropriate and was usually undertaken in the mornings.

During an interview with the researcher Ms L stated that all her activities followed a pre-determined development programme. She made an assessment at the end of each week and this determined: the following week's worksheet or workcards; activity trays; and grouping of children. She considered the assessment was a concept and materials based judgement. A "group" could consist of children requiring further practice and those beginning a particular stage. She allowed a certain amount of pupil-to-pupil help within a "narrow" ability range. There was an individual pupil's record sheet which fitted inside the children's folder or book for them to complete at the end of each task. The children would follow the ITV programme "Let's Go Maths". There was a very well equipped computer centre in the school which was not used by the reception children. She considered that although the children come from a good "middle class" area the wider use of language needed to be encouraged and developed. Assessment and development would be undertaken during sorting,

matching and comparison activities. At the start of each term several children would have already been with her for at least one term so would know her organisation and be well enough trained to allow her greater flexibility for assessment and placement of the new intake. She thought that the children's area of number understanding during their first two terms would be: counting and associating a quantity with symbol, the children having completed sorting, ordering, comparison, seriation and ordinal number activities previously. She would deliberately not "force the pace" to get children doing formal recording.

Her main concern was that the group organisation broke down at the start of each term because there were always incoming and outgoing children. She also worried that the Easter starters could well be rushed as there were always more children in the class when they started school than for any other group of children. After their first term in school there was also the six weeks Summer holiday. The children starting at Summer or Spring had two terms to consolidate their learning whilst Easter starters had only one term. She was very aware that these children would be treated as a "class" by the time they reached top infants ready for their transfer to the junior school.

During the observations Ms L would begin the day with the children sitting on the floor around her whilst she marked the register. This period would give rise to informal social talk between the teacher and the children before they moved on to begin their tasks (cf Cummings 1982). These social interactions were between a child and the teacher and not among the children themselves. They were one-to-one rather

than one-to-many conversations. This continued within the group activities when pupil comments were made to the teacher and not to each other.

The teacher was extremely soft spoken. During the entire observation she never once raised her voice to a child or to the class, and her quietness was reflected by the noise level within the classroom. The children almost whispered to each other. Ms L would employ a "whispering" technique as part of her teaching style whereby children would come up to her and "whisper" the solution to a particular problem, or she would "whisper" a message to a child. At the start of Lesson 4 she informed the children what they had to do with the "feely box" during the course of the day. They had to guess the identity of the mystery object inside the box by feeling it, then whisper its name to the teacher at any time during the day. A label on the box read, "What is in the box today?" and this was surrounded with texture words such as "hard", "soft", "silky" and "rough". She would change the mystery object in the box each day. She would also write mystery words in children's books and they would have to come to her and whisper what the words were.

After registration there would be a brief class activity which the teacher used to develop language situations. During Lesson 2 this class activity centred around comparison of children's heights. All the children were in the bay grouped around a very large paper sunflower which was fastened to the wall. On the stem of the sunflower were marked the heights and names of several pupils. The teacher discussed with the children who was the tallest on the flower, who the shortest, who was taller than a named child and who was

shorter. Three more children were called to the sunflower and had their heights marked on the stem. This was followed by further discussion as to the relative heights marked on the flower. From the class activity the children would move to their designated group activities. The group sizes were usually between four and six children and the composition of each group changed significantly from activity to activity and from day to day. Ms L grouped her children according to her assessment of their conceptual development and not for managerial reasons. The target children, Nathan, Matthew, Stuart, David, Emma and Caroline were observed working in many combinations with each other and with other children. In the observed lessons Ms L would sit with one of the groups undertaking some teaching task whilst the remainder of the class were monitored by a parent-helper, who happened to be a teacher. Whilst she was working with a specific group there were very few interruptions from other children. The teacher regarded these working periods as "precious" and stated that each group would get their turn for "precious time". It was her attempt at trying to overcome the asymmetry of teacher-pupil interactions (cf Galton et al 1980). She would occasionally leave her working group to complete a quick monitoring tour of the classroom.

During the early observations whilst the children were involved in sorting, matching and comparing activities Ms L would be very careful to try and structure her language so that the children would "develop language skills". It was noticeable that she would use the language she wished to develop and the children had to respond to it.

TEACHER : Make me a longer snake. (Emphasised the word "longer").
The children made longer plasticine snakes in silence.
Lesson 1

The children were handling objects in a feely box.
TEACHER : Is it squelchy?
EMMA : No.
TEACHER : Is it pointed?
EMMA : No
Lesson 3

The children were sorting various objects, by end matching, and placing them into two hoops labelled "longer" and "shorter".
TEACHER : Do you think the cane is longer?
NATHAN : Yes.
TEACHER : How can you tell?
Nathan end matched them and showed the teacher.
TEACHER : Which hoop will you put it in?
Nathan placed it in the "longer" hoop
Lesson 4

During these exchanges the children either responded by action or answered monosyllabically, however in later lessons children were encouraged to express themselves orally and a more open style of questioning was adopted.

The children had to match the teacher's four cubes with four of their own. David miscounted and took five cubes, he recounted and removed one of them.
TEACHER : How did he make four again?
MATTHEW : He took one off. Five take off one is four.
Lesson 8

TEACHER : I've got a number in my mind that I am not going to tell you. You have to guess. It's between one and twenty. I'll give you some clues.
STUART : Twenty-one.
TEACHER : It's between one and twenty.
MATTHEW : Nineteen.
TEACHER : Fewer than nineteen.
DAVID : Twenty.
TEACHER : Not as many as twenty, fewer than twenty.
CHRIS. : Ten.
TEACHER : It's more than ten but fewer than twenty.
RICHARD : Twenty-two.
STUART : Fourteen.

TEACHER : It's more than fourteen.
MATTHEW : Fifty.
DAVID : One thousand.
TEACHER : We'll start with a number less than twenty. (She counted out ten cubes in a line).
TEACHER : It's one of these numbers. (She recounted to ten slowly).
STUART : Nine.
TEACHER : Fewer than that.
MATTHEW : One.
TEACHER : More than one.
DAVID : Four.
TEACHER : More than four.
CHRIS. : Nine.
TEACHER : Fewer than nine.
RICHARD : Er. (He paused, and the teacher prompted).
TEACHER : More than five, but not as many as eight.
RICHARD : Eight.
TEACHER : Not as many as eight.
STUART : Er.(He paused, and the teacher prompted).
TEACHER : More than five, not as many as seven.
STUART : I think it's (he was interrupted by Matthew)
MATTHEW : Six

Lesson 8

During the group activities she would sometimes join in the activity as a participant member. In Lesson 1 she played a word matching game with the children and in Lesson 4 she joined in an ordering of colour-hue game. She would also employ the "deliberate error" technique whereby children had to correct her mistakes. During a numeral recognition activity in Lesson 9 she looked at some numerals and incorrectly stated what they were, the children quickly corrected her.

During the observed lessons the target children were engaged predominantly on comparison activities with some counting experiences (Appendix 1). These counting experiences concentrated upon the cardinal aspect of number with some reference to numeral recognition and numeral formation, the objects the children counted were limited in extent (Table 1-L).

Table 1-L (Counting tasks observed)

LESSON	RANGE	TYPE	APPARATUS	ACTIVITY
4	1-5	Cardinal	Paint chart spots	Counting 'How many?'
5	1-6	Cardinal	Painting materials	Painting a given number of pictures.
	1-5	Cardinal	Cups of water	Counting cups of water added to flour.
6	1-20	Cardinal	Classroom objects	Counting 'How many?'
	1-20	Comparison for more/less		Comparing two groups by counting.
7	1-10	Cardinal	Crayons	Drawing and labelling a set of pictures.
8	1-10	Numeral recognition	Numeral cards	Flash card activity stating numerals.
	1-10	Matching	Cubes	Matching the size of the teacher's set.
	20	Cardinal	Cubes	Counting cubes.
	1-20	Number facts		'Guess the number' game.
9	1-10	Numeral recognition	Numeral cards	Flash card activity stating numerals.
	1-10	Numeral formation	Fingers	Tracing numerals in the air.
	1-10	Numeral recognition	Small numeral cards	Matching teacher's numeral.
	3	Cardinal	Cubes	Matching a quantity to a numeral.
	1-10	Cardinal	Picture cards	Matching pictures of quantities to numerals.

Ms L stated that she did not believe in introducing the children to zero as the concept was too difficult for them to grasp. In the test results only Emma and Nathan did not recognise the numeral zero, whilst in the ordering of the numerals zero to ten only David and Matthew managed the correct sequence. Caroline tacked zero at the end of her sequence whilst Stuart went to great pains to try and hide his zero card. Eventually he sat on it (Appendix 6). There were no number track or number line activities observed, nor were any in

evidence within the classroom. Three target children, Emma, Nathan and Caroline, were observed trying to sequence numeral cards with two other children during Lesson 9 after some experience of numeral recognition and looking at the cardinal value of the numbers.

The teacher placed Unifix cubes in centre of table and showed flash cards of numerals one to ten in random order to the children. Six was shown and "Eight" was said in unison, except Tim who said "Six". Five was shown and "Five" said in unison, the teacher then reminded them how five was written, "Down, fat tummy, put his hat on". She then showed five and said it was six, the children corrected her. Numeral one was shown and "One" correctly stated. Nine was shown, the teacher stating it was seven, she was corrected by the children. Four was shown inverted and Tim stated that it was upside down. The children were asked how it was drawn and replied "Down, along, then the stick." Ten was shown and there were several guesses, eventually the teacher had to tell them what it was. Seven was shown and answered correctly in unison. Three was shown and answered correctly in unison, except by Emma who said "Five". Two and eight were shown and answered correctly in unison. The teacher told them that eight was written like an "S" first then joined up, the children traced an eight with their fingers on the table. She gave out small cards which had one to ten written on them.

TEACHER : See if you hold up the same as me.
She held up 5, 6 then 8, the children responded correctly.
TEACHER : What number is it Caroline? (Showing eight)
CAROLINE: Six

Lesson 9

The Teacher showed Caroline the six card to highlight the difference,

she then held up the two card, Emma showed her two upside down so Ms L queried whether that was correct, Emma corrected herself.

TEACHER : Find three Unifix to match the number (Showing the three card).

Emma took five cubes, the teacher removed them, then placed one at a time in front of her and counted to three slowly.

TEACHER : How many Nathan? (Nathan had four cubes).
NATHAN : Five (the teacher counted and placed three in front of him).

Lesson 9

Caroline had three cubes, the Teacher counted them with her. Ms L then showed five cubes to the children and asked them to show her an equal number. Emma took four cubes, Nathan, Nicola, Caroline and Tim each showed five. The Teacher counted with Emma, she moved one at a time and all the group counted with her. Emma tried to count her cubes, she reached to two and stopped, whereupon the other children helped her to count to five. Caroline moved her cubes and counted correctly. Nathan moved and counted his cubes with some help from the teacher. Envelopes were given to the children, inside were yellow cards and small squares. On the squares were numerals 1-10 and on the yellow cards were arrangments of pictures in sets of one to ten. The children had to match numbers to pictures. They began by putting the numerals in order in front of them. Caroline's order was correct but Emma and Nathan had a mixed jumble of numerals in front of them. The teacher counted with Caroline along her line of numbers. At this point Emma felt unwell so the Teacher asked for someone to help put her numbers in order. The numbers one to five were placed in front of the teacher and the children counted them.

TEACHER : What comes after five?
UNISON : Six.

Caroline placed six after the five. The teacher counted out the seven to ten cards as the children pointed to them and stated the numbers.

TEACHER : Let's see if we can sort Nicola out. One, Two, what's next? (Nicola pointed to eight).
The Teacher moved the numbers in order and counted as she did so.
TEACHER : Tim, can you put Nathan's right for me? (He did so).
TEACHER : Let's look at the pictures
The pictures were of butterflies and stars.
TIM : We could match the pictures with Unifix.
The teacher did so with a picture of four items.
TIM : We could use numbers as well.
TEACHER : Which number goes with this? (Pointing to the picture of four items).
UNISON : Four.

Lesson 9

The target children appeared confused over which numbers some of the numeral cards represented, the order of the numerals, and the technique of accurately counting objects. This confusion continued for Emma and Nathan as the results of the counting, numeral recognition and numeral ordering tests show (Appendix 6). The teaching of counting skills appeared in sharp contrast to the very careful detailed and systematic development of comparison which took place over a matter of many weeks (Appendix 1). The results of the counting tests using numbers within the 0-10 range show that many of the children seemed to subitize rather than count for numbers less than five (Table 2-L).

Table 2-L (Test Results: Counting numbers to ten)

NAME	MOVE			FIXED			VISUAL					AURAL				MATCHING		
	4	9	7	2	10	6	5	3	7	9	8	3	8	5	10	4	7	9
DAVID	M/TM/TM/T			I	Tx	T	E	I	E	E	E				x	I	I	I
CAROLINE	I	P	P	E	E	E	E	E	E	E	Ex					I	T	T
EMMA	M	M	M	I	Tx	T	Ex	I	E	Ex	Ex		x			*	*	*
STUART	I	T	T	I	Tx	T	E	I	E	P	P					I	T	T
NATHAN	T	T	T	I	Tx	T	E	E	E	E	E				x	I	Tx	Tx
MATTHEW	I	T	P	I	P	E	E	I	E	Ex	E				x	I	I	I

1. The counting test included:
   - MOVE - counting moveable objects
   - FIXED - counting immoveable objects which could be touched
   - VISUAL - counting immoveable objects which could not be touched
   - AURAL - counting sounds
   - MATCHING - matching a numeral card to a card showing plastic counters.

2. An error is signified by x
   No attempt is signified by *

3. I= Immediate response M= The item was moved
   T= The item was touched P= The item was pointed at
   E= Eye or head movement

4. Numbers at the top of the columns show the appropriate response

References

Cummings,C. (1982) "A First Try: Starting the Day" in Payne,G.C.F. and Cuff,E.C. (Eds) "Doing Teaching: The Practical Management of Classrooms" Batsford Academic and educational Ltd:London

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Ms H was a deputy headteacher, aged between 40 and 50, with experience of teaching at three previous schools. Her special responsibility was for the mathematics throughout the school. The school had 180 infant and nursery aged children housed in early 1900's buildings. The infants were in the main building and the nursery children in an annexe. The catchment area was mainly council housing and pre-war terraces on the edge of a medium sized industrial town. Her class room had the four corners designated for various activities: library; sand and water play; painting and artwork; dressing up and general apparatus. It was well equipped with a variety of apparatus and materials all of which were easily accessible to the children. Mathematics workcards, worksheets, home-made apparatus and games were housed in a series of drawers outside the classroom. They were well categorised and beautifully presented. The centralisation ensured that all the staff had easy access to them. On the walls of the classroom and surrounding corridors were large friezes of topics currently being undertaken by the class, smaller informative displays and displays of children's work. Working with the teacher were: the Welfare Assistant who helped for one day per week; a mother who helped each Friday afternoon; a pupil from a local secondary school who was on a "Community Care" programme for one morning session each week; a young man who helped for one morning session each week, he had been doing so over a number of years; and the Headteacher on a regular fortnightly time-tabled basis.

Children moved from the school's nursery unit into the reception class at the beginning of each of the three terms. The Spring Term of 1985

saw an intake of fifteen children joining an existing group of ten Middle Infants. The School previously had a policy of parallel grouping throughout the school and this was the first year that there was a reception class. At the start of the Summer Term there was an intake of five children from the nursery unit whilst five middle infants moved out to another class.

During an interview with the researcher Ms H explained that she usually organised her lessons so that there was either a class activity on the carpet followed up by various connected activities; these would be previously set out on the tables. Sometimes she would direct groups of children to activities set out on tables whilst she worked with the remaining group either on the carpet or at a table. The children would be organised and taught mainly as members of a group although there would be frequent individualised teaching occurring because several children had acute learning problems. Children would work on their own tables which acted as their base. Mathematics would be integrated with other topics wherever applicable, taking place either in the morning or in the afternoon. She would have the reception children working in two groups, of seven and eight, although these would sometimes be further subdivided to make four groups altogether. Her Middle Infants would be in two groups of five and all children would be moved between groups according to the teacher's assessment of their development. A flexible routine would be followed to allow for maximum organasational freedom. All the mathematics activities would follow a pre-determined development programme written by the teacher. In broad terms the areas to be covered would be planned at half-termly intervals. She would make an assessment at the end of each week for her to plan the subsequent

week's activities. This planning would be based upon a skills-concept awareness programme. A matrix would be built up for each week showing each day listed against a range of skills and content, entering what was to be developed and which groups had to do the particular activities. A full assessment was made at the end of each half-term for each group and each child made a monthly entry into a "special book" as a record of his or her progress. The computer was used on a weekly time-tabled basis. No mathematics programme was followed on television. The school had a very mixed catchment area and there was a very wide ability range so she would begin their mathematics education by assessing language development because she found that a great deal of extra language experiences was needed by most children. Assessment would be made whilst the children were working on the sorting, matching and comparison activities. She considered that by the end of the Easter term the children's area of number understanding would be: incidental counting to ten; wide language development, occuring through sorting, matching and comparing. By the end of the Summer term they would be able to count beyond ten and have experience of cardinality to ten. She would not expect to cover activities on number operations.

Ms H was a very "motherly" teacher, she would frequently place her arm around children when talking to them, or take upset children upon her knee to comfort them when they became distressed. She would exert control through extraverbal meaning and voice tone as observed by King (1978, 1979 and 1984) and often referred to the children by endearments instead of using their names. Some observed lessons began with the teacher working with the group of fifteen reception children sitting on the carpet. During other lessons she worked with a group

of ten reception children on the carpet or with a table of between six and eight children. Whilst she was occupied with her working group the remaining childen were working at their tables or in the activity corners. During these working sessions there was a tendency for some of the more dominant children to monopolise the proceedings, particularly Jessicca, Ben and Craig (the boys were both target children). During Lesson 1 which lasted for 30 minutes and involved the children in using attribute shapes for a variety of activities only Ben and Craig of the target children took part either verbally or in handling the shapes. Similarly in other lessons it was noticable that, these two boys apart, there was little unprompted response from the other target children. Ms H would accept "call outs" or "unison" responses during her oral activities rarely nominating children by name to respond. The responses tended to be single word answers to closed questions.

TEACHER : This is a new shape. Let us count the sides.
This was done with the teacher touching the sides and the children counting aloud with her.
TEACHER : It has eight sides. Do you know what an eight sided shape is called? (No answer).
It is called an octagon. All say it with me so that you remember. Octagon.
UNISON : Octagon.
TEACHER : What is the colour of the octagon?
UNISON : Green.
TEACHER : How many shapes have we here altogether?
Some children counted to four whilst others said four immediately. She then added a blue circle, a red triangle and a green square to the line of shapes in front of her.
TEACHER : How many shapes?
UNISON : Seven.
TEACHER : What is the new number we have been looking at this week?
UNISON : Seven.

Lesson 4

She would also employ the strategy of making a deliberate mistake for the children to correct.

TEACHER : Which is the last shape?
UNISON : Square
TEACHER : This one? (Pointing to the blue square)
UNISON : No, this one (Many children pointed).
CHILD : The green one.

Lesson 4

During some of the oral activities she would try and steer the children towards producing the response she expected or wanted. During Lesson 8 she began by referring to previous measuring tasks where the children had measured with straws and cubes.

TEACHER : These are no good for measuring in shops. (Pushing away a tray of straws and cubes).
TEACHER : What could we use instead?
Ben stood up and showed his foot.
BRETT : Legs. (He crawled over the mat).
TEACHER : Not a good idea.
LINZI : Hands. (This was ignored).
TEACHER : I want some part of the body. (She strode along the carpet).
TEACHER : To give you a clue. (She strode back).
CRAIG : Walking.
TEACHER : What was I doing in my head?
BEN : Counting.
TEACHER : What have I discovered? (Striding the mat).
BEN : Five feet
TEACHER : I wasn't counting in feet. What was I using? What do you call the measuring? Five what?
CHILD : You're counting numbers.
TEACHER : (Taking one stride). This is one (pause)?
CHILD : Step.
TEACHER : A good word. The word we use is paces. Nathan, you do some paces (Nathan paced the carpet).
TEACHER : How many paces?
CHILD : Five.

Craig was chosen to pace the mat, he did so slowly, counting to six as he walked. Danielle was then selected, she took seven paces. The teacher paced the carpet in five strides.

TEACHER : My what is bigger than yours?
This was unanswered so the teacher showed her span.
TEACHER : This is called a span. Let's name parts of the body we can measure.
Several children called out "Hands" and "Feet".
TEACHER : Anything else?
BEN : Fingers.
CRAIG : Span.
DANIELLE : Walking.
BEN : Paces

TEACHER : That's the word. I'm going to ask someone to pace for us (pause).
Ben, you pace outside, use the edge of the drawers.
Find how many paces long the cupboard is.
Lesson 8

During the observations a range of counting experiences were offered to the children (Table 1-H).

Table 1-H (Counting tasks observed)

LESSON	RANGE	TYPE	APPARATUS	ACTIVITY
3	1-5	Cardinal	Unifix cubes	Counting cubes (Show me).
	1-5	Ordinal	Unifix towers	Ordering towers.
	1-5	Cardinal	Plastic objects	Recognising the number in a group (How many?).
	3-4	Number facts		Recalling rhymes and facts containing 'threeness' and 'fourness'.
4	8	Counting	Octagon	Counting the sides of an octagon.
	1-7	Cardinal	Shapes	Counting shapes (How many?).
	1-7	Ordinal	Shapes	Discussing position of shapes placed in a line.
	1-7	Ordinal	Children	Discussing position of children ordered to size.
5	6	Conservation	Butter beans	Making several patterns with six beans.
	6	Partitioning	Butter beans	Partitioning six beans into two sets.
	6	Recording	Pencils	Recording partitions of six.
	6	Number trios		Recording the four additions to six, no reversals allowed.
6	1-9	Ordinal	Children	Ordering of children round a table.
	5	Cardinal	Pictures	Counting pictures (How many?).
	1-5	Ordinal	Pictures	Ordering pictures to size.
7	1-10	Cardinal	Pictures	Counting pictures (How many?).
	1-10	Numerals	Pictures and numerals	Matching quantities to numerals.
	1-10	Ordinal	Pictures	Ordering quantities.
	0-10	Writing numerals	Crayons	Tracing and writing numerals.
8	1-8	Measure	Children	Counting 'how many' body units.
9	1-10	Counting on	Colour track	Counting 'How many' from x to y on tracks and lines.
	1-10	Counting back	Shape track	Counting on y from x.
	1-10	Addition	Number line	Adding on a number line.

Ms H used a cardinal-count activity in Lesson 3 with a group of fourteen children. The group included all the target children. She held up to five objects in her hand and asked "How many have I?". The children called out answers in unison. Three trays of Unifix cubes were placed in front of children and they were told to take one blue cube, two yellow cubes, three brown cubes and four green cubes. This the children did with some help from the teacher and their peers. She asked who had placed their cubes in steps whereupon those who had their cubes in 'singles' quickly fastened them together. Nathan was asked to count his cubes because he had towers of 1,2,2,3 instead of the required 1,2,3,4. He counted the towers as 1,2,3,4 but didn't realise that his third tower should contain three cubes and his fouth tower four. The incorrect number of cubes in his third tower was pointed out to him by the teacher. He corrected both his third and fourth towers. The children were told to count and point to zero, one, two, three and four which they did by touching their towers. Fifteen plastic objects were then placed in front of children, one bottle, two scissors, three elephants, four ships and five plant pots. The children were told to point to what there was only one of, two of, three of and four of. They then had to count how many were left. Ms H also used the method of concentrating upon a specific number and finding out several facts about that number.

TEACHER : We're thinking about three and four. What stories do we know about these numbers?
CHILD : Three Pigs.
CHILD : Three Bears.
TEACHER : What about mice?
CHILDREN : Three Blind Mice.
The children then sang an action version of 'Three Blind Mice'.
TEACHER : What other things have three somethings?
JESSICA : Triangles have three sides and stools can have three legs.
TEACHER : Let's think about four. What has four of somethings?

Several answers were called which included, table, cats, dogs and pram wheels. The children were given two books, one in the shape of a three with three pages and the other in the shape of a four with four pages. They were told to draw pictures of three things on a page or four things on a page, this to be done after playtime.

Lesson 3

TEACHER : How many shapes?
UNISON : Seven.
TEACHER : What is the new number we have been looking at this week?
UNISON : Seven

Lesson 4

In Lesson 4 Ms H went on to develop ideas of ordinality based upon the number seven which was the focus of their number work for that lesson. The ordinal aspect was initially introduced through looking at the relative positions of shapes placed in a line. Seven shapes which differed either by colour or shape were placed in a straight line between the teacher and the children. Ms H pointed to her left hand shape and stated that this was the start. It was to the right side of the children who were all facing her. This resulted in a little confusion for some of the children who were used to left-right positioning.

TEACHER : Which is first?
No answer, so the teacher pointed and repeated the question.
TEACHER : Which is first?
BEN : Triangle
TEACHER : Which triangle?
UNISON : The yellow one.
TEACHER : Which is last? (Pointing to the last shape).
UNISON : Square.
TEACHER : This one? (Pointing to the blue square).
UNISON : No, this one (Many children pointed).
CHILD : The green one.
TEACHER : Which is the middle one?
UNISON : Octo, octo (The children struggled to remember the word).
JESSICA : Octopus.
TEACHER : Nearly, it's octagon. Sarah, show me the second.
Sarah pointed to the sixth which was the second looked at from left to right.
TEACHER : Show me second on our line.
The teacher went along the line of shapes touching and naming them ordinally from first to seventh.

TEACHER : Ben, stand behind the yellow triangle. Michelle, stand behind the orange circle. Danielle, stand behind the last one. Craig, stand behind the fourth one.
All these commands were followed correctly with some help from other children.
TEACHER : Lyndsay, stand by the fifth one.
Lyndsay stood by the third.
TEACHER : If we start from Ben she's third but if we start from Danielle she's fifth. Start from Ben.
Lyndsay looked, saw where the teacher was pointing and moved there.
TEACHER : What's left? What position?
JESSICA : Third (She went and stood there).
TEACHER : One empty position. What is it?
DANIELLE : Sixth (Sarah went and stood there).
TEACHER : Brett, I want you to replace the third. (He did so)
TEACHER : Replace the middle one. Jessica changed with Craig.
TEACHER : Craig, replace the person behind the red triangle, tell me their position.
He didn't answer but moved to the red triangle.
TEACHER : Sixth is the same. Sarah, replace the yellow triangle and tell me the position.
Sarah said nothing but went to the yellow triangle and moved Ben.
Lesson 4

From considering ordinal labelling according to position she moved on to ordinality through relative size.

TEACHER : Ben, find the smallest child and put them first.
He correctly selected Brett and moved him to the side of the carpet.
TEACHER : Now put the other children in order.
He correctly placed Sarah and Lyndsay then pondered because all the rest were very close in height, except Michelle, who was the tallest. He moved some children around, changed his mind, rearranged them, placed Michelle fourth, seemed confused and stood back.
TEACHER : Look at the line. It should be a smooth line and it should go up nicely.
Ben nodded and correctly arranged the children except for Michelle. The teacher intervened and placed Michelle correctly.
Lesson 4

Ordinality was considered further in subsequent lessons (Table 1-H).

Ms H also used the 'focusing upon a number' technique to develop counting skills, cardinality, conservation, partitioning, operations and relationships. She would introduce all these ideas within one activity. During Lesson 5 she based her mathematics around a bag of butter beans. The children had sheets of paper on which were drawn circles to act as set enclosures. There was some talk about butter

beans and how the teacher liked to eat them.

TEACHER : What is our new number?
UNISON : Six.
Ms H placed a pile of beans in centre of table.
TEACHER : Who will be first to have just six in their hand?
The children counted out beans and held them.
TEACHER : Put them in front of you and count.
Two children had incorrect quantities, the teacher counted with them and corrected the error.
Each child was then given one of the set enclosures.
TEACHER : Shake the beans in your hand and drop them on your paper. Look at the patterns.
Do you notice anything different about them?
Several children said that some were together and some apart.
TEACHER : Pick them up and try again
The children dropped the beans again.
TEACHER : Yours is different this time (To Ben). How many have you got?
BEN : Six.
Three children were asked in turn how many they had. Each child counted aloud and stated six.
Ms H drew a straight line across each child's set enclosure.
TEACHER : Look at what I've done to your sets. Get the beans in your hand.
We're going to see what happens when you drop them.
The children dropped the beans.
TEACHER : How many here? (To Ben, pointing at the beans) and here? (pointing). Altogether?
BEN : I've five here and one here (He counted all to find six).
MICHELLE : I've got three and three, that makes six.
The children dropped the beans again.
TEACHER : What have you got now? Has the pattern changed?
BRETT : I've got a five and a one this time.
TEACHER : Linzi, count for me.
Linzi counted three then three then six.
MICHELLE : I've got five and one.
TEACHER : What makes six then?
MICHELLE : Butterbeans.
TEACHER : See how many ways, by moving the beans, you can make six.
The children did this and were prompted to find different ways of making six. She asked questions related to how many in each partition and how many altogether. She then wrote on a large sheet of paper:

6,0 $\longrightarrow$ 6
2,4 $\longrightarrow$ 6
1,5 $\longrightarrow$ 6
3,3 $\longrightarrow$ 6

TEACHER : Have we got yours? (To Michelle).
MICHELLE : It's five and one
TEACHER : It's very like one and five. Look nought and six is like six and nought.

Lesson 5

Occasionally the children would work in small groups of two's and three's looking at a similar aspect of number but using different materials. In Lesson 7 the target children were involved in cardinality and associating a quantity to a numeral or number word.

Three children were on the carpet each with a jigsaw problem. The jigsaws comprised of three pieces, two pieces showing the same quantity and the third piece showing either the numeral or the word. The completed jigsaw showed two sets of objects with the matching 'name'. Three other children were on a table with a 'matching equal groups' activity, they had picture cards showing number groups from one to ten and had to make sets of cards which showed the same quantity. Two children were matching quantities to symbols using two-piece umbrella jigsaws. The quantity was on the canopy in the form of dots and the numeral was on the handle. The group of children who sorted picture cards counted the number of 'spots' on each card they picked up and tried to place it on another card which showed the same amount. They were attempting to make ten piles, one for each cardinal number. There were piles of cards in random order in front of them showing six, seven, five and four spots at which point they lost track of which pile was which. They frequently counted the spots on the top cards of the piles before placing another card on it. Ms H suggested that they place a Unifix number cap on each pile to tell them which was which.

When teaching numeral formation she would give the children practice in both tracing and copying the symbols. At the end of Lesson 7 she gave the children 'Number Books' which had ruled lines across the page:

Line 1 showed the numbers 0-10 for reference.
Line 2 showed dotted numbers 0-10 for tracing.
Line 3 showed partially drawn numbers 0-10 for completion.
Lines 4 and 5 were blank for copying the numerals 0-10.

Ms H stated that this type of activity "occupied" some children which then allowed her the opportunity of working uninterrupted with a child

or with another group.

Ms H liked to use strips of card on which were shapes, colours or numerals. The children would then count forward and backwards along these strips. During Lesson 8 she used all three types with the children.

The children were sat round a table with the teacher who had a long card strip showing ten shapes: circle, hexagon, rectangle, triangle, oval, square, pentagon, semi-circle, diamond and parallelogram. The diamond was a rotated square.

TEACHER : Lyndsay, what shape? (pointing)
LYNDSAY : Zero.
TEACHER : Yes, but this is a circle. Ben, this shape? (pointing to the hexagon).
Ben counted the sides by touching, lost his place so the teacher helped him. They counted to six.
BEN : Octagon.
TEACHER : No, its a hexagon. Michelle? (pointing to the rectangle).
MICHELLE: Rectangle.
TEACHER : Linzi? (Pointing to the triangle. Ben interrupted).
BEN : Triangle. It's got three sides.
The teacher then moved along the other shapes in turn naming them.
TEACHER : Ben, how many jumps from the rectangle to the semi-circle?
He placed his finger on the rectangle and counted on to the semi-circle.
BEN : Five jumps.
TEACHER : Craig, how many jumps from the hexagon to the diamond? (He counted on).
CRAIG : Seven.
TEACHER : What did he do?
LINZI : He jumped.
TEACHER : He counted on.

Ms H brought out a similar strip showing nine colours: red, blue, green, yellow, purple, brown, orange, pink, and grey.
TEACHER : How many from blue to pink? Sarah moved six jumps with her finger.
TEACHER : We counted on six.

Lesson 9

The children were then placed into two groups. Some small workcards were removed from a pocket at the back of the shape and colour strips. The cards showed statements with missing numbers:

There are __ jumps from square to triangle.
There are __ jumps from red to grey.

Some of the jumps were from left to right, others were from right to left. The children took turns to answer each card with the rest of

the group looking on. The teacher helped individual children by making them put their finger on the first shape, or colour, and then "jumping along" to the required shape, or colour, counting the jumps. She placed a number line on the table showing the numerals one to ten. The points were numbered not the spaces. She gave the children duplicated sheets on which were lines of dots equally spaced. Above each line of dots was a sentence:

Count in 1's
Count in 2's
Count in 3's
Count in 1's and 2's
Count in 2's and 3's

The children were instructed to make "jump patterns" along the lines.

TEACHER : Go along the dots in ones. One, one, one, one.
She completed one line by joining each dot.
TEACHER :The next one is a bit trickier. It is in two's.
Lesson 9

The children began the task. The pattern of "one's" were completed satisfactorily although "two's" caused some joining up problems for Danielle, Ben, Craig and another child so the teacher helped them. Four plastic number lines were placed on the table which had the numerals one to ten written on them. There were no divisions or markings on the strips, just numerals. The children were told to work in pairs around a strip.

TEACHER : First partners touch two. Count on five. Where are you?
UNISON : Seven.
TEACHER : Yes, two and five makes seven. Other partner, finger on three, count on six. Where are you?
UNISON : Nine.
TEACHER : So three and six are nine
One child made an error, she had counted the first number. The teacher showed her how to count on from the first number.
TEACHER : What's three and three.
BEN : Six. (Answered without counting).

TEACHER : Put fingers on two, count on eight. All do it (Pause for children to finish).
TEACHER : What's two and eight?
UNISON : Ten.

Lesson 9

Although the teacher had not given the children experience of counting "sounds" apart from one mistake by Nathan all the target children were error free (Table 2-H).

Table 2-H (Test Results: Counting numbers to ten)

NAME	MOVE			FIXED			VISUAL					AURAL				MATCHING		
	4	9	7	2	10	6	5	3	7	9	8	3	8	5	10	4	7	9
LYNDSAY	E	Ex	E	I	E	E	E	I	E	E	E					T	Tx	Tx
DANIELLE	M	M	M	T	T	T	E	I	Ex	Ex	E					I	E	T
JOANNE	T	Tx	Tx	I	Tx	Tx	Ex	I	E	E	Ex					P	P	P
BEN	I	M	T	I	T	T	P	I	P	E	E					I	T	T
NATHAN	P	Px	E	I	T	T	Ix	I	Ex	Ex	Ex			x		I	T	T
CRAIG	M	M	M	I	Tx	T	E	I	P	P	P					I	T	T

1. The counting test included:
   MOVE - counting moveable objects
   FIXED - counting immoveable objects which could be touched
   VISUAL - counting immoveable objects which could not be touched
   AURAL - counting sounds
   MATCHING - matching of a numeral to a quantity.

2. An error is signified by x

3. I= Immediate response M= The item was moved
   T= The item was touched P= The item was pointed at
   E= Eye or head movement

4. Numbers at the top of the columns show the appropriate response

References

King,R. (1978) "All Things Bright and Beautiful?: A Sociological Study of Infants' Classrooms",John Wiley and Sons:Chichester

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MATERIALS AND ACTIVITIES PREPARED FOR INSET

The materials and activities which were prepared for each individual teacher formed a 'counting package'. Each counting package had two clearly defined aims; to develop the range of counting experiences already on offer to the children within the classrooms and to address the organisational demands and constraints placed upon the teacher. The activities were designed to specifically take on board some of the problems found when children work individually, as a group or as a class.

The technical details and references to the materials used can be found in Appendices 8 and 9.

Desi-stick

The Desi-stick can be used with a class, a group, or with individual children. It is designed to allow children the opportunity to:

a) sequence the number words.

b) count forwards and backwards.

c) recognise the relative positions of one number to another without reference to numeral or quantity.

d) estimate a number's position relative to other numbers in the sequence.

e) count on and back from numbers other than one.

f) recognise the sequences of decades.

g) realise numbers form a continuum, with numbers existing between numbers.

The stick is in essence used as a versatile unnumbered number line.

The stick is held horizontally with the alternate painted sections facing the children. One end of the stick is given a number name (e.g. zero). Children count on from that number name as the teacher moves her finger along the stick touching the divisions between the colours until she reaches the other end. This gives each division mark and each end a number name. Children count forwards and backwards through a number sequence in time to the teacher moving her finger from division to division. The stick is also held vertically to allow children the opportunity of counting 'vertically' as well as 'horizontally'.

Random division marks are then touched and the children state which 'number' goes there. Responses eventually become very rapid. Eye movements suggest that children are using either end of the stick as reference points.

The blank side of the stick is eventually shown to the children. The ends are given appropriate number names and a finger placed at various positions on the stick for the children to estimate which number goes there. The relative position of the numbers at each end of the stick is changed to allow children the opportunity of counting from left to right or from right to left.

Instead of moving along the divisions in "ones", "tens" can be used

to build up the order of decades. Intermediate points are touched showing the position of "fives".

One end is given any appropriate number (e.g. 34) and children count either forward or backward from this number to arrive at a decade above or below it. This allows experience of counting on and back from numbers other than one.

The stick is also used to count on and back in "two's".

Holding Numbers

The activities are designed to involve as many children as possible in a group or class activity. Those pupils holding number cards are called NUMBER CHILDREN and those not holding numbers (they are usually sitting on a carpet) are called MAT CHILDREN. The activities involve pupils in changing places with each other; mat children with number children and number children with pupils holding different numbers. The activities engender a feeling of "taking part" in the activity and offer the opportunity for pupil to pupil help and advice.

This "changing places with" activity develops several aspects of counting:

a) Numeral recognition. (e.g. Change places with number four. Change places with number ten).
b) Positional counting. (e.g. Change places with a number next to three. Change places with a number between one and four).
c) Cardinality. (e.g. Change places with a number more than four. Change places with a number less than five).

d) Ordinality. (e.g. Change places with the fifth number. Change places with the last number).

The range and choice of language criteria used in any one teaching session changes as the children progress and develop in their other number activities. Distinctions are made between positional, cardinal and ordinal language situations.

Some further activities involving the Holding Numbers are:

e) Number children are moved out of order. Mat children have to put them back in order by verbal instruction.

f) Number children stand in order, some with their backs to the mat children so that their numbers can not be seen. The mat children have to state the 'hidden' numbers.

Children are actually holding the numbers and physically moving into position, relative to other numbers, to form a number sequence. The children are handling an ACTIVE NUMBER LINE because the numbers can be moved, removed and rearranged.

Walking Numbers

Walking Numbers are designed as a group activity where children walk forwards and backwards along a number track. Although the number track is STATIC in that the numbers on it cannot be moved, the children are ACTIVE in that they walk and jump along the track.

Walking Numbers are used to develop:

a) numeral recognition.

b) positional language of number.

c) counting forwards and backwards.

d) counting on from numbers other than one.

e) counting back from numbers other than one.

f) counting on (and back) a number x.

g) counting on (and back) to a number x.

The activities involve the children in:

a) starting at one and moving to a nominated numeral stating all the numerals walked on.

b) starting at a nominated numeral and moving backwards to "one" stating all the numerals walked on.

c) starting at a nominated numeral and moving forwards (or backwards) to another nominated numeral counting the steps (or jumps) taken.

d) starting at a nominated numeral and moving forwards (or backwards) a given number of steps, stating the numeral finally landed upon.

Floor Numbers and Action Cards

This activity is designed for a group of children to work co-operatively. Some of the Action Cards can only be placed on one appropriate Floor Number whilst others can be placed on one of several numbers. This suggests to the children that there is not always one 'correct answer' to questions, sometimes there is a degree of choice. The choice permits discussion among the children before the Action Card is actually placed.

The Action Cards are used to develop:

a) positional counting.

b) cardinality.

c) ordinality.

e) numeral recognition.

f) number word recognition.

g) number facts.

Some examples of Action Cards are:

A number between 2 and 7
The number before 6
* * * *
A number more than two
The second number
The last number
Six
An even number
Number of legs on a dog

Initially children are involved with one type of Action Card dealing with one aspect of counting at a time, such as positional language. Eventually combinations of cards dealing with several aspects of counting are used. Some teachers extend their Action Cards to include operations and relationships. At the completion of the activity several Action Cards are on each Floor Number. Each number is then taken in turn and the Action cards which are on it summarised to give several pieces of information about the number e.g.

Five is a number between three and six.
Five is an odd number.
Five is one more than four.

The activity is designed to offer children the opportunity to talk about numbers and to realise numbers have many 'properties'.

Washing Line Numbers

Washing Lines with pegs attached entail children in finding "a home" for card numerals. They have to clip the numeral onto an appropriate peg. Because positions are fixed on the washing line, children tend to use a count forward and back strategy, frequently counting on (or

back) from a number already in position on the line. The children are involved in using an ACTIVE number line. The range of numbers which can be used on the line is discretionary.

The activities allowed the children experience of:

a) positional counting.

b) numeral recognition.

c) sequencing.

d) number facts.

e) counting forwards and backwards.

Children are involved in:

a) hanging numbers in order (ascending and descending).

b) removing/replacing nominated numbers.

c) removing/replacing numbers 'between' nominated numbers.

d) removing/replacing odd (or even) numbers.

Washing Lines which do not have pegs attached enable the children to use a different range of skills in placing (or removing) the number cards. Because there are no pegs already in position on the line it tends to play down a count strategy. Instead children focus on the position the numbers should occupy. They slide the numbers along the line to make room for their number or leave room on the line for other numbers to be placed. It also highlights the fact that numbers are part of a continuum.

Flap Jacks

A Flap Jack has to be folded in various ways in order to show different quantities to the children. The activities allow children

the opportunity to:

a) subitize.

b) count.

c) conserve number.

d) count on.

e) recall number combinations.

f) be involved in cardinal operations.

Either the teacher shows the children a Flap Jack and asks them questions or each child has a Flap Jack and responds to the questions asked.

Teacher with Flap Jack activities include:

a) Folding a Flap Jack in various ways and asking the question "How many pictures can you see?"

b) Folding a Flap Jack in various ways and asking the question "How many pictures are 'hidden'?"

Children with Flap Jack activities include:

a) Asking the children to show nominated quantities.

b) Matching the quantity shown by the teacher.

c) Showing more (less) than that shown by the teacher.

d) Children working in pairs and showing a nominated total.

Numeral Cards

Each child has a set of numeral cards and as a consequence everyone takes part in the activities by holding up an appropriate card in response to the teacher questions. It helps to remove the habit of "calling out" and the problem of pupils "opting out" in oral activities. It also appears to develop confidence in children who are

not as dominant as their peers. It does not seem as threatening to hold up a piece of card as it does to verbalise the answer. Teacher questions involve those which have a range of possible responses as well as those with a single answer.

The activities are designed to develop:

a) numeral recognition.

b) ordering numerals.

c) positional language.

d) cardinal language.

Children begin by arranging the numeral cards in order in front of themselves. They then either hold up a specific numeral card to show to the teacher or they sort the cards according to various criteria. The criteria include:

a) Showing a nominated numeral (e.g. Show me number six).

b) Showing a numeral according to positional criteria (e.g. Hold up a number between three and six).

c) Showing a numeral according to cardinal criteria (e.g. Hold up a number which is more than three).

d) Sorting numerals according to their formation (e.g. Sort out numbers which have straight lines in them).

e) Sorting numerals according to positional criteria (e.g. Sort numbers which come before five).

f) Sorting numerals according to cardinal criteria (e.g. Sort numbers which are less than five).

King and Queen Problems

King and Queen problems involve children in acting out word problems using stand-up cardboard King and Queen figures with a basket of red and green apples (plastic counters). The numerical results are of secondary importance to the ability of the child being able to interpret the word problem by acting out what is happening using the models. Some of the problems have a range of possible solutions, whilst others have but one answer. It is important to allow discussion among the children as what is happening in the problem. It allows the teacher to observe the count strategies employed by the children in the solution to the problems. The different types of word problems are categorised in Appendix 9.

SCHOOL BASED INSET

Throughout the research the individual teachers received copies of the case notes for reflection and comment. It was the result of the case notes, test results and discussions with the researcher that helped the teachers and researcher decide the most profitable form of INSET activities and those counting materials which would suit each teachers particular situation and method of teaching.

Each teacher was involved in three INSET meetings either alone with the researcher to discuss the materials and activities or with a class of children, and the researcher, to implement some of the ideas in action.

It was decided that there was a need for children to be thoroughly familiar with the standard number word sequence, initially up to ten, eventually up to twenty. This would enable children to develop a general procedure for producing other counting numbers and improve efficiency when counting objects. It was also decided to introduce the numerals earlier than some of the teachers usually did, not as a representation of a cardinal value, but as a representation of a number word. Many of the activities involved children in moving numerals around and discussing the relative positions of numerals in sequences. This form of counting experience was referred to as POSITIONAL COUNTING. Most of the children's previous counting experiences centred on counting discrete items. In order to widen counting experiences activities were designed to involve them in counting on a continuum. The use of zero caused debate with Teacher L and Teacher M as to whether to include it in the counting activities so early in the child's schooling because it was not 'a counting number'. Once clarification of the difference between positional counting and counting for cardinality was established it was decided to use it as the number which 'comes before one' when positional counting was being developed. Children's experience of number lines was to be widened to involve children in ACTIVE Number Lines, where the numbers can be changed and moved around, and STATIC Number Lines where the numbers are written in a fixed order and cannot be moved.

INSET with Teacher A

In her initial interview with the researcher Ms A expressed concern that she felt under some pressure from parents because the children in

her class were not recording "sums" early in their education and that this pressure caused some constraint in the activities she wished to undertake. It was decided to hold a Parent's Afternoon in the school for the parents of her present class of children and for parents who would have children joining the class in the near future. The afternoon was planned by the teacher and the researcher and was in two parts. Part one consisted of the teacher giving a demonstration lesson with her children using HOLDING NUMBERS and FLAP JACKS. Part two consisted of the researcher undertaking a discussion-workshop with the parents. He used a DESI-STICK and FLAP JACKS to demonstrate a range of mathematical experiences which resulted in no recording but lots of worthwhile 'recognisable' mathematics to parents. There followed an open forum to discuss with the forty-six parents present the issues raised during the course of the afternoon. One of the issues covered was the type of discussion a parent could undertake with their child in order to develop conversation rather the child simply "answering questions". A result of the Parent's Afternoon was goodwill from the parents to the teacher (the demonstration lesson was a great success for her) and a teacher perceived lessening of pressure to record before she considered the children were ready.

After analysis of the observed lessons it was thought appropriate to further develop positional counting skills for the children without necessarily involving numerals. Ideas based on the DESI-STICK were produced and used with the children. It was also thought appropriate to try and involve the children in a little more discussion with each other rather than always be answering teacher questions. The role of the group activities which occurred after the class lesson was also discussed along with the purpose of children handling manipulatives

and telling someone what they had done with them. Interest was expressed in word problem-solving as a possible vehicle for a group activity involving children in discussion and handling simple materials. The King and Queen Problems were suggested.

INSET with Teacher H

The need to involve all children in oral activities and not let the more forceful children dominate was discussed along with the importance of removing anxiety from children by always expecting them to produce immediate responses. The role of "wait-time" (cf Rowe 1973) and of becoming a listening teacher was also referred to. The teacher commented upon the researcher's listening role and how much clearer things seemed once she had been given the opportunity and vehicle to articulate her thoughts. She considered that this might also apply to children. How children develop from knowing the standard number word sequence and recognising numerals to understanding the cardinal value of the numerals was talked about at length. The difference between positional language and cardinal language was also covered in the conversations. The activities which were considered appropriate for engaging a whole group of children on a counting activity were those based on HOLDING NUMBERS and NUMERAL CARDS. DESI-STICK and WALKING NUMBERS were also suggested because the teacher wanted experiences which would improve positional language.

It was arranged that the researcher work with Ms H and her class of children on the suggested activities. However, this proved to be impossible because she was relieved of her class in order to allow a

probationary teacher who was having difficulties the opportunity of completing her probationary year in supportive surroundings. Ms H became a temporary supernumerary teacher within the school and became headteacher of the school shortly afterwards. She undertook the suggested activities with the teachers and children in various classes through the school.

INSET with Teacher L

Ms L discussed her role in group activities and decided that she should take a slightly less directed part. She considered that instructions such as "Give me the long rod" relied much on memory, whereas allowing the childern to sort for their own chosen criteria then discussing that criteria with the teacher and the other children in the group might be a more productive use of language. She was aware that previously she was the one using the language and the children only had to respond to it. The discussion revolved around whether language can be "inputted" by the teacher or whether it develops out of an activity by the child and the need for the words then becomes apparent. She also began to doubt the validity of completing a whole block of work on sorting, matching and comparing before attempting some counting activities. Perhaps she was not using these early activities for assessing the children as she had always thought. She posed the question "Why am I doing it in the way that I am?" A decision was made to integrate some counting activities into earlier activities with the children. Ms L discussed the role of counting and the difficulty of teaching word order, numerals and the techniques of counting objects all at the same time. She decided to undertake some oral group activities based upon memorising the standard number word sequence and recognising the numerals. The tasks

would involve the use of positional language rather than cardinal language. The suggested activities were FLOOR NUMBERS and ACTION CARDS, NUMERAL CARDS and HOLDING NUMBERS. These suggested activities proved to be so enjoyable with both the teacher and the children that more activities were requested. In a subsequent visit the researcher worked with the children on WALKING NUMBERS and a DESI-STICK whilst the teacher observed the children's reactions and involvement. One child who had been struggling with counting up to five objects gained great success with the Desi-stick. He was error free on all the activities with numbers up to ten. His spatial awareness and ability to recognise the relative positions of numbers on the stick was impressive.

INSET with Teacher J

The discussions over the results of the observations centred around the role of trying to develop a child's "metal number line" through oral activities and the importance of developing sophisticated counting techniques in order to solve word problems. Also discussed was the importance of a teacher allowing herself time to talk and work with children who were apparently not having difficulties with the tasks in hand. She considered that there was a tendency to quickly pass these children by after a quick check over their work. She thought it important to confirm the positive features of children's work. The oral activities suggested to develop a child's mental number line were the DESI-STICK, HOLDING NUMBERS and WASHING LINE NUMBERS. To allow for a wider experience of word problems the suggestions included in the KING and QUEEN PROBLEMS were proposed (Appendix 9).

On a subsequent visit the researcher worked with two children on problem-solving whilst the teacher observed the strategies they employed in answering the problems. One child would use a counting technique whenever possible whilst the other would use a comparison technique. The three line word-story was given orally for the children to solve. However, both children expressed a wish to see the problem written because they kept forgetting the first part of the story.

INSET with Teacher M

The discussions centred around the amount of teacher-time each child received during a lesson and the quality of teacher-pupil and pupil-pupil interaction. She thought she should look to ways of spending a little more time with each group of children and of giving them the opportunity of discussing mathematics with her and among themselves. She was also of the opinion that she should undertake a little more oral counting with the children before they commenced activities based on cardinal numbers. FLOOR NUMBERS and ACTION CARDS, WALKING NUMBERS and HOLDING NUMBERS were suggested for the teacher to try with the children. On a subsequent visit the researcher worked with a group of children with FLAP JACKS whilst the teacher observed.

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OBSERVATIONS ON TEACHERS AND RESULTS OF TESTING

	Page
Results of observations on Teachers	181
Results of tests of Pupil's counting	186
Analysis of test results	196

All teachers

A record was kept of teacher-pupil interaction at five minute intervals on a predetermined coding schedule. The record showed whether the teacher was operating with the class, a group, an individual or no-one. It also showed whether verbal or non-verbal interaction was occurring. A completed record for the five teachers over nine observed lessons can be found in Appendix 3.

A Chi-square Test was applied to the frequency of observations of teachers actions using 'Microtab' on a BBC Microcomputer (Table T-1). The null hypothesis is that there is no significant relationship between the teachers and their actions. Since the sample yielded a χ^2 value of 109.80 (df=12) and the table value of χ^2 = 21.03 (α =0.05) then the null hypothesis can be rejected at the 5% level.

To ascertain whether the results for Teacher L were distorting the findings because of the high frequency under category H a further Chi-square Test was applied which omitted her results (Table T-2). Since the sample yielded a χ^2 value of 32.99 (df=9) and the table value of χ^2 = 16.92 (α =0.05) then the null hypothesis is still rejected. As there were four expected frequencies less than five under the "H" categorization in the table a further Chi-square Test was applied which omitted this category (Table T-3). Now the sample yielded a χ^2 value of 27.38 (df=6) against a table value of χ^2 =12.59 (α =0.05). The null hypothesis remains rejected.

TABLE T-1 (CHI-SQUARE TEST ON OBSERVED ACTIONS: ALL TEACHERS)

TEACHER/ACTION		Q	H	S	N	TOTAL
A	O	49	1	21	17	88
	E	42.4	8.9	10.6	26.1	
H	O	25	0	6	23	54
	E	26	5.5	6.5	16	
J	O	34	2	9	12	57
	E	27.4	5.8	6.9	16.9	
L	O	45	30	0	19	94
	E	45.2	9.6	11.3	27.9	
M	O	27	5	9	40	81
	E	39	8.2	9.7	24	
TOTALS		180	38	45	111	374

O = OBSERVED E = EXPECTED

CHI-SQUARE = 109.80 DF = 12

TABLE T-2 (CHI-SQUARE TEST ON OBSERVED ACTIONS: LESS TEACHER L)

TEACHER/ACTION		Q	H	S	N	TOTAL
A	O	49	1	21	17	88
	E	42.9	2.5	14.1	28.9	
H	O	25	0	6	23	54
	E	26	1.5	8.7	17.7	
J	O	34	2	9	12	57
	E	27.5	1.6	9.2	18.7	
M	O	27	5	9	40	81
	E	39.1	2.3	13.0	26.6	
TOTALS		135	8	45	92	280

O = OBSERVED E = EXPECTED

CHI-SQUARE = 32.99 DF = 9
4 EXPECTED FREQS < 5

TABLE T-3 (CHI-SQUARE TEST ON OBSERVED ACTIONS: LESS TEACHER L & CATEGORY H)

TEACHER/ACTION		Q	S	N	TOTAL
A	O	49	21	17	87
	E	43.2	14.4	29.4	
H	O	25	6	23	54
	E	26.8	8.9	18.3	
J	O	34	9	12	55
	E	27.3	9.1	18.6	
M	O	27	9	40	76
	E	37.7	12.6	25.7	
TOTALS		135	45	92	272

O = OBSERVED E = EXPECTED

CHI-SQUARE = 27.38 DF = 6

Consideration was given as to how each teacher spent her time interacting with different sized groups of pupils for each lesson (Appendix 3). The percentage of each lesson spent with the whole class, with groups, with individuals and not interacting was calculated (Appendix 3). The mean percentage of time spent with the different groupings over the nine observed lessons was then calculated (Appendix 3). Pie graphs drawn to show how the teachers spent their time with groups of children (Fig. 1) indicate that:

a) Teacher A taught the children mainly as a class.

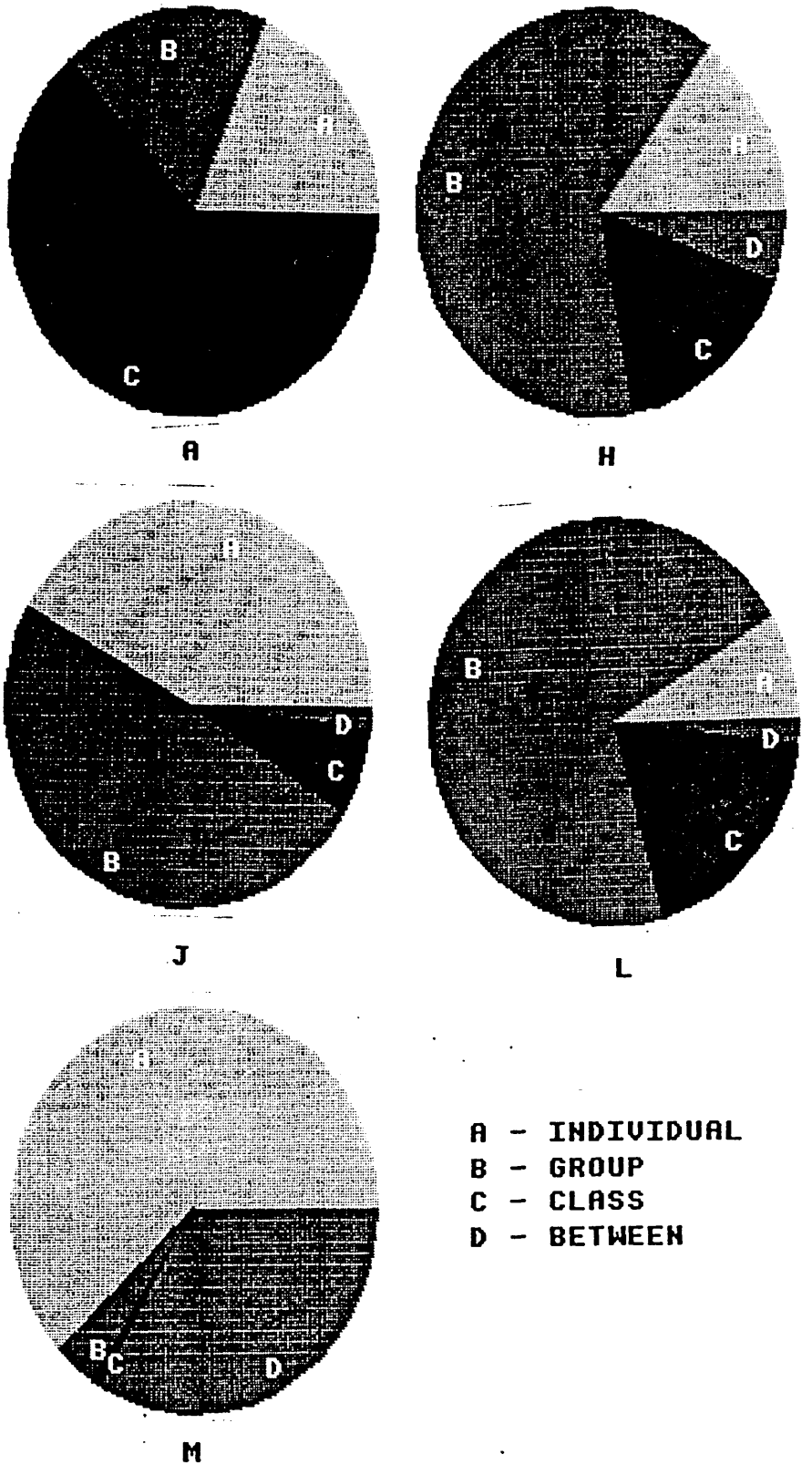
b) Teacher M taught predominently in an individualised way a third of her time spent not interacting with the children.

c) Teachers L and H concentrated on group teaching. Teacher H worked with individuals rather more than Teacher L.

d) Teacher J tended to share her time equally between group and individualised teaching.

FIGURE 1: PIE GRAPHS OF TIME SPENT WITH DIFFERENT GROUPINGS

The segments represent the mean percentage of time the teachers spent with different group sizes each lesson.



TESTING PUPILS' COUNTING SKILLS

Each child was given seven tests to test different aspects of counting skills (Appendix 5). The results of the tests and observable solution strategies were recorded (Appendix 6). The raw scores were tabulated, standardised using 'Microtab' ZScores, and percentaged (Appendix 7).

Table T-4 shows the mean test scores and Table T-5 the rankings. With the exception of the Aural Test, the results of Teacher A placed her in first ranking on all the other tests.

TABLE T-4 (MEAN PERCENTAGED TEST SCORES)

TEACHER/TEST	1	2	3	4	5	6	7
A	86.67	80.00	96.67	53.33	91.27	98.41	100.00
H	66.67	70.00	73.33	86.67	76.98	69.84	86.67
J	83.33	73.33	86.67	83.33	88.89	80.95	93.33
L	80.00	66.67	83.33	73.33	65.08	62.70	63.33
M	80.00	73.33	90.00	60.00	72.22	53.97	93.33

TABLE T-5 (RANKING OF TEST MEANS)

TEACHER/TEST	1	2	3	4	5	6	7	TOTAL
A	1	1	1	5	1	1	1	11
H	5	4	5	1	3	3	4	25
J	2	2	3	2	2	2	3	15
L	3	5	4	3	5	4	5	29
M	3	2	2	4	4	5	2	22

A two way analysis of variance using 'Microtab' was carried out on the percentaged test scores using 7 Levels of Teacher Variation and 5 Levels of Test Variation (Table T-6).

TABLE T-6 (RESULTS OF 2-WAY ANOVA ON PERCENTAGED SCORES)

SOURCE OF VARIATION	SUM OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARE	COMPUTED F
A(TEACHERS)	7689.70947	4	1922.42737	3.024
B(TESTS)	7463.62646	6	1243.93774	1.9568
AB(INTERACTION)	16012.54300	24	667.18929	1.049
ERROR	111245.8	175	635.69031	
TOTAL	142411.68000	209		

From the F tables (α = 0.05):

F(A) = 2.37 F(B) = 2.10 F(AB)= 2.37

The teacher variation is significant at the 5% level. The null hypothesis is rejected.

The test variation is not significant at the 5% level. The null hypothesis is accepted.

The interaction variation is not significant at the 5% level. The null hypothesis is accepted.

OBSERVATIONS ON HOW CHILDREN ATTEMPTED THE COUNTING TESTS

Counting items

The strategies employed by children in answering the test questions can be found in Appendix 6. The frequency of pupils' solution strategies when counting items in Tests 1-3 is shown in Table T-7.

TABLE T-7 (STRATEGY USED WHEN COUNTING ITEMS: TESTS 1-3)

TEST/STRATEGY	I	E	M	P	T
MOVEABLE	14	24	54	13	52
FIXED	28	25	--	7	90
VISUAL	43	77	--	30	--

I = IMMEDIATE E = EYE/HEAD MOVEMENT
M = MOVE P = POINT T = TOUCH

In counting Moveable items three children were observed using 'double' strategies.

When counting Moveables, Fixed and Visual items with quantities less than five, there were 67 out of 90 Immediate responses.

During the Aural Counting Test two children tried to clap in time to

A record was kept of whether children counted aloud or counted silently whilst undertaking the counting 'items' tests (Appendix 6). The frequency of pupil responses is shown in Table T-8.

TABLE T-8 (SILENT OR VERBAL COUNTING: TESTS 1-4)

	MOVEABLE					FIXED					VISUAL					AURAL				
No.	4	7	9	11	15	2	6	10	12	14	3	5	7	8	9	3	5	8	10	13
I	13	1	0	0	0	26	1	0	1	0	27	7	5	3	2					
S	5	15	15	14	15	1	14	15	13	15	1	14	15	15	15	8	12	11	10	12
C	12	14	15	16	15	3	15	15	16	15	2	9	10	12	13	22	18	19	20	18
E	0	2	6	7	16	0	5	12	16	9	0	5	5	5	6	3	8	8	7	17

I= IMMEDIATE RESPONSE S= SILENT COUNT C= VERBAL COUNT E= ERRORS MADE

The number of errors made on the Counting 'items' Tests were totalled under the categories of Silent Counting, Verbal Counting and Immediate Responses (Table T-9).

TABLE T-9 (SILENT, VERBAL AND IMMEDIATE RESPONSE ERRORS: TESTS 1-4)

	MOVEABLE	FIXED	VISUAL	AURAL
I	0	2	5	
S	15	15	8	26
C	16	25	8	17
TOTAL	31	42	21	43

I= IMMEDIATE RESPONSE S= SILENT COUNT C= VERBAL COUNT

Numeral Recognition

Numerals were shown on card and there was usually a quick response from the children as what they thought the numeral was, however some numerals caused a noticable pause (Fig. 2). Some of the pauses eventually resulted in correct responses (Fig. 3).

Ordering Numerals

The numeral cards were given to the children in two separate packs 0-10 then 11-20 (Appendix 5).

The observed strategies were:

a) The pack was spread out so that all numerals could be seen. The numerals were then lined up in order, either right to left or vice-versa.

b) The pack was spread out so that all the numerals could be seen. The numerals were then placed on top of each other to make a pack beginning with the smallest numeral.

c) The cards were kept in a pack and shuffled through them until a required numeral was found. The numerals were then arranged in a line either left to right or vice-versa.

d) One child changed from shuffling through the pack to spreading out the cards part way through the task.

e) One child changed from arranging his cards in a line to putting them in a pile part way through the task.

FIGURE 2: CORRECT RESPONSES AND PAUSES TO NUMERAL RECOGNITION TEST

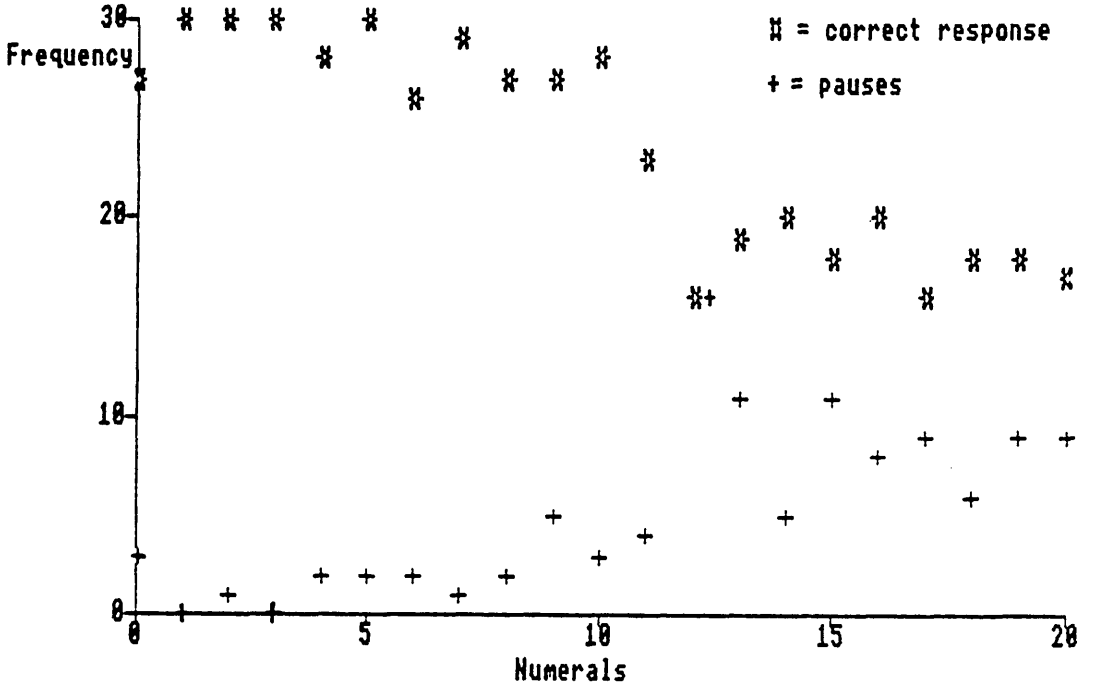
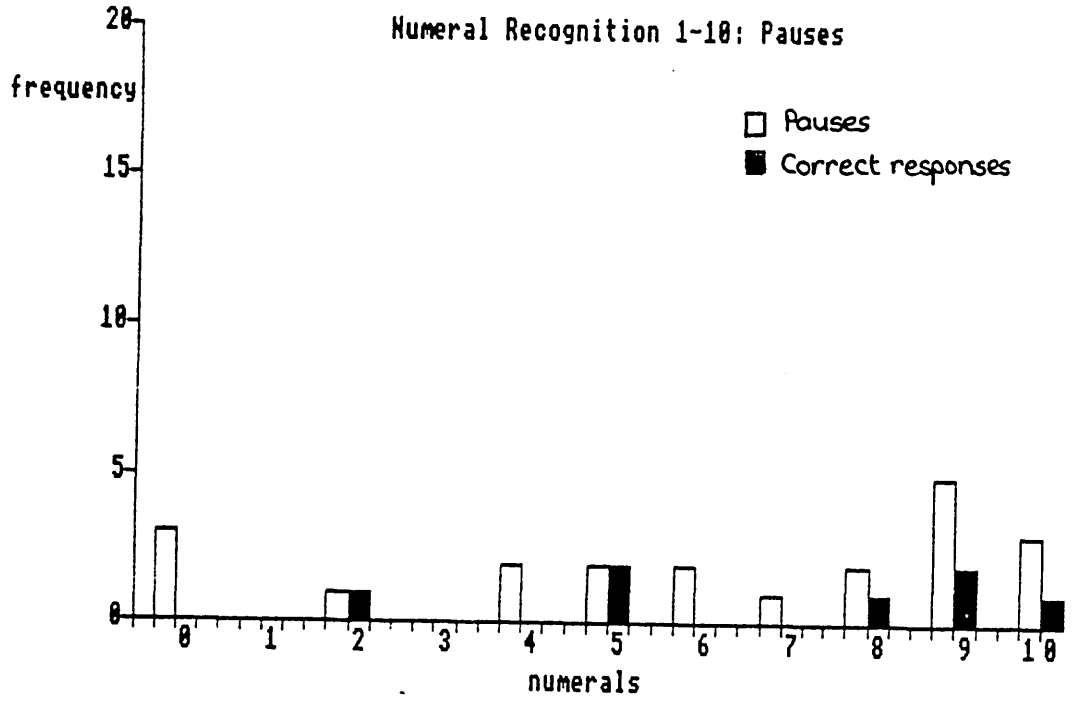
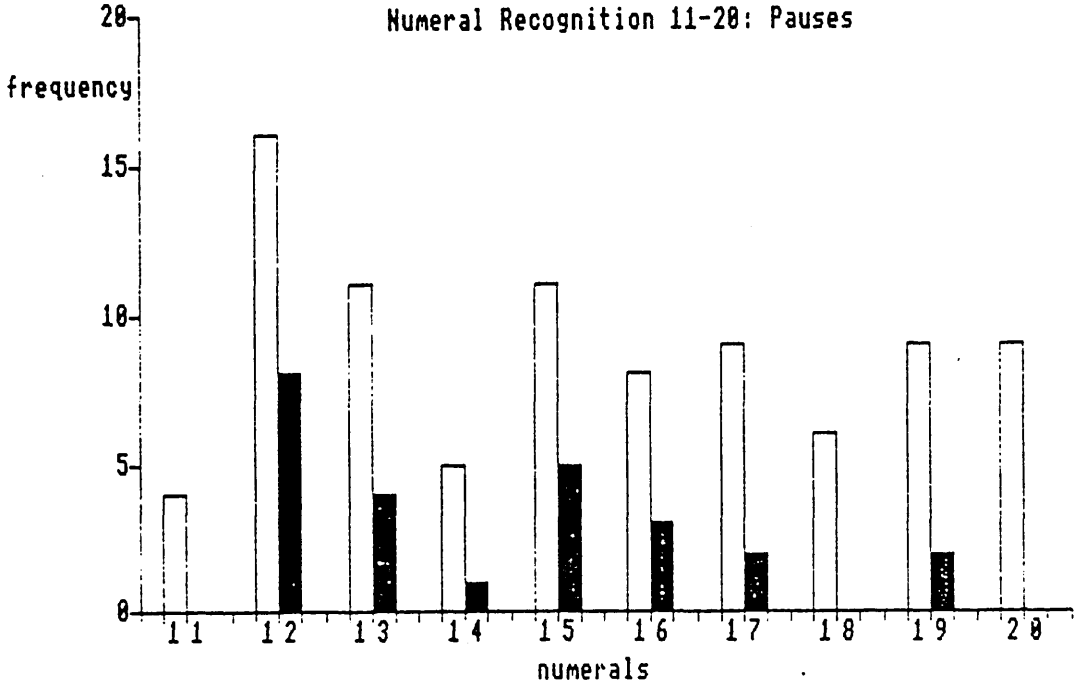


FIGURE 3: PAUSES AND SUBSEQUENT CORRECT RESPONSES TO NUMERAL RECOGNITION TEST





f) One child (with 0-10 cards) began with 5 then worked alternately towards the 10 and the 0. With the 11-20 cards she placed the cards as she found them on a mental number line, leaving appropriate spaces for the "missing" numbers. The cards were spread out to begin with.

g) All the other children began with the smallest number and looked for the next in sequence.

h) Four children placed 10 upside down and two placed 18 upside down.

i) Four children placed 0 at the wrong end of the sequence. One child actually hid the 0 by sitting on it.

j) Three children who had errors in the numeral order read the word sequence correctly.

Matching Numeral to Quantity

Only five children made errors on this test with one child refusing to do the test stating that it was too hard (Appendix 6).

Two children immediately placed the correct numeral cards onto the quantity cards without a count. One of these children then checked her matching by going back after the placement and totalled the counters.

One child undertook a visual match with the twelve and fifteen quantity cards. She placed them side by side, stated that the fifteen card had most counters and placed the numeral 15 on it.

because there were an equal number of quantity and numeral cards there were fewer options available to the children after the first few matchings. As a consequence matching the fifth numeral card was done immediately without a count being undertaken by 50% of the children.

Observations on teachers

The observed actions of the teachers were categorised under the headings of Utterances, Hearing children read, Silent interaction and No interaction. The Chi-square Test rejected the null hypothesis of no significant differences between the teachers and their actions. As the observed categorical frequencies were relatively small in the various tables, several expected frequencies lying between 5 and 10, no inferences other than to state that the teachers were significantly different according to the categories used will be drawn.

The Pie Graphs (Fig. 1) show that the relative amount of time spent with Individual children, Groups of children, Class of children and Between children (i.e. interacting with no-one) varied considerably from teacher to teacher. Teachers H and L appear to have a similar time profile. There was a difference in each teacher's size of group in the group activities. Teacher H often operated with group sizes of over ten children whilst Teacher L rarely operated with a group size over six. The Pie Graphs do not show the form of teacher-child(ren) interaction for each grouping nor whether the types of grouping are episodic.

Each teacher was consistent in her teaching style. No attempt has been made to compare teaching style. The results have been used to show that the teaching styles were 'different' according to various criteria.

Testing pupils counting skills

When placing numerals in correct sequence Danielle (Teacher H) did so in such a way as to suggest she was referring to a mental number line (cf Resnick 1983). With the 0-10 numeral cards she spread them out and selected card 5. She then placed the remaining cards in correct sequence, alternately placing cards either side of the five. When placing 11-20 in sequence she again spread the cards out and then appeared to select cards at random. She placed the selected cards in a line leaving gaps for the "missing" numbers. It was as if she was matching the cards to a mental number line.

It was noted that numeral 12 caused the highest number of pauses from the target children, over 50% of them halted when faced with it. Half the children who paused eventually named it correctly (Fig. 2). The researcher also noted fractional pauses from several other children when faced with numeral 12.

Gelman and Gallistel (1978) considered that counting aloud was a measure of the difficulty children had in counting. The present study does not confirm this view (Tables T-8 and T-9). When children changed from a silent count to a verbal count it tended to occur when they were faced with a different 'unit count item' rather than when the countables increased in number. There were no disparate differences between silent count errors and verbal count errors. The

results show that what children are expected to count does affect the strategies they employ. This supports the Gelman and Gallistel (1978) stance that investigation into a child's counting skill cannot be done apart from questions as to what the countable items are and where they come from.

The number of errors made by the target children (Table T-8) supports the findings of Schaeffer, Eggleston and Scott (1974) and Gelman and Gallistel (1978) that procedural accuracy in counting for cardinality becomes less proficient as the set becomes larger. The presentation of the test items was such that it involved the children in coordination counting rather than sequence counting (cf Von Glasersfeld, Steffe and Richards 1983).

With quantities less than five the children tended to give immediate answers without an apparent count taking place (Table T-8). This supports the findings that children can subitize for small sets of numbers (cf Schaeffer, Eggleston and Scott 1974; Ginsburg 1977; Saxe 1979; Resnick 1983; Fuson and Hall 1983; Von Glasersfeld, Steffe and Richards 1983; Cooper, Campbell and Blevins 1983; Baroody and Ginsburg 1984; Hughes 1986).

McConkey and McEvoy (1986) considered the three basic number skills of rote counting to 20, recognising numerals 0-9 and counting objects from 1-20 to be independent, with competence in one not meaning ability in another. The results of the counting tests in the present study do not support that view. The two way analysis of variance showed the test variance not to be significant (Table T-6).

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At the commencement of this study the researcher had three specific aims in view. One was to design materials and activities which may help children develop a greater understanding and confidence in their counting skills. The second aim was to design activities which would allow children to actively co-operate and participate as members of the class, as members of a group and as individuals. The third aim was to help teachers effect the management of change within their classroom.

COUNTING ACTIVITIES

Children enter school with a disparate understanding of number concepts and counting skills (Hughes 1986). Pre-school children are aware of numbers around them and the uses to which some of them are put, they are able to differentiate between differing uses numerals in an environmental setting (Sinclair and Sinclair 1984). Pre-school children can and do use sophisticated counting priciples (Baroody and Price 1983). Pre-school children can use counting strategies to solve simple problems (Groen and Resnick 1977; Starkey and Gelman 1982; Carpenter and Moser 1982; Hughes 1986).

In their interview with the researcher the Case Study Teachers stated that the initial activities reception children would be undertaking in their classes would be sorting, matching and comparing. This was for "assessment purposes" and to develop language experiences. No mention was made of assessing a child's counting ability on entering school

and of developing numerical language. There was often a time-lapse between children entering school and their involvement in counting activities. This counting delay has also been noted by the researcher in many other schools.

Counting involves many overlapping and intertwined concepts, skills and processes:

Accessing 'number lines'

Using a stable order of number words; knowing the SNWS forwards and backwards; Knowing the teen structure; knowing the decade structure; using the generative rule for a count sequence; counting on and back from numbers other than one; realising numbers are part of a continuum.

Procedural accuracy

Uses one-to-one correspondence; counts each item once; knows that the order of count is irrelevent; can count items in a set; can form a set of nominated size; uses appropriate techniques in counting (eg moving and touching items).

Strategy convenience

Counts on from x; counts on to x; counts back y; counts back to y; counts in two's; subitizes

Number context

Cardinal; ordinal; positional; convenience.

Numeral facility

Numeral recognition; numeral formation; differing environmental uses of numerals; representing quantity; representing a "number word".

Concept formation

Conservation of number; estimation skills; numbers as entities; numbers as part of a continuum.

Operational facility

Solving simple addition and subtraction problems.

The present study has only addressed a small part of this complex process of developing children's counting skills. Results of the testing suggest that there is a transfer of skills from one aspect of counting to another; that they are not independent entities. The activities designed for the individual teachers to undertake with their pupils took an aspect of counting that they did not normally cover. In the main the activities considered the POSITIONAL aspect of counting and using numerals as representations of number words rather than as as representations of a cardinal value. It was noted within the case studies that cardinal and positional language were used in conjunction with each other. Children were expected to infer the relationship between cardinal values and relative positions in a number sequence.

The DESI-STICK is a non-numerical representation of a number line. It allows children to consider the relative positions of numbers in sequence, to estimate the relative position of one number to another, to perceive a number line in several dimensions. It allows children the opportunity to practice counting on and back from numbers other than one and to develop the idea that numbers can form part of a continuum.

HOLDING NUMBERS allow children to move numerals around in various sequences, to develop ideas of position and ordinality. Because children are actually holding the numeral cards and physically moving themselves the language used is language born out of experience.

Number lines of consecutive and non-consecutive numerals can be used and the range of numerals on which children operate is instantly variable. The children are operating on an ACTIVE number line. Children holding numerals can also be used to develop ideas of cardinality, number operations and numerical sorting.

WALKING NUMBERS allow children to be active on a STATIC number track. Children moving forward and back on the numbers can be used to develop ideas of position, counting on, counting back, counting on x from y, counting on from x to y, counting back x from y, counting back from x to y.

FLOOR NUMBERS and ACTION CARDS are designed to show that numbers have many properties, cardinal, ordinal, positional and convenience.

WASHING LINE NUMBERS take two forms, those with pegs attached to the washing line and those without pegs attached to the line. When pegs are attached the children have points of reference and they tend to use a count strategy in order to place the numeral cards on the line. The children have the opportunity of counting on and back from numbers other than one. Without pegs attached the children do not have a point of reference, they tend to use positional skills to place the numeral cards on the line. Both types are ACTIVE number lines.

FLAP JACKS are used to promote subitizing skills, rapid counting skills and recall of number combinations. They allow children to conserve number and be involved in cardinal operations.

NUMERAL CARDS are used to develop numeral recognition, sequencing,

sorting and ordering. They are used to promote positional and cardinal language situations. The cards are used as ACTIVE number lines.

KING and QUEEN PROBLEMS are used to develop operational language situations and to allow children to use counting techniques in the solving of simple word problems. The emphasis is not on the numerical solution to the problem but on the ability to act out the problem using card models. By acting out the problem the child demonstrates his or her understanding of the context in which the numbers are placed. It is more valuable than allowing a child to glance at the problem, pick out the numbers within it and undertake an educated guess as to the answer.

The researcher suggests through these activities that the children are gaining EXPERIENCE in counting and that experience need not always be related to counting concrete materials. Children can operate on numerals often before they have an appreciation of the cardinal value of those numerals, they can use positional ideas of number. The use of numerals before they have cardinal meaning, as a representation of the number word in order to develop the position concept did not cause observable difficulties for children in the trials.

PUPIL PARTICIPATION IN THE ACTIVITIES

Participation in class or group oral activities emphasised individual rather than group effort (Mehan 1986). The 'turn allocation procedure' imposed constraints on interaction and had organisational

implications in that children had to learn the important communicative skill of answering questions correctly (Doyle 1983; Mehan 1986).

The present study shows that during class and group activities most of the discourse was through the teacher. There was little pupil to pupil discussion. With Teacher H the dominant pupils overwhelmed the more passive pupils during group oral activities, some children opted out of the activities.

The INSET activities were designed to ensure that children became actively involved in class or group activities. Co-operation was encouraged. Different types of discussion were promoted in the teaching situation. Some of the questions posed had a range of possible answers in order to break down the right-wrong response syndrome. They were also designed to allow the more timid and less secure child to participate without too high a "stress level".

The design of HOLDING NUMBERS activities ensured that there was a frequent interchange of NUMBER CHILDREN and MAT CHILDREN. All the children were "pulled in to the activity", opting out was not an option that was available. Childen had to co-operate in many of the activities by organising themselves in particular sequences and by finding partners according to some criteria.

FLOOR NUMBER and ACTION CARDS enabled children to discuss among themselves the placement of the Action Cards on Number Cards. Some of the Action Cards could only be matched to one appropriate Number Card whilst other Action Cards could be placed on one of several Number

Cards. There was not always one answer to each question.

Because each child has a set of NUMERAL CARDS and responds to teacher questions by holding up an appropriate card every child has to take part. Not all questions asked have but one answer. This activity appears to remove much of the stress experienced by some children of having to respond verbally in front of their peers. It also helps overcome the problem of "call outs" by the more dominant class members during oral activities.

WASHING LINE NUMBERS and WALKING NUMBERS involve the children in actively moving along number tracks and in physically moving numerals on a number line. They are actively involved in the proceedings.

The KING and QUEEN PROBLEMS can be done by individual children but they are more profitably undertaken by small groups of two and three pupils to promote discussion between them. Several problems have a range of possible solutions and techniques for solving them.

MANAGEMENT OF CHANGE WITHIN THE CLASSROOM

Bolam (1983) considered that change was an individual experience and process occurring within the context of a social system. Change was a process not an event and the people involved in the change process interacted with each other over time and were changed by the change experience itself. The implementation phase was the most crucial one in the whole process and yet it continued to be neglected by practitioners.

The characteristics which were embedded into the study in order to facilitate change were: the need for teacher initiative; impetus stimulated by external expertise; interpretation of data in the light of each teacher's perceptions and different classroom situations; innovation taking account of a wide range of contingent factors (cf Hoyle 1985).

The researcher acted as an external change agent to the teachers involved in the study (cf Bolam 1983). Essential to how the innovations were implemented was the centrality of the teachers in the research process (cf Elliott 1980, 1985; Street 1986). The study focused on matters of concern to each teacher (cf Bennett and Desforges 1985; Cummings and Hustler 1986). The innovations were simple, flexible and easily adaptable to suit the individuality of the teachers in order for them to develop a feeling of 'owning' the ideas (cf Bolam 1983). The study had a cultural perspective in that the innovations were contextualised and the teachers placed their own meanings and values on its design (cf Bolam 1983; Stake 1985).

This research shows, through the five case studies and the results of the systematic observation, that the teachers organised the children, the resources and themselves in different ways. They proportioned their time very differently and grouped the children according to different criteria.

Teacher A undertook the main part of the lesson as a class activity where she "directly taught" and instructed. The subsidary part of the lesson was as a group activity which was far more informal and served to allow for enrichment and practice activities.

Teacher M had the children working as individuals sitting in groups. She undertook very little group or class activities. The group sizes were six to a table.

Teacher L taught the children as group according to their "stage of development" and the activities were part of a structured programme. She concentrated upon that group for a length of time, the other children undertaking practice or enrichment activities under the supervision of a parent-teacher. The groups sizes were about six children. The class activities occurred at registration time,

Teacher J began the day with child-initiated talk. It was personal and informal (cf Cummings 1982; Rawers 1984). The children would then move to directed groups with clearly defined tasks. She would then move from group to group spending some time with each. Her discussions were group centred rather than individualised. The children were at "similar" stages of mathematics within the groups and frequently varied in composition. The group sizes were between two and six children. She would also spend time with individual children who were having specific problems.

Teacher H taught the children mainly as large group of about twelve to sixteen children. The class interactions were organisational rather than directed teaching. She had two age groups in her class.

The design of each 'counting package' was specific and practical to enable these 'different' teachers to sustain and sucessfully implement change. The INSET activities were personalised for each individual

teacher as the result of frequent discussions with the teacher, results of feedback on the case notes and each teachers perceived role in the teaching of mathematics. They reflected what each teacher wanted to do with her children in her way of teaching. The innovations were not the imposition of solutions to particular problems. The emphasis was on problem-to-be-solved rather than knowledge-to-be-transmitted (cf Hoyle 1985). Each teacher was effecting change within her classroom by adaption rather than solution (cf McIntyre 1980). Activities were provided in an on-the-job and classroom context (cf Bolam 1983).

The researcher worked with each teacher as an interested non-judgemental observer. He operated as a collaborative colleague who did not treat the teachers as the subject of research, they were participants in the research process. It was a piece of action-research through "naturalistic generalization" (cf Stake 1985). Dissemination of the findings of the study used interactive strategies with each individual teacher rather than the 'spray and pray' mode across all the teachers (cf Hoyle 1985). The researcher's role in bringing about change within the classroom was as facilitator, objective observer and diagnostic consultant. His role was not a knowledge-linking one. It was to concentrate on 'how' to manage change rather than 'what' to change (cf Havelock 1969).

POSSIBLE AREAS FOR FURTHER RESEARCH

Further research is needed into children's understanding of positional concepts and links with cardinal concepts.

Some of the King and Queen Problems caused particular difficulty when they had to be interpreted with the cardboard models. Children could answer the problems correctly numerically. This is an area which will stand further study.

Further work could be undertaken to see whether there is any significant difference in children's performance when an activity is "task focused" rather than "time focused".

Further work can be done to develop activities which help overcome individual effort rather than group effort in oral activities.

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APPENDICES

APPENDIX 1 — Page 3
Tasks observed each lesson

APPENDIX 2 — Page 11
Observational records on Teacher M

APPENDIX 3 — Page 21
Five minute observations on all teachers

APPENDIX 4 — Page 27
Dates of Birth of Target Children

APPENDIX 5 — Page 30
Administration of counting tests

APPENDIX 6 — Page 39
Results of counting tests

APPENDIX 7 — Page 49
Analysis of counting tests

APPENDIX 8 — Page 55
Counting materials for INSET activities

APPENDIX 9 — Page 64
Description of Active Word Problems

APPENDIX 1

TASKS OBSERVED EACH LESSON

ALL TEACHERS

A record of the mathematical tasks observed during nine lessons by target children.

The lengths of the observed lessons are shown in minutes.

TEACHER A	Page 5
TEACHER H	Page 7
TEACHER J	Page 8
TEACHER L	Page 9
TEACHER M	Page 10

TASKS OBSERVED EACH LESSON: TEACHER A

LESSON	TIME	CONTENT	ACTIVITY	MATERIALS
1	53	Numeral recognition. Sequencing numerals. Matching shape to picture. Counting. Cardinal number. Ordinal number. Matching numeral to quantity. Language development.	Responding to oral questions. Holding numerals and positioning children. Walking on a number line. Matching activities. Counting objects.	Numeral cards. Floor number line. Beads. Laces. Sequence pattern cards. Bobbin lines. Numeral board. Textured numbers. Flannel board. Sorting and matching cards.
2	45	Numeral recognition. Sequencing numerals. Counting. Counting in two's. Conservation of number. Cardinal number. Partitioning. Language development.	Responding to oral questions. Holding numerals and positioning children. Matching numeral to quantities of objects. Partitioning. Counting. Sorting. Feely bag activity.	Numeral cards. Unifix cubes. Bucket. Plastic numerals. Plastic sorting shapes. Bobbin line. Toys, Feely bag.
3	43	Numeral recognition. Sequencing numerals. Counting. Conservation of number. Cardinal number. Place value. Partitioning. Properties of a square. Taking away. Language development.	Responding to oral questions. Holding numerals and positioning children. Ordering numeral cards. Counting. Partitioning. Taking away objects. Counting games. Sorting objects and cards.	Numeral cards. Plastic counting objects. Bobbin line. Toys. Sorting and matching cards.
4	47	Numeral recognition. Place value. Cardinal number. Measuring length. Weighing objects. Finding capacity of containers. Language development.	Responding to oral questions. Holding numerals and positioning children. Measuring length. Weight and capacity with arbitrary units. Using cubes on inset boards. Sliding numerals up from behind a card wall.	Numeral cards. Cardboard wall. Published workcards. Bucket balance. Containers. Arbitrary units for measuring and weighing. Unifix cubes. Inset trays.

TASKS OBSERVED EACH LESSON: TEACHER A (Continued)

LESSON	TIME	CONTENT	ACTIVITY	MATERIALS
5	50	Subitizing. Visual counting. Subtracting. Counting back. Counting on. Cardinal number. Ordering numerals. Properties of shape. Language development.	Responding to oral questions. Holding numerals and positioning children. Counting pictures. Playing counting games.	Flap-jacks. Numeral cards. Floor number lines. Number strips. Published games.
6	50	Subitizing. Visual counting. Subtracting. Counting back. Counting on. Cardinal number. Conservation of number. Sorting children. Language development.	Responding to oral questions. Walking on a sorting track. Playing with games and toys.	Flap jacks. Unifix cubes. Easter egg. Floor sorting track. Jigsaws. Toys.
7	60	Ordinal number. Cardinal number. Conservation of number. Properties of shape. Counting forward. Counting back. Number facts. Language development. Place value.	Responding to oral questions. Holding cards and ordering children. Standing in shape patterns. Walking on floor number lines. Playing published games. Sliding numerals up behind a card wall.	Ordinal word cards. Unifix cubes. Bucket. Floor number lines. Published games. Numeral cards. Cardboard wall. Feely bag. Plastic numerals.
8	55	Number facts. Sequencing numerals. Cardinal number. Ordinal number. Addition. Counting. Balancing. Comparison. Ordering.	Stating number facts. Holding cards and ordering children. Counting mushrooms. Balancing mushrooms. Ordering leaves for size. Sorting leaves for quantity. Playing with number apparatus.	Numeral cards. Grow-bag of mushrooms. Cards showing leaves. Flap jacks. Clock face.
9	45	Numeral recognition. Sequencing numerals. Number facts. Counting. Partitioning.	Stating number facts. Holding cards and ordering children. Counting objects.	Numeral cards. Counting objects.

TIME=minutes

TASKS OBSERVED EACH LESSON: TEACHER H

LESSON	TIME	CONTENT	ACTIVITY	MATERIALS
1	30	1-1 Correspondence. Naming 2-D shapes. Comparison of size. Describing 2-D shapes.	Naming 2-D shapes. Comparing shapes for size. Comparing more/less by 1-1 correspondence. Describing shapes by feel. Drawing large/small pictures.	Logiblocks. Hoops. Plastic shapes & arrows. Feely bag. Crayons.
2	20	Comparison of weight. Language of weight.	Sorting pictures. Ordering parcels.	Picture cards. Hoops. Language labels. Parcels.
3	25	Counting. Ordering. Colour recognition.	Counting objects. Ordering cube towers. Finding cubes of nominated colour.	Unifix cubes. Plastic objects.
4	40	Name of colours. Name of 2-D shapes. Counting. Ordinal numbers.	Naming shapes and colours. Counting shapes. Ordinal language.	Plastic shapes.
5	20	Comparison of time. Comparison of length. Conservation of number. Partitioning.	Threading beads. Comparing strings of beads. Arranging six beans. Partitioning six beans. Recording partitioning	Egg timer. Beads. Laces. Butter beans. Partitioning chart.
6	50	Ordinal number. Matching. Comparison of size.	Ordering for size. Matching pictures for size. Ordering for time.	Wall display. Picture cards. Crayons.
7	20	Counting. Numeral formation. Matching.	Completing jigsaws. Matching picture cards. Tracing numerals. Writing numerals.	Jigsaws. Unifix number caps. Picture cards. Crayons.
8	30	Measuring lengths.	Using body units.	
9	35	Counting on. Counting back. Shape recognition Colour recognition. Addition.	Moving on/back. Using shape and colour tracks. Using a number line. Naming shapes and colours. Adding using a number strip.	Shape track. Colour track. Number line

TIME=minutes

TASKS OBSERVED EACH LESSON: TEACHER J

LESSON	TIME	CONTENT	ACTIVITY	MATERIALS
1	40	Matching shapes. Sorting. Recording.	Cutting out shapes. Matching shapes to outline. Arranging in order of size. Sorting according to length. Drawing "tall" and "short".	Published worksheet. Scissors. Glue. Picture cards. Word cards. Crayons.
2	35	Counting to eight. Number language. Numeral formation. Comparison of length. Recording. One 'less than'.	Sorting into eights. Matching language cards to numerals. Tracing numeral eight. Drawing eight items (four 'tall' and four 'short')	Sorting tray & objects. Numeral cards. Language cards. Sticks. Crayons.
3	30	Partitioning. Counting. Adding.	Partitioning 10. Adding by counting. Recording by drawing.	Plastic ducks. Published workcards.
4	28	Counting. Matching numeral to quantity. Equivalence of number. Ordering of number.	Matching quantity to numerals. Counting cubes. Totalling. Matching cubes to rods. Ordering number rods.	Unifix cubes. Inset boards. Stern rods.
5	25	Balancing- weight. Counting. Totalling. Measuring length.	Balancing with arbitrary units for comparison. Measuring length with arbitrary units. Combining two groups and totalling.	Balance. Scissors. Cubes. Ribbon. Matchboxes. Cane. Published workcards. Number line.
6	35	Number equivalence. Sorting shapes.	Matching two Stern rods to a third. Sorting plastic shapes.	Stern rods. Inset board. Published workcards. Plastic circles. Shapes.
7	30	'More than'. Addition.	Finding x 'more than' y. Oral additions.	Stern rods. Published workcards.
8	38	Number facts. 'Less than'. Counting. 'More than'. Addition.	Matching number facts to numerals. 'Less than' by subtraction. Counting. Addition. 'More than' from workcards.	Numeral cards. Language cards. Cubes. Buttons. Number strips. Stern rods. Published workcards.
9	25	Balancing. Addition. Measuring.	Balancing - arbitrary units. Measuring - arbitrary units. Addition with rods in a number track.	Balance. Various units. Stern rods. Number Track. Straws. Matchboxes. Published workcards.

TIME=minutes

TASKS OBSERVED EACH LESSON: TEACHER L

LESSON	TIME	CONTENT	ACTIVITY	MATERIALS
1	53	Comparison of long and short.	Recognition of words. Pairing words. Comparison for long/short. Making plasticine snakes.	Language cards- large. Language cards- small. Everyday items for comparing. Sorting tray. Plasticine.
2	60	Comparison for longer, shorter and taller.	Making paper snakes. Making paper spirals. Large paper sunflower.	Paper snakes. Paper circles. Scissors.
3	60	Language development. Comparison for taller & shorter. Days of the week. Names of the months.	Handling objects in a feely box. Drawing pictures. Oral activity on days of the week.	Feely box. Classroom objects. Crayons.
4	60	Comparison for colour hue. Comparison for longer & shorter. Recognition of words. Counting. Language development.	Comparing colour spots. Matching words 'lighter' and 'darker'. Sorting for longer/shorter. Counting moveable and fixed items.	Crayons. Paint chart spots. Language cards. Game board. Plastic hoops. Everyday sorting items. Feely box.
5	60	Comparison of size. Language based on dates. Capacity.	Painting different sized pictures. Oral activity on dates. Making play dough. Making various sized dough apples.	Painting materials. Containers. Flour. Salt. Colouring.
6	55	Comparison of size. Timed activities. Counting.	Comparing classroom objects for size. Working within a fixed period of time. Counting objects.	Sandtimer. Toy mouse. Ribbon. Plastic bottle. Classroom objects.
7	60	Counting. Recording skills.	Drawing items. Counting drawn items.	Crayons.
8	40	Numeral recognition. Counting.	Responding to oral questions. Counting out cubes. 'Guess the number' game.	Large numeral cards. Unifix cubes.
9	40	Numeral recognition. Counting.	Responding to oral questions. Matching numeral to quantity. Holding and moving card numerals.	Large numeral cards. Small numeral cards. Unifix cubes. Picture cards.

TIME=minutes

TASKS OBSERVED EACH LESSON: TEACHER M

LESSON	TIME	CONTENT	ACTIVITY	MATERIALS
1	45	Drawing round templates to create a picture.	Drawing round shapes. Colouring. Gluing. Cutting out. Making free choice picture. Using published worksheet.	Logic blocks. Gummed paper. Scissors. Crayons. Commercial worksheet.
2	40	1-to-1 correspondence. Matching egg to eggcup	Drawing an egg. Colouring. Gluing. Cutting out. Matching egg to eggcup.	Drawings of 5 eggcups. Scissors. Crayons. Gummed paper.
3	45	Matching the symbol 2 to a quantity	Cutting out 2 pictures. Drawing round template of symbol 2. Gluing.	Pictures from magazines. Scissors. Paste. Number symbol template.
4	55	Matching the symbol 4 to a quantity. Counting 1 more than.	Drawing in books. Questions pre-written by teacher. All recording by drawing.	Pencils.
5	40	Matching a quantity to a symbol.	Colouring and mapping in pupil book. Pictures and symbols pre-drawn by teacher. Mapping symbol to quantity.	Pencils.
6	45	Modelling with junk material to make models.	Sticking boxes and tubes together.	Packets. Tubes. Paste. Scissors. Paper
7	45	Writing about the models made.	Creative writing.	Pencil.
8	50	Matching symbol to quantity.	Computer program on matching quantity to symbols. Matching symbol to quantity by drawing in workbook.	Computer program. Published workcards.
9	55	Matching symbol to quantity. Counting. More than tasks.	Drawing in workbook.	Published workcards.

TIME=minutes

APPENDIX 2

OBSERVATIONAL RECORDS

TEACHER M

Observation schedules on Teacher M.
Systematic 25 second timings

Blank record sheet	Page 13
Record for Lesson 1	Page 14
Record for Lesson 2	Page 15
Record for Lesson 3	Page 16
Record for Lesson 4	Page 17
Record for Lesson 5	Page 18
Record for Lesson 7	Page 19
Record for Lesson 9	Page 20

BLANK RECORDING SHEET (25 SECOND INTERVALS)

Time Time Time Time

NOTES:

T=Table number
R=Table of target children
B=Bay
BT=Between tables
OB=Child out of base
U=Unobserved
I=Interruption from outside person

Q=Utterance
L=Observing (general)
M=Marking
H=Hearing child read
W=Writing in child's book
C=Checking child's work (closely & silent)
N=Routine

+=Same child seen
*= Child summoned

COMPLETED RECORD FOR LESSON 1 (25 SECOND INTERVALS)

11.10	11.25	11.40
T1 Q	R Q	BT
R Q KIRSTY	BT	B ROBERT OB
R Q ROBERT	T4 Q	BT
R Q ROBERT+	BT	R Q DANIEL
B	T2 Q	B
B	BT I HEAD	B
BT M	R Q ROBERT	T3 L
BT	BT Q	T3 I HEAD
B	BT Q	T3 I HEAD+
T1 M	T3 Q	T5 #1
R Q ROBERT	T3 L	T1 M
T2 Q	R Q KIRSTY	T1 L

BT	R Q OB	T2 L
T5 L	R Q KIRSTY	T2 Q OB
R L	T1 L	T1 M
R Q DANIEL	B	T4 M
R Q LEANNE	T1 Q	T4 Q OB
R Q KIRSTY	T1 Q	T4 Q
T1 L	T1 Q OB	T4 Q ROBERT OB
T3 Q	BT Q DANIEL OB	T4 Q
T3 Q	T3 Q	T1 M
T4 L	T3 Q	T3 Q
T4 Q	BT	B
T4 Q	T1 L	B

BT	T1 L	T3 Q
T4 C	BT	T3 Q OB
T4 C	T5 L	BT
T1 L	R Q LEANNE	T4 Q
T3 Q	R Q LEANNE+	R Q KIRSTY
T3 Q	R Q OB	BT I TEACHER
T3 Q OB	R Q OB	T3 L
T2 Q OB	T4 L	BT Q OB
BT I TEACHER	B LEANNE OB	R Q WHOLE CLASS
BT	R Q ROBERT	R Q ROBERT
T2 Q	R Q ROBERT+	
T4 L	R Q ROBERT+	

NOTES:
#1=TEACHER SHOWING WORK TO THE ADULT AT T5
KIRSTY WORKING WITH TARGET CHILDREN

COMPLETED RECORD FOR LESSON 2 (25 SECOND INTERVALS)

11.16	11.31	11.46
T1 Q	T4 M	T4 H
T1 Q	T4 Q OB	T1 M
R L	T4 Q OB	T4 M
T4 Q	T4 Q OB+	R Q DANIEL
T3 Q	BT	R Q DANIEL+
T3 Q	T1 H OB	R Q DANIEL+
T3 Q	T1 Q OB	T4 M
T3 Q	T1 H OB	BT
T2 C	T1 H OB+	T3 Q ROBERT OB
T1 Q	T1 H OB	T3 Q ROBERT OB+
T1 Q OB	T1 H OB+	T3 Q DANIEL OB
BT I CHILD	T1 H OB	T3 Q CLAIRE OB

BT Q OB	T1 H	T3 Q OB
T1 M	T1 H	T3 Q OB
BT Q OB	T1 Q DANIEL OB	T3 Q OB+
BT	T1 Q DANIEL OB+	T3 Q OB
B	T1 Q DANIEL OB+	T3 Q
T3 Q	B DANIEL OB+	T3 Q
T3 Q CLAIRE OB	B DANIEL OB+	T3 M OB
T3 Q OB	R Q CLAIRE	T3 M OB
T3 H	BT	T3 M OB+
T3 H	T4 H	T3 M OB
T3 H+	T1 I CHILD	T3 M OB
T3 Q DANIEL OB	T4 L	BT

T3 H	BT
T3 H	T4 L
T3 H	T1 Q
T3 H+	T4 Q CLAIRE & LEANNE OB
T3 H	T4 Q CLAIRE & LEANNE OB+
T3 H	T4 Q CLAIRE OB+
BT W	T4 Q CLAIRE OB+
R Q DANIEL	T4 H
BT Q OB	T4 H
R Q ROBERT	T4 H
R Q LEANNE	T4 H+
R Q CLAIRE	T4 H

NOTES:

COMPLETED RECORD FOR LESSON 3 (25 SECOND INTERVALS)

11.05	11.20	11.35
R L	T5 Q	T3 M
T3 L	R L	T3 Q NEAL OB
BT	R Q CLARE	T3 Q NEAL OB+
B	T3 Q	R L
T2 Q	BT Q DANIEL OB	R Q WHOLE GROUP
R Q DANIEL	T3 Q	R M
T4 C	BT Q OB	B
BT Q OB	D Q OB	BT Q OB
BT Q OB	D Q OB	BT Q OB
R C DANIEL	T1 M	T3 Q OB
BT	B	T5 Q
T2 L	T3 W OB	T5 Q

T2 L	T3 W OB	T5 M
T3 C	T3 W OB+	T5 Q
R C ROBERT	T3 Q OB	T5 M
BT Q OB	T3 Q CLAIRE OB	T3 M
R Q NEAL	T3 W OB	R L
T5 L	T3 W OB	T5 M
T2 M	T3 W OB	T5 Q
T3 Q	T3 W OB+	T5 M
T3 Q	BT	T1 M
T3 Q	R Q DANIEL	T1 M
R L	T2 Q OB	T2 L
BT I CHILD	BT I TEACHER	B

BT	BT	B
BT	T3 L	BT Q OB
T3 L	T3 Q DANIEL OB	T1 M
B	T3 Q OB	T1 Q DANIEL OB
T3 Q	BT	T1 M
T3 Q	T5 Q	B
T2 Q	T5 M	T2 Q
BT Q DANIEL OB	T5 Q	BT Q CLAIRE OB
BT Q CLAIRE OB	T5 M	T1 L
T3 Q	BT	T2 M
T2 Q	T2 Q	BT I TEACHER
BT	T2 Q OB	BT

NOTES:

D= TEACHER AT WALL DISPLAY

COMPLETED RECORD FOR LESSON 4 (25 SECOND INTERVALS)

11.04	11.19	11.34	11.49
R L	BT	T5 C	T5 Q OB
R Q CLAIRE	T1 L	R Q OB	T5 Q
B	T5 M	R Q LEANNE	T5 L
T2 Q	R Q CLAIRE	R C OB	R M NEAL
T5 Q	R Q LEANNE	BT C OB	R Q NEAL+
BT	R Q DANIEL	T2 M	T5 M OB
BT Q OB	T4 C	T3 C	BT
T3 W	BT	BT	T5 L
T2 W	T1 Q	T1 C	BT
BT	T2 C	BT	T3 M
BT	R Q LEANNE	T5 Q	R Q DANIEL
R Q WHOLE GROUP	T5 C	R C OB	R C CLARE

R Q LEANNE	BT	R Q CLAIRE	R Q CLARE+
R Q CLAIRE	R C ROBERT	R Q DANIEL	BT
BT	R C CLARE	BT	B
T3 L	T5 Q	BT M OB	END OBSERVATION
B	T5 Q	T2 Q	
T1 L	T5 Q	T3 C	
R Q DANIEL	T4 Q	T3 M	
R Q CLAIRE	T4 C	T1 C	
R Q ROBERT	T4 Q	R C NEAL	
BT M OB	T3 C	R Q LEANNE	
T4 Q	T2 M	R Q ROBERT	
BT M OB	T2 Q	R Q OB	

R L	BT	BT	
BT	T3 C	T5 Q OB	
T1 Q OB	R Q LEANNE	T5 Q OB	
T1 Q OB+	R Q CLAIRE	T5 M OB	
T1 L	BT C OB	T5 Q OB	
T4 M	BT C OB	T5 M OB	
T1 M OB	T2 M	T5 C OB	
T1 Q CLAIRE OB	T5 Q	T5 Q DANIEL OB	
T1 Q CLAIRE OB+	BT	T5 C OB	
T1 M OB	T3 C	T5 Q OB	
T1 Q DANIEL OB	R Q ROBERT	T5 M LEANNE OB*	
T2 M	R C CLARE	T5 Q OB	

NOTES:

COMPLETED RECORD FOR LESSON 5 (25 SECOND INTERVALS)

11.02	11.17	11.32	11.47
T3 Q	B Q T5	BT	T2 C DANIEL OB+
T1 Q	B Q T5	B	T2 C DANIEL OB+
BT	B Q T5	BT	T2 Q OB
BT I WELFARE	B Q T5	R Q CLARE	T2 M OB
BT Q OB	B Q T5	R I CHILD	T2 Q OB
BT Q OB	B Q T5	R Q LEANNE	T2 M OB
BT	B Q T5	T4 Q	T2 Q OB
B Q T5	B Q T5	T4 Q	T1 C
B Q T5	B Q T5	T4 Q	BT
B Q T5	B Q T5	T4 Q ROBERT OB	BT M OB
B Q T5	B Q T5	T4 Q	R Q CLARE
B Q T5	B Q T5	T4 Q	T4 Q
B Q T5	B Q T5	T5 C	T4 L
B Q T5	B Q T5	T4 Q	BT
B Q T5	R C DANIEL	T1 Q	BT L
B Q T5	R C CLARE	T1 L	T3 Q
B Q T5	R C CLARE+	R Q DANIEL	BT Q OB
B Q T5	R Q LEANNE	R C DANIEL+	BT Q CLASS
B Q T5	R C ROBERT	R Q DANIEL+	OBSERVATION ENDED
B Q T5	R C ROBERT+	R C DANIEL+	
B Q T5	R Q NEAL	R Q LEANNE	
B Q T5	R Q CLAIRE	R Q LEANNE+	
B Q T5	R C CLAIRE+	R Q LEANNE+	
B Q T5	R Q CLAIRE+	T4 Q	
B Q T5	R Q DANIEL	R Q CLARE	
B Q T5	R Q ROBERT	R Q CLARE+	
B Q T5	T2 C	BT	
B Q T5	BT	BT	
B Q T5	T4 Q	BT I WELFARE	
B Q T5	BT	B	
B Q T5	B	B	
B Q T5	T1 Q	T2 C	
B Q T5	T1 Q OB	T2 C	
B Q T5	BT	T2 C	
B Q T5	T4 Q OB	T2 C	
B Q T5	T4 Q OB	T2 C DANIEL OB	

NOTES
TEACHER WAS IN BAY WITH T5 FOR ORAL ACTIVITY

COMPLETED RECORD FOR LESSON 7 (25 SECOND INTERVALS)

11.09	11.24	11.39	11.54
T3 Q STUDENT	R W NEAL+	T2 Q CLARE OB+	OBSERVATION ENDED
BT	R W NEAL+	T2 Q LEANNE OB+	
T4 Q	R Q NEAL+	T2 Q LEANNE OB+	
T4 M	BT	T2 Q LEANNE OB+	
T1 Q	T2 Q	T2 Q OB	
BT	T3 L	T2 Q OB	
T1 N	BT	T2 Q	
B	BT I TEACHER	T2 Q	
BT	T2 Q	T2 Q	
R C NEAL	T1 Q	T2 Q	
BT	R Q DANIEL	T2 Q DANIEL OB	
BT	R I TEACHER	T2 Q DANIEL OB+	
BT	R I TEACHER	T2 Q DANIEL OB+	
BT	R Q DANIEL	T2 Q DANIEL OB+	
T4 L	R W DANIEL+	T2 L	
R Q DANIEL	R W DANIEL+	T2 Q	
T4 L	R W DANIEL+	T2 L	
T4 M	BT	T2 Q OB	
T4 Q	R Q DANIEL	T3 Q	
R Q CLARE	R Q CLAIRE	T2 Q	
R W CLARE+	R W CLAIRE+	T2 Q	
R W CLARE+	R W CLAIRE+	T2 Q OB	
R W CLARE+	R W CLAIRE+	T2 I HEAD	
R W CLARE+	B	T2 I HEAD+	
R Q CLARE+	BT I STUDENT	T2 I HEAD+	
R Q LEANNE	BT	B	
BT	T4 Q	T2 Q OB	
R W LEANNE	R W ROBERT	T2 L	
R W LEANNE+	R W ROBERT+	T2 Q OB	
R W LEANNE+	R Q ROBERT+	T2 Q OB	
R W LEANNE+	R Q ROBERT+	T2 Q OB+	
R W LEANNE+	BT	T2 Q CLAIRE OB	
BT	BT	T2 Q CLAIRE OB+	
R L	T2 Q DANIEL OB	T2 Q DANIEL OB	
R Q NEAL	T2 Q	T2 Q CLASS	
R W NEAL+	T2 Q CLARE OB	T2 Q CLASS	

NOTES

COMPLETED RECORD FOR LESSON 9 (25 SECOND INTERVALS)

11.07	11.22	11.37	11.52
B	T1 Q OB	T1 Q ROBERT OB	B
B	T1 M OB+	T1 Q DANIEL OB	T2 M
BT	BT Q DANIEL OB	T1 Q DANIEL OB+	T2 M
T3 N	BT	T1 Q ROBERT OB	T1 Q OB
BT M OB	T3 Q	T1 M OB	T1 Q OB+
R C DANIEL	T3 Q	T1 L	B
BT	T3 Q OB	T1 I TEACHER	BT M OB
T2 M	T2 L	T1 I TEACHER	BT M OB+
T2 L	R L	T1 I TEACHER	BT L
B	T1 H	T1 Q OB	T4 Q
BT	T1 Q	T1 M OB	B Q DANIEL OB
T4 L	T1 L	R L	BT

T1 Q	T1 Q OB	BT	BT Q LEANNE OB
TA Q	T1 C DANIEL OB	T1 M	BT W OB
T3 L	T1 L	BT	BT
T1 Q	T1 C	T3 M	T3 L
R Q CLAIRE	T1 L	T2 Q	T3 Q
R Q CLARE	T1 I TEACHER	BT Q OB	T3 Q
R Q CLARE+	T1 I TEACHER+	T1 L	BT M OB
R Q LEANNE	T1 I TEACHER+	T1 M	OBSERVATION ENDED
R Q ROBERT	T1 I TEACHER+	R Q OB	
B	T1 I TEACHER+	R L	
BT M OB	T1 I TEACHER+	BT	
TN M OB	T1 I TEACHER+	T4 M	

TN L NEAL	T1 I TEACHER+	T4 M
BT	T1 I TEACHER+	T4 M+
T1 H	T1 I TEACHER+	BT
T1 H+	T1 I TEACHER+	B
T1 H+	T1 I TEACHER+	T2 M
T1 Q OB	T1 M OB	T2 M
T1 H	T3 Q OB	BT
T1 H+	T2 M	BT
T1 L	BT	T1 Q
T1 Q OB	BT	T1 Q
T1 Q OB	T3 M OB	T2 L
T1 M OB+	T1 L	B

NOTES
TA=CHILD WORKING ALONE AT A TABLE
TN=NEAL WORKING ALONE AT A TABLE

APPENDIX 3

OBSERVATION OF ALL TEACHERS

5 MINUTE INTERVALS

List of abbreviations	Page 23
Observation Record	Page 24
Percentage of time spent with groupings of children	Page 25
Mean percentage of time spent with groups	Page 26

ABBREVIATIONS USED IN RECORDINGS

I=Individual child: Teacher focusing on an individual child

G=Group of children: Teacher focusing on a group of children

C=Whole class: Teacher focusing on the whole class

Q=Utterance: Talking to child(ren)

N=No action with child: Observing work, silent marking

S=Silent action: Pointing, showing, demonstating

U=Unobserved: Out of researcher sight

H=Hearing readers

B=Between children: Routine activities, moving between groups

A=Teacher A
H=Teacher H
J=Teacher J
L=Teacher L
M=Teacher M

TABLE OF TEACHER OBSERVATIONS AT 5 MINUTE INTERVALS

5 mins	1	2	3	4	5	6	7	8	9	10	11	12
TEACHER A												
1	C S	C Q	C Q	C S	C Q	C N	G Q	G Q	G Q	G Q		
2	C S	C Q	C S	I Q	C Q	C Q	C Q	G Q	G Q			
3	C S	C Q	C Q	I Q	C S	I Q	C Q	G N				
4	C S	C S	C Q	I Q	C N	C N	I H	G N	G Q	C N		
5	C Q	C S	C S	C S	C S	C N	I Q	I Q	G Q	G N		
6	C S	C S	I N	C Q	C Q	C Q	C Q	C Q	C N	G N		
7	C S	C S	C Q	I Q	C S	I Q	C Q	I Q	I Q	C N	G N	C N
8	C S	C Q	C S	I Q	C S	G S	I Q	C Q	G Q	G N	C N	
9	C Q	I Q	C Q	I Q	C Q	C S	C Q	I Q	C N			
TEACHER H												
1	G Q	G Q	I Q	C N	G N	G N						
2	G Q	I Q	G Q	C N								
3	G Q	G Q	G S	G Q	G N							
4	C N	G N	G Q	G Q	C N	G N	G Q	C N				
5	G N	G Q	I Q	G N								
6	C N	G Q	G Q	G Q	G N	I Q	G S	I S	G Q	C N		
7	C N	G Q	G Q	C N								
8	G Q	I Q	I Q	G N	I S	G N						
9	G S	G N	G Q	G S	B N	B N	B N					
TEACHER J												
1	C N	C N	G Q	G Q	I Q	G Q	G Q	I S				
2	G Q	G Q	G Q	G N	G Q	G Q	I Q					
3	G Q	G Q	G Q	I Q	G N	G N						
4	G N	G H	B N	G Q	G Q	G N						
5	I S	G N	I S	C N	I Q							
6	G Q	G Q	I Q	G Q	I S	I S	G Q					
7	I Q	I Q	U	I Q	C N	G Q						
8	G S	I Q	G Q	I Q	I N	I S	I Q	I Q				
9	I Q	I S	I H	I S	I Q							
TEACHER L												
1	G Q	G Q	G Q	I Q	G Q	G Q	G H	G H	G Q	G H		
2	C Q	C H	C Q	B N	I Q	G Q	G Q	G Q	G H	G H	I Q	G Q
3	C Q	C Q	G Q	G H	G H	G Q	G H	G Q	C N	G H	G N	G N
4	C H	C N	G Q	G Q	G H	G Q	G Q	G H	G Q	B N	G N	G H
5	C H	G H	G Q	G H	I Q	I Q	G H	G N	G Q	G H	G H	G Q
6	C H	C N	G Q	G Q	G H	G Q	G Q	G Q	G N	G H	C N	
7	C N	C Q	G N	G Q	G L	G N	G Q	U	G N	G Q	G H	C H
8	C N	G Q	G H	I Q	I Q	G Q	G Q	I H				
9	C N	C N	G Q	G H	G H	G H	G N	G Q				
TEACHER M												
1	I Q	B N	B N	I Q	I Q	G N	B N	I N	I Q			
2	I Q	I Q	I H	I S	I H	B N	I H	I Q				
3	I N	G N	B N	I Q	I S	B N	I S	I S	U			
4	I N	I Q	I N	B N	B N	B N	I N	I Q	B N	I Q	I Q	
5	I Q	U	I N	B N	I Q	B N	I Q	C N				
6	I S	I S	B N	I S	B N	B N	G N	I H	I H			
7	B N	B N	I Q	I S	B N	B N	I Q	I Q	B N			
8	I N	B N	B N	I Q	I Q	I Q	B N	I Q	B N	I N		
9	U	I Q	I N	I Q	I Q	B N	I Q	B N	I S	B N	I Q	

PERCENTAGE OF TIME SPENT WITH GROUPS OF CHILDREN FOR EACH OBSERVED LESSON

LESSON	AI	AG	AC	AB	HI	HG	HC	HB
1	00.0	40.0	60.0	00.0	16.7	66.7	16.7	00.00
2	11.1	22.2	66.7	00.0	25.0	50.0	25.0	00.0
3	25.0	12.5	62.5	00.0	00.0	100.0	00.0	00.0
4	20.0	20.0	60.0	00.0	00.0	62.5	37.5	00.0
5	20.0	20.0	60.0	00.0	25.0	75.0	00.0	00.0
6	10.0	10.0	80.0	00.0	20.0	60.0	20.0	00.0
7	33.3	08.3	58.3	00.0	00.0	50.0	50.0	00.0
8	18.2	27.3	54.5	00.0	50.0	50.0	00.0	00.0
9	33.3	00.0	66.7	00.0	00.0	57.1	00.0	42.9

LESSON	JI	JG	JC	JB	LI	LG	LC	LB
1	25.0	50.0	25.0	00.0	10.0	90.0	00.0	00.0
2	14.3	85.7	00.0	00.0	16.7	50.0	25.0	08.3
3	16.7	83.3	00.0	00.0	00.0	75.0	25.0	00.0
4	00.0	83.3	00.0	16.7	00.0	75.0	16.7	08.3
5	60.0	20.0	20.0	00.0	16.7	75.0	08.3	00.0
6	42.9	57.1	00.0	00.0	00.0	72.7	27.3	00.0
7	60.0	20.0	20.0	00.0	00.0	72.7	27.3	00.0
8	75.0	25.0	00.0	00.0	37.5	50.0	12.5	00.0
9	100.0	00.0	00.0	00.0	00.0	75.0	25.0	00.0

LESSON	MI	MG	MC	MB
1	56.6	11.1	00.0	33.3
2	87.5	00.0	00.0	12.5
3	62.5	12.5	00.0	25.0
4	63.6	00.0	00.0	36.4
5	57.1	00.0	14.3	28.6
6	55.6	11.1	00.0	33.3
7	44.4	00.0	00.0	56.6
8	60.0	00.0	00.0	40.0
9	70.0	00.0	00.0	30.0

MEAN PERCENTAGE OF TIME SPENT WITH GROUPS OF CHILDREN OVER NINE LESSONS

	I	G	C	B	TOTAL
A					
Frequency	17	16	56	00	89
Percentage	19.1	18.0	62.9	00.0	
H					
Frequency	08	34	09	03	54
Percentage	14.8	63.0	16.7	5.6	
J					
Frequency	24	28	04	01	57
Percentage	42.1	49.1	07.0	01.8	
L					
Frequency	08	68	18	02	96
Percentage	08.3	70.8	18.8	02.1	
M					
Frequency	50	03	01	27	81
Percentage	61.7	03.7	01.2	33.3	

DATES OF BIRTH OF TARGET CHILDREN

Teacher J	DoB	Age at test
Peter	18.03.80	5.25
David	17.01.80	5.42
Nathan	11.01.80	5.42
Elizabeth	23.03.80	5.25
Emma	11.01.80	5.42
James	20.04.80	5.17
Teacher L		
David	15.01.80	5.42
Caroline	02.01.80	5.42
Emma	03.04.80	5.17
Stuart	13.03.80	5.25
Nathan	04.02.80	5.33
Matthew	10.03.80	5.25
Teacher H		
Lyndsay	12.03.80	5.25
Danielle	19.04.80	5.17
Joanne	29.04.80	5.17
Ben	29.01.80	5.42
Nathan	03.03.80	5.25
Craig	03.04.80	5.17
Teacher A		
Kate	05.02.80	5.33
Michelle	22.02.80	5.33
Helen	03.04.80.	5.17
Peter	02.04.80	5.17
Matthew	01.03.80	5.25
David	17.04.80	5.17
Teacher M		
Leanne	19.02.80	5.33
Clare	01.01.80	5.42
Claire	03.03.80	5.25
Robert	06.03.80	5.25
Neal	19.01.80	5.42
Daniel	17.03.80	5.25
Mean ages at test		
TEACHER J		5.32
TEACHER L		5.31
TEACHER H		5.24
TEACHER A		5.24
TEACHER M		5.32
Overall Mean		5.29

APPENDIX 5

ADMINISTRATION OF COUNTING TESTS

TO TARGET CHILDREN

Test 1: Counting moveables	Page 32
Test 2: Counting Fixed objects	Page 33
Test 3: Visual counting	Page 34
Test 4: Aural Counting	Page 35
Test 5: Numeral Recognition	Page 36
Test 6: Numeral Order	Page 37
Test 7: Matching Numeral to Quantity	Page 38

ADMINISTRATION OF TEST 1: Counting moveables

Materials used

Green, non-interlocking, plastic 18mm cubes.

Presentation

A number of cubes were placed on the table in front of the child in a random order.

Order of presentation

4, 9, 7, 15, 11 cubes.

Initial statement

"I am going to put some cubes on the table. I want you to count how many there are."
(Four cubes were then placed on the table).

Question

"How many cubes are there?"
(After the child had counted and responded the cubes were removed. The initial statement and question were then repeated for 9, 7, 15 and 11 cubes).

Response

A record was kept of how the child counted; Touching; Moving; Pointing at; Eye or head movement; Immediate response. Any incorrect response was recorded (APPENDIX 6).

ADMINISTRATION OF TEST 2: Counting Fixed objects

Materials used

Gummed 25mm diameter circles stuck on 170mm by 210mm card rectangles. The circles were in lines but irregularly spaced.

Presentation

One card at a time was placed in front of the child.

Order of presentation

2, 10, 6, 14 and 12 circles.

Initial statement

"I am going to show you some circles. I want you to count how many there are."
(The card showing 2 circles was then placed in front of the child).

Question

"How many circles are there?"
(After the child had counted and responded the card was removed. The initial statement and question was then repeated for 10, 6, 14 and 12 circles).

Response

A record was kept of how the child counted: Touching; Pointing at; Eye or head movement; Immediate response. Any incorrect response was recorded. (APPENDIX 6)

ADMINISTRATION OF TEST 3: Visual counting

Materials used

A flap-jack made from sixteen 50mm squares. Ten of the squares showed pictures of teddy bears on 45mm diameter circles. The flap-jack could be folded to show different numbers of teddy bears. The unfolded pattern was:

T * * *
T T T T
T T T *
T T * *

(Teddy bears are shown by the letter T and blank squares by the astrisk *).

Presentation

The flap jack was folded to show a number of teddy bears to the child. A number of blank squares could also be seen. The child could not touch the flap-jack.

The folded patterns shown to the child were:

T * * *	* *	T *	T T T T	T * * *
T T T T	T T	T T	T T T *	T T T T
	T *	T T	T T * *	T T T *
	* *	T T		

Order of presentation

The child was shown 5, 3, 7, 9 and 8 pictures of teddy bears.

Initial statement

"I am going to show you some pictures of teddy bears. I want you to count how many there are."
(The flap-jack was then folded to show 5 teddy bears).

Question

"How many teddy bears are there?"
(After the child had counted and responded the flap-jack was folded to show the next number. The initial statement and question was then repeated for 3, 7, 9 and 8 teddy bears).

Response

A record was kept of how the child counted; Pointing at; Eye or head movement; Immediate response. Any incorrect response was recorded (APPENDIX 6).

ADMINISTRATION OF TEST 4: Aural counting

Materials used

A tape recorder and tape with a recording of a bell being rung at 2 second intervals. Between each set of rings there was was a pause.

Presentation

The recording was played to the child, if the child's response was slow the tape was paused between the different sets of rings.

Order of presentation

The number of rings were 3, 8, 5, 10 and 13.

Initial statement

"I am going to play you a tape of a bell ringing. I want you to tell me how many times it rings."

Question

"How many times does the bell ring?"
(After the child had counted and responded the tape continued to the next set of bell rings. The question was then repeated).

Response

A record was kept of any incorrect response (APPENDIX 6).

ADMINISTRATION OF TEST 5: Numeral recognition

Materials used

A flip-board showing number symbols. The flip-board was 210mm by 147mm cards on which were written 60mm high number symbols in the range 0-20.

Presentation

The child was shown one number symbol at a time. After the response the card was flipped over to reveal the next number symbol.

Order of presentation

The number symbols were shown in the order: 3, 0, 2, 4, 1, 5, 7, 6, 9, 10, 8, 11, 13, 15, 12, 14, 18, 16, 20, 19, 17

Initial statement

"I am going to show you some numbers. I want you to tell me what each number says."

Question

There were no questions or subsequent statements. The test was undertaken with researcher silence.

Response

A record was kept of any numeral a child could not recognise (APPENDIX 6).

ADMINISTRATION OF TEST 6: Numeral order

Materials used

Blank playing cards (88mm by 58mm) on which were written 40mm high number symbols.
Pack A showed numerals in the range 0-10.
Pack B showed numerals in the range 11-20.

Presentation

The child was given the cards from Pack A to put in order. On completion, the cards were gathered together. Pack B was then given to the child be put in order.

Order of presentation

Pack A's random order was: 1, 3, 6, 9, 0, 2, 5, 7, 10, 8, 4
Pack B's random order was: 11, 16, 17, 19, 14, 12, 20, 18, 15, 13.

Initial statement

"I am going to give you a pack of cards. On the cards are written numbers. The numbers are all mixed up. I want you to sort the numbers out for me."
(This statement was later repeated with the second pack of cards).

Question

There were no questions or subsequent statements. The test was undertaken with researcher silence.

Response

A record was kept of the order in which the numerals were placed (APPENDIX 6).

ADMINISTRATION OF TEST 7: Matching numeral to quantity

Materials used

Quantity cards were 100mm by 160mm rectangles on which were stuck 16mm diameter plastic counters. There were five cards which had 4, 7, 9, 12 and 15 counters on them. The counters were in lines but irregularly spaced.
Numeral cards were 88mm by 58mm blank playing cards on which were written 40mm high number symbols. The number symbols were 4, 7, 9, 12 and 15.

Presentation

The quantity cards and numeral cards were randomly placed on the table in front of the child.

Initial statement

"Here are some cards with counters on them. Here are some cards with numbers on them. I want you to match the numbers to the counters."

Question

There were no questions or subsequent statements. The test was undertaken with researcher silence.

Response

A record was kept of the order in which the child attempted the match and of any incorrect match. The count strategy was also recorded: Touch; Immediate response; Eye or head movement; Point; Visual match (APPENDIX 6).

APPENDIX 6

RESULTS OF COUNTING TESTS

Counting Tests 1 and 2 (Strategies Employed)	Page 41
Counting Tests 3 and 4 (Strategies Employed)	Page 42
Counting Tests 1 and 2 (Silent Counting or Counting Aloud)	Page 43
Counting Tests 3 and 4 (Silent Counting or Counting Aloud)	Page 44
Counting Test 5	Page 45
Counting Test 6	Page 47
Counting Test 7	Page 48

RESULTS OF COUNTING TESTS 1 and 2
(Strategies employed)

	MOVEABLES					FIXED				
Nos USED										
ORDER	4	9	7	15	11	2	10	6	14	12
TEACHER A:										
KATE	I	E	E	EM	E	I	T	E	T	T
MICHELLE	I	E	I	E14	E	I	E	E	E	E
HELEN	I	E7	E	E13	E9	I	E9	E5	E	E10
PETER	T	T	T	TM	T	I	T9	T	T	T11
MATTHEW	M	M	M	M	M	I	T	T	T	T11
DAVID	I	P	P	P	P	I	P	P	T	P
TEACHER H:										
LYNDSAY	E	E8	E	T16	T9	I	E	E	T	E
DANIELLE	M	M	M	M	M	T	T	T	T	T13
JOANNE	T	T8	T6	T17	T12	I	T9	T5	T13	T10
BEN	I	M	T	M16	M	I	T	T	T	T
NATHAN	P	P8	E	E12	P	I	T	T	T12	T11
CRAIG	M	M	M	M	M	I	T11	T	T	T11
TEACHER J:										
PETER	T	T	T	T14	T	I	T7	T	T	T
DAVID	T	T	T	T	T	I	T9	I3	T15	T11
NATHAN	I	T10	E6	T	T	I	T	E	E16	E
ELIZABETH	E	T	T	T16	T	I	T	T	T	T
EMMA	I	M	E	M	M	I	T	T	T	I11
JAMES	P	M	P	M17	M	I	T11	P	T	T
TEACHER L:										
DAVID	MT	MT	MT	MM	MT	I	T9	T	T	T
CAROLINE	I	P	P	P16	E10	E	E	E	E	E10
EMMA	M	M	M	M	M	I	T9	T	T4	T3
STUART	I	T	T	T14	T12	I	T9	T	T	T13
NATHAN	T	T	T	M8	M12	T	T9	T	T8	T18
MATTHEW	I	T	P	T	T	I	P	E	T	P11
TEACHER M:										
LEANNE	I	E8	E	E	E3	I	E	E	E	E
CLARE	M	M	M	M	M	T	T	T	T15	T
CLAIRE	I	T	T	T14	T	I	T11	P5	T13	T
ROBERT	M	M	M	M17	M	I	T	T	T13	T11
NEAL	M	M	M	M16	M	I	T	T	T	T11
DANIEL	I	T	T	T16	T	I	T	T5	T	T

NOTES:
NUMBERS ENTERED IN THE TABLE ARE THE STATED INCORRECT RESPONSES
I= IMMEDIATE RESPONSE M=MOVE T=TOUCH P=POINT E=EYE/HEAD MOVEMENTS

RESULTS OF COUNTING TESTS 3 and 4
(Strategies employed)

	VISUAL					AURAL				
Nos USED ORDER	5	3	7	9	8	3	8	5	10	13
TEACHER A:										
KATE	E	I	E	E	E			4		11
MICHELLE	E	I	E6	E	E					
HELEN	E	I	E	E	E		5	4	12	9
PETER	E	I	I	P	P			6		12
MATTHEW	P	I	P	P	P	5	10	3	13	8
DAVID	I	I	I	E	I					12
TEACHER H:										
LYNDSAY	E	I	E	E	E					12
DANIELLE	E	I	E8	E8	E					
JOANNE	E4	I	E	E	E6					14
BEN	P	I	P	E	E					12
NATHAN	I4	I	E6	E8	E7			4		
CRAIG	E	I	P	P	P					
TEACHER J										
PETER	I	I	I	P	P					
DAVID	I4	I	I6	I7	I9					
NATHAN	I	I	E	E	E	4	10	6	8	9
ELIZABETH	P	I	P	P	P					
EMMA	I	I	P	P	P					
JAMES	E	I	E	E	E					
TEACHER L:										
DAVID	E	I	E	E	E				11	14
CAROLINE	E	E	E	E	E7					
EMMA	E4	I	E	E2	E6		5			
STUART	E	I	E	P	P					15
NATHAN	E	E	E	E	E				12	18
MATTHEW	E	I	E	E8	E				12	15
TEACHER M:										
LEANNE	E	I	E	E	E		7			
CLARE	E	I	E	E7	E		10	7		14
CLAIRE	P6	I	P	P	P					
ROBERT	E	E	E6	E	E			6		12
NEAL	E	I	P	P	P					12
DANIEL	I	I	I	I	I	2	12	8	5	4

NOTES:
J:NATHAN- CLAPPED TO THE SOUNDS AND COUNTED THE CLAPS

L:STUART- CLAPPED FOR 10 AND 13 AND COUNTED THE CLAPS

NUMBERS ENTERED IN THE TABLE ARE THE STATED INCORRECT RESPONSES
I= IMMEDIATE RESPONSE M=MOVE T=TOUCH P=POINT E=EYE/HEAD MOVEMENTS

RESULTS OF COUNTING TESTS 1 and 2
(Silent Counting or Counting Aloud)

	MOVEABLES					FIXED				
Nos USED										
ORDER	4	9	7	15	11	2	10	6	14	12
TEACHER A:										
KATE	I	S	S	S	S	I	S	S	S	S
MICHELLE	I	S	I	S14	S	I	S	S	S	S
HELEN	I	S7	S	S13	S9	I	S9	S5	S	S10
PETER	S	S	S	S	S	I	S9	S	S	S11
MATTHEW	C	C	C	C	C	I	C	C	C	C11
DAVID	I	S	S	S	S	I	S	S	S	S
TEACHER H:										
LYNDSAY	C	C8	C	C16	C9	I	C	C	C	C
DANIELLE	C	C	C	C	C	C	C	C	C	C13
JOANNE	C	C8	C6	C17	C12	I	C9	C5	C13	C10
BEN	I	C	C	C16	C	I	C	C	C	C
NATHAN	C	C8	C	C12	C	I	C	C	C12	C11
CRAIG	C	C	C	C	C	I	C11	C	C	C11
TEACHER J:										
PETER	C	C	C	C14	C	I	S7	S	S	S
DAVID	C	C	C	C	C	I	S9	I3	S15	S11
NATHAN	I	S10	S6	S	S	I	S	S	S16	S
ELIZABETH	C	C	C	C16	C	I	C	C	C	C
EMMA	I	S	S	S	S	I	S	S	S	I11
JAMES	S	S	S	S17	S	I	S11	S	S	S
TEACHER L:										
DAVID	S	S	S	S	S	I	S9	S	S	S
CAROLINE	I	S	S	S16	S10	C	C	C	S	C10
EMMA	C	C	C	C	C	I	C9	C	C4	C3
STUART	I	S	S	S14	S12	I	C9	C	C	C13
NATHAN	S	S	S	C8	C12	S	S9	S	C8	C18
MATTHEW	I	S	S	S	S	I	S	S	S	S11
TEACHER M:										
LEANNE	I	S8	S	S	S3	I	S	S	S	S
CLARE	C	C	C	C	C	C	C	C	C15	C
CLAIRE	I	C	C	S14	C	I	C11	C5	C13	C
ROBERT	C	C	C	C17	C	I	C	C	C13	C11
NEAL	S	C	S	C16	C	I	C	C	C	C11
DANIEL	I	S	S	S16	S	I	S	S5	S	S

NOTES:
NUMBERS ENTERED IN THE TABLE ARE THE STATED INCORRECT RESPONSES
I= IMMEDIATE RESPONSE S= SILENT C= COUNT ALOUD

RESULTS OF COUNTING TESTS 3 and 4
(Silent Counting or Counting Aloud)

	VISUAL					AURAL				
Nos USED										
ORDER	5	3	7	9	8	3	8	5	10	13
TEACHER A:										
KATE	S	I	S	S	S	S	S	S4	S	S11
MICHELLE	S	I	S6	S	S	C	S	C	S	S
HELEN	C	I	C	C	C	S	S5	S4	S12	S9
PETER	S	I	I	S	S	S	S	S6	S	S12
MATTHEW	C	I	C	C	C	S5	S10	S3	S13	S8
DAVID	I	I	I	C	I	S	C	S	C	S12
TEACHER H:										
LYNDSAY	C	I	C	C	C	C	C	C	C	C12
DANIELLE	S	I	S8	S8	S	C	C	C	C	C
JOANNE	C4	I	C	C	C6	C	C	C	C	C14
BEN	C	I	C	C	C	C	C	C	C	C12
NATHAN	I4	I	S6	S8	S7	C	C	S4	C	C
CRAIG	S	I	S	S	S	C	C	C	C	C
TEACHER J										
PETER	I	I	I	S	S	C	C	C	C	C
DAVID	I4	I	I6	I7	I9	C	C	C	C	C
NATHAN	I	I	S	S	S	C4	C10	C6	C8	C9
ELIZABETH	S	I	S	S	S	C	S	S	C	C
EMMA	I	I	S	C	C	C	S	S	S	S
JAMES	S	I	S	S	S	S	S	S	S	S
TEACHER L:										
DAVID	S	I	S	S	S	C	C	C	C11	C14
CAROLINE	C	C	C	C	C7	C	C	C	C	C
EMMA	C4	I	C	C2	C6	C	S5	C	C	C
STUART	S	I	S	S	C	C	C	C	C	C15
NATHAN	S	S	S	S	S	C	C	C	S12	S18
MATTHEW	S	I	S	S8	S	S	S	S	S12	S15
TEACHER M:										
LEANNE	S	I	S	C	S	C	C7	S	C	C
CLARE	S	I	S	S7	S	C	C10	C7	C	S14
CLAIRE	C6	I	C	C	C	C	C	C	C	C
ROBERT	C	C	C6	C	C	C	C6	C	C	C12
NEAL	S	I	C	C	C	C	C	C	C	C12
DANIEL	I	I	I	I	I	S2	S12	S8	S5	S4

NOTES:
NUMBERS ENTERED IN THE TABLE ARE THE STATED INCORRECT RESPONSES
I= IMMEDIATE RESPONSE S= SILENT C= COUNT ALOUD

RESULTS OF TEST 5: NUMERAL RECOGNITION

	0-10	11-20
TEACHER A:		
KATE	CORRECT	CORRECT
MICHELLE	CORRECT	CORRECT
HELEN	CORRECT	12 14 16 17 18 19
PETER	CORRECT	15
MATTHEW	CORRECT	17 18 19
DAVID	CORRECT	17
TEACHER H:		
LYNDSAY	6 9	ALL ERRORS
DANIELLE	CORRECT	CORRECT
JOANNE	8	11 12 13 14 15 16 18 20
BEN	CORRECT	12 20
NATHAN	CORRECT	11 13 15 16 17 20
CRAIG	CORRECT	CORRECT
TEACHER J:		
PETER	CORRECT	CORRECT
DAVID	CORRECT	12 13 15 16 17 18 19
NATHAN	CORRECT	CORRECT
ELIZ.	CORRECT	12 13 14 15 16 17 19
EMMA	CORRECT	CORRECT
JAMES	CORRECT	CORRECT
TEACHER L:		
DAVID	CORRECT	CORRECT
CAROLINE	8	ALL ERRORS
EMMA	0 4 6 7 8 9 10	ALL ERRORS
STUART	CORRECT	11
NATHAN	0 4 6	ALL ERRORS
MATTHEW	CORRECT	17 19
TEACHER M:		
LEANNE	6	17 19 20
CLARE	CORRECT	12 19 20
CLAIRE	0 9 10	12 13 14 15 16 17 18 19 20
ROBERT	CORRECT	12 14 18 20
NEAL	CORRECT	12 13 15 18 20
DANIEL	CORRECT	12 13 14 15 17 18 20

NOTES:

NUMBERS NOT ATTEMPTED, OR INCORRECTLY STATED, ARE ENTERED IN THE TABLE.

THE NUMERALS ORDER WAS:
3 0 2 4 1 5 7 6 9 10 8
AND
11 13 15 12 14 18 16 20 19 17

PAUSES MADE DURING TEST 5 (NUMERAL RECOGNITION)

NUMERAL	PAUSES	CORRECT AFTER PAUSE
0	3	0
1	0	
2	1	1
3	0	
4	2	0
5	2	2
6	2	0
7	1	0
8	2	1
9	5	2
10	3	1
11	4	0
12	16	8
13	11	4
14	5	1
15	11	5
16	8	3
17	9	2
18	6	0
19	9	2
20	9	0

The number of distinct pauses and subsequent correct responses after the pause are shown in the table.

RESULTS OF TEST 6: NUMERAL ORDER

	0-10	11-20
TEACHER A:		
KATE	CORRECT	CORRECT
MICHELLE	CORRECT	CORRECT
HELEN	CORRECT	CORRECT
PETER	CORRECT	11-14 17-20 16 15
MATTHEW	CORRECT	CORRECT
DAVID	CORRECT	CORRECT
TEACHER H:		
LYNDSAY	CORRECT	12-14 17-20 16 11 15
DANIELLE	CORRECT	CORRECT
JOANNE	CORRECT	COULD NOT DO
BEN	1-10 0	COULD NOT DO
NATHAN	CORRECT	COULD NOT DO
CRAIG	CORRECT	11 12 15 14 13 19 17 18 16 20
TEACHER J:		
PETER	CORRECT	CORRECT
DAVID	0-7 9 8 10	13 15 18 11 12 17 20 16 14 19
NATHAN	CORRECT	CORRECT
ELIZ.	1-10 0	CORRECT
EMMA	CORRECT	CORRECT
JAMES	CORRECT	CORRECT
TEACHER L:		
DAVID	CORRECT	CORRECT
CAROLINE	1-10 0	COULD NOT DO
EMMA	1 2 COULD NOT DO	COULD NOT DO
STUART	1-10	CORRECT
NATHAN	1-5 7 10 8 9 0 6	COULD NOT DO
MATTHEW	CORRECT	CORRECT
TEACHER M:		
LEANNE	CORRECT	COULD NOT DO
CLARE	1-10 0	11-13 18 17 19 15 14 20 16
CLAIRE	1-8 10 9 0	COULD NOT DO
ROBERT	CORRECT	11-13 15 19 16 14 18 17 20
NEAL	CORRECT	15 18 20 17 11 16 14 12 19 13
DANIEL	CORRECT	COULD NOT DO

NOTES:
THE ORDER IN WHICH CHILDREN PLACED THE CARDS IS SHOWN IN THE TABLE.

H.CRAIG VERBALLY COUNTED 11-20 CORRECTLY, POINTING TO HIS INCORRECT SEQUENCE.
J.DAVID VERBALLY COUNTED 0-10 CORRECTLY, POINTING TO HIS INCORRECT SEQUENCE.
M.CLAIRE VERBALLY COUNTED 0-11 CORRECTLY, POINTING TO HER INCORRECT SEQUENCE.
L.STUART HID THE CARD SHOWING 0, HE SAT ON IT.
H.DANIELLE PICKED 'RANDOM' NUMBERS FROM A SPREAD AND PLACED THEM IN SEQUENCE, LEAVING GAPS FOR MISSING NUMBERS

RESULTS OF TEST 7: MATCHING NUMERAL TO QUANTITY

	Q4		Q7			Q9			Q12			Q15		
TEACHER A:														
KATE	1	I	2	I		3	E		5	I		4	T	
MICHELLE	3	I	2	E		1	E		4	E		5	I	
HELEN	1	I	2	E		3	T		4	T		5	I	
PETER	1	E	5	I		2	E		4	T		3	T	
MATTHEW	1	I	4	IT		2	T		5	I		3	T	
DAVID	2	I	5	I		3	T		4	T		1	T	
TEACHER H														
LYNDSAY	2	T	1	T	N9	3	T	N15	5	I	N7	4	I	N12
DANIELLE	1	I	2	E		3	T		5	V		4	V	
JOANNE	2	P	3	P		1	P		5	T		4	T	
BEN	2	I	4	T		3	T		1	T		5	I	
NATHAN	5	I	3	T		1	T		4	T		2	T	
CRAIG	1	I	2	T		4	T		3	T		5	I	
TEACHER J:														
PETER	3	I	1	T		4	T		5	T	N15	2	I	N12
DAVID	5	T	4	T		2	T		3	T		1	T	
NATHAN	1	I	3	E		2	E		4	T		5	T	
ELIZ.	1	T	2	T		4	T		5	T		3	T	
EMMA	3	I	1	T		4	T		5	I		2	T	
JAMES	1	I	5	I		3	T		2	T		4	T	
TEACHER L:														
DAVID	1	I	4	I		5	I		2	I		3	I	
CAROLINE	2	I	5	T		4	T		3	T	N15	1	T	N12
EMMA	NOT DONE		NOT DONE			NOT DONE			NOT DONE			NOT DONE		
STUART	1	I	4	T		2	T		3	T		5	I	
NATHAN	1	T	2	T	N9	3	T	N7	NOT DONE			NOT DONE		
MATTHEW	1	T	3	I		2	I		4	I		5	I	
TEACHER M:														
LEANNE	1	I	2	T		3	T		4	T		5	T	
CLARE	1	I	2	I		3	T		4	T		5	T	
CLAIRE	2	IT	4	IT		5	IT		1	IT		3	IT	
ROBERT	2	T	1	T		5	T		4	T		3	T	
NEAL	1	T	2	T		4	T		3	T		5	T	
DANIEL	1	T	2	T		3	T		T	T	N15	5	T	N12

NOTES:
N=NUMERAL CARD
Q=QUANTITY CARD
I=IMMEDIATE T=TOUCH E=EYE/HEAD MOVEMENT P=POINT V=VISUAL MATCH

THE NUMBERS IN THE TABLE SHOW THE ORDER IN WHICH NUMERAL CARDS WERE PLACED ON QUANTITY CARDS

APPENDIX 7

ANALYSIS OF COUNTING TESTS

Raw test scores	Page 51
ZSCORES	Page 52
Percentaged scores	Page 53
ANOVA on percentaged scores	Page 54

RAW TEST SCORES FOR THE 30 TARGET CHILDREN ON SEVEN COUNTING TESTS

RESULTS BY 'MICROTAB'

TEACHER A = ROWS 1-6
TEACHER H = ROWS 7-12
TEACHER J = ROWS 13-18
TEACHER L = ROWS 19-24
TEACHER M = ROWS 25-30

.PRINT C1-C7 RAW SCORES

ROW	TEST1	TEST2	TEST3	TEST4	TEST5	TEST6	TEST7
1	5	5	5	3	21	21	5
2	4	5	4	5	21	21	5
3	2	2	5	1	15	21	5
4	5	3	5	3	20	19	5
5	5	4	5	0	18	21	5
6	5	5	5	4	20	21	5
7	2	5	5	4	9	18	1
8	5	4	3	5	21	21	5
9	1	1	3	4	12	11	5
10	4	5	5	4	19	10	5
11	3	3	1	4	15	11	5
12	5	3	5	5	21	17	5
13	4	4	5	5	21	21	3
14	5	1	1	5	14	8	5
15	3	4	5	0	21	21	5
16	4	5	5	5	14	10	5
17	5	4	5	5	21	21	5
18	4	4	5	5	21	21	5
19	5	4	5	3	21	21	5
20	3	4	4	5	10	10	3
21	5	2	2	4	4	2	0
22	3	3	5	4	20	20	5
23	3	3	5	3	8	5	1
24	5	4	4	3	19	21	5
25	3	5	5	4	17	11	5
26	5	4	4	2	18	13	5
27	4	2	4	5	9	8	5
28	4	3	4	3	17	14	5
29	4	4	5	4	16	11	5
30	4	4	5	0	14	11	3

STANDARDIZED ZSCORES FOR THE 30 TARGET CHILDREN

RESULTS BY 'MICROTAB'

TEACHER A = ROWS 1-6
TEACHER H = ROWS 7-12
TEACHER J = ROWS 13-18
TEACHER L = ROWS 19-24
TEACHER M = ROWS 25-30

.PRINT C1-C7 ZSCORES

ROW	TEST 1	TEST 2	TEST 3	TEST 4	TEST 5	TEST 6	TEST 7
1	0.94105	1.17900	0.59381	-0.36123	0.92694	0.95505	0.45188
2	0.03036	1.17900	-0.25449	0.91369	0.92694	0.95505	0.45188
3	-1.79103	-1.40905	0.59381	-1.63614	-0.32757	0.95505	0.45188
4	0.94105	-0.54637	0.59381	-0.36123	0.71786	0.61598	0.45188
5	0.94105	0.31632	0.59381	-2.27360	0.29969	0.95505	0.45188
6	0.94105	1.17900	0.59381	0.27623	0.71786	0.95505	0.45188
7	-1.79103	1.17900	0.59381	0.27623	-1.58207	0.44644	-2.40209
8	0.94105	0.31632	-1.10278	0.91369	0.92694	0.95505	0.45188
9	-2.70172	-2.27174	-1.10278	0.27623	-0.95482	-0.74030	0.45188
10	0.03036	1.17900	0.59381	0.27623	0.50877	-0.90984	0.45188
11	-0.88034	-0.54637	-2.79937	0.27623	-0.32757	-0.74030	0.45188
12	0.94105	-0.54637	0.59381	0.91369	0.92694	0.27691	0.45188
13	0.03036	0.31632	0.59381	0.91369	0.92694	0.95505	-0.97510
14	0.94105	-2.27174	-2.79937	0.91369	-0.53665	-1.24891	0.45188
15	-0.88034	0.31632	0.59381	-2.27360	0.92694	0.95505	0.45188
16	0.03036	1.17900	0.59381	0.91369	-0.53665	-0.90984	0.45188
17	0.94105	0.31632	0.59381	0.91369	0.92694	0.95505	0.45188
18	0.03036	0.31632	0.59381	0.91369	0.92694	0.95505	0.45188
19	0.94105	0.31632	0.59381	-0.36123	0.92694	0.95505	0.45188
20	-0.88034	0.31632	-0.25449	0.91369	-1.37299	-0.90984	-0.97510
21	0.94105	-1.40905	-1.95108	0.27623	-2.62750	-2.26612	-3.11558
22	-0.88034	-0.54637	0.59381	0.27623	0.71786	0.78551	0.45188
23	-0.88034	-0.54637	0.59381	-0.36123	-1.79116	-1.75752	-2.40209
24	0.94105	0.31632	-0.25449	-0.36123	0.50877	0.95505	0.45188
25	-0.88034	1.17900	0.59381	0.27623	0.09060	-0.74030	0.45188
26	0.94105	0.31632	-0.25449	-0.99868	0.29969	-0.40123	0.45188
27	0.03036	-1.40905	-0.25449	0.91369	-1.58207	-1.24891	0.45188
28	0.03036	-0.54637	-0.25449	-0.36123	0.09060	-0.23170	0.45188
29	0.03036	0.31632	0.59381	0.27623	-0.11848	-0.74030	0.45188
30	0.03036	0.31632	0.59381	-2.27360	-0.53665	-0.74030	-0.97510

PERCENTAGED TEST SCORES FOR THE 30 TARGET CHILDREN

TEACHER A = ROWS 1-6
TEACHER H = ROWS 7-12
TEACHER J = ROWS 13-18
TEACHER L = ROWS 19-24
TEACHER M = ROWS 25-30

ROW	TEST1	TEST2	TEST3	TEST4	TEST5	TEST6	TEST7
1	100	100	100	60	100	100	100
2	80	100	80	100	100	100	100
3	40	40	100	20	71.4	100	100
4	100	60	100	60	95.2	90.5	100
5	100	80	100	0	85.7	100	100
6	100	100	100	80	95.2	100	100
7	40	100	100	80	42.9	85.7	20
8	100	80	60	100	100	100	100
9	20	20	60	80	57.1	52.4	100
10	80	100	100	80	90.5	47.6	100
11	60	60	20	80	71.4	52.4	100
12	100	60	100	100	100	81	100
13	80	80	100	100	100	100	60
14	100	20	20	100	66.7	38.1	100
15	60	80	100	0	100	100	100
16	80	100	100	100	66.7	47.6	100
17	100	80	100	100	100	100	100
18	80	80	100	100	100	100	100
19	100	80	100	60	100	100	100
20	60	80	80	100	47.6	47.6	60
21	100	40	40	80	19	9.5	0
22	60	60	100	80	95.2	95.2	100
23	60	60	100	60	38.1	23.8	20
24	100	80	80	60	90.5	100	100
25	60	100	100	80	81	52.4	100
26	100	80	80	40	85.7	62	100
27	80	40	80	100	42.9	38	100
28	80	60	80	60	81	66.7	100
29	80	80	100	80	76	52.4	100
30	80	80	100	0	66.7	52.4	60

TWO-WAY ANALYSIS OF VARIANCE ON PERCENTAGED SCORES OF TARGET CHILDREN

RESULTS BY 'MICROTAB'

.PRINT C1-C35 PERCENTAGED SCORES FOR ANOVA

ROW	A1	A2	A3	A4	A5	A6	A7	H1
1	100	100	100	60	100.0000	100.0000	100	40
2	80	100	80	100	100.0000	100.0000	100	100
3	40	40	100	20	71.4286	100.0000	100	20
4	100	60	100	60	95.2381	90.4762	100	80
5	100	80	100	0	85.7143	100.0000	100	60
6	100	100	100	80	95.2381	100.0000	100	100

ROW	H2	H3	H4	H5	H6	H7	J1	J2
1	100	100	80	42.8571	85.7143	20	80	80
2	80	60	100	100.0000	100.0000	100	100	20
3	20	60	80	57.1429	52.3810	100	60	80
4	100	100	80	90.4762	47.6190	100	80	100
5	60	20	80	71.4286	52.3810	100	100	80
6	60	100	100	100.0000	80.9524	100	80	80

ROW	J3	J4	J5	J6	J7	L1	L2	L3
1	100	100	100.0000	100.0000	60	100	80	100
2	20	100	66.6667	38.0952	100	60	80	80
3	100	0	100.0000	100.0000	100	100	40	40
4	100	100	66.6667	47.6190	100	60	60	100
5	100	100	100.0000	100.0000	100	60	60	100
6	100	100	100.0000	100.0000	100	100	80	80

ROW	L4	L5	L6	L7	M1	M2	M3	M4
1	60	100.0000	100.0000	100	60	100	100	80
2	100	47.6190	47.6190	60	100	80	80	40
3	80	19.0476	9.5238	0	80	40	80	100
4	80	95.2381	95.2381	100	80	60	80	60
5	60	38.0952	23.8095	20	80	80	100	80
6	60	90.4762	100.0000	100	80	80	100	0

ROW	M5	M6	M7
1	80.95238	52.38095	100
2	85.71429	61.90476	100
3	42.85714	38.09524	100
4	80.95238	66.66667	100
5	76.19048	52.38095	100
6	66.66667	52.38095	60

.ANOVA 2 VARS, 0 REP, 5 LEVELS A, 7 LEVELS B, C1-C35

SOURCE	SOS	DF	MS
A	7689.70947	4	1922.42737
B	7463.62646	6	1243.93774
A B	16012.543	24	667.18929
ERROR	111245.8	175	635.69031
TOTAL	142411.68	209	

APPENDIX 8

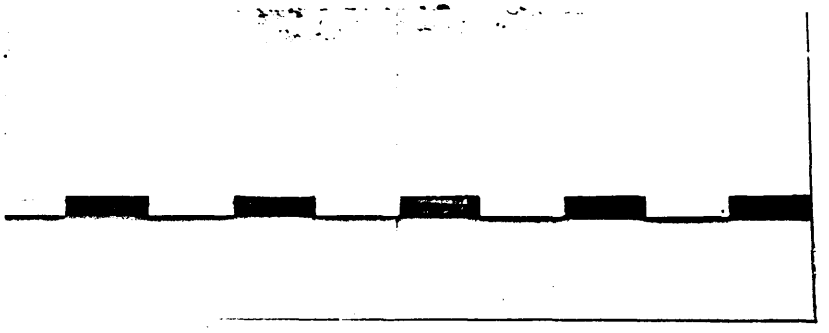
COUNTING MATERIALS FOR SCHOOL BASED INSET ACTIVITIES

Desi-stick	Page 57
Holding numbers	Page 58
Walking numbers	Page 59
Floor numbers and action cards	Page 60
Washing line numbers	Page 61
Flap Jacks	Page 62
Numeral cards	Page 63

DESI-STICK

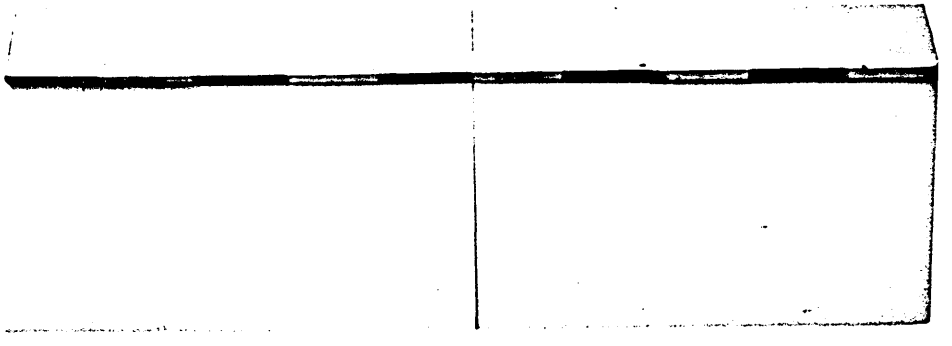
A Desi-stick was developed from an original idea by Des Wilson, Principal Lecturer, Mathematics Education Centre, Sheffield City Polytechnic. It is a metre long length of 25x25mm wood alternately painted black and white in ten centimetre sections on three of its sides. The fourth side is left blank. There are no numerals on the stick.

PLATE 1: Desi-stick



View of sectioned side of Desi-stick

PLATE 2: Desi-stick



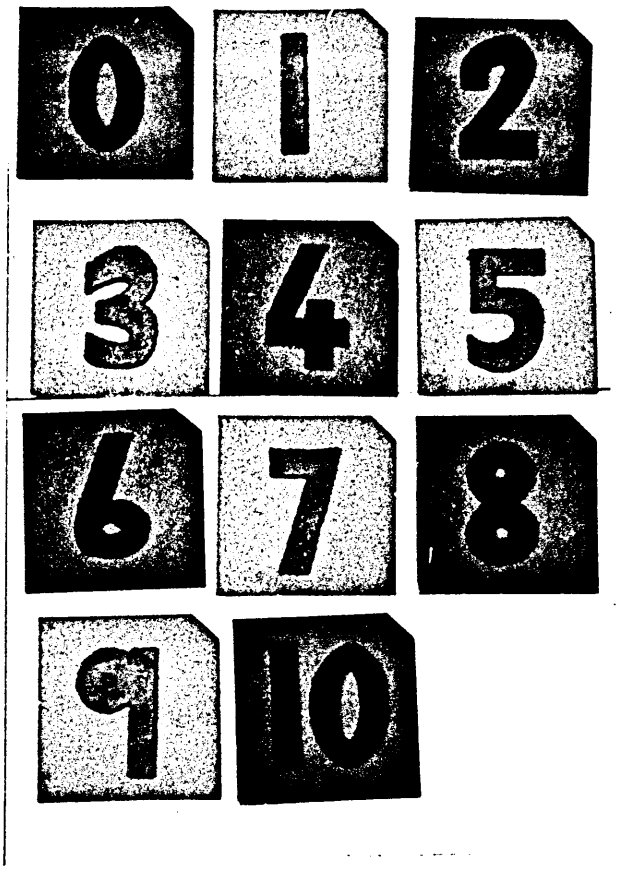
View of blank side side of Desi-stick

HOLDING NUMBERS

Holding numbers are A4 pieces of card which have numerals written on them. The numeral is written on the back and front of the card so that children can see which numeral they are holding by looking at the back of the card. This saves them having to look over the top of the card and getting an inverted perspective of numerals. A corner is removed from the top right hand corner of each card to enable children to hold them the 'right way up'.

The range of numerals used is discretionary. It is usually in the 0-5 range gradually increasing to 0-20.

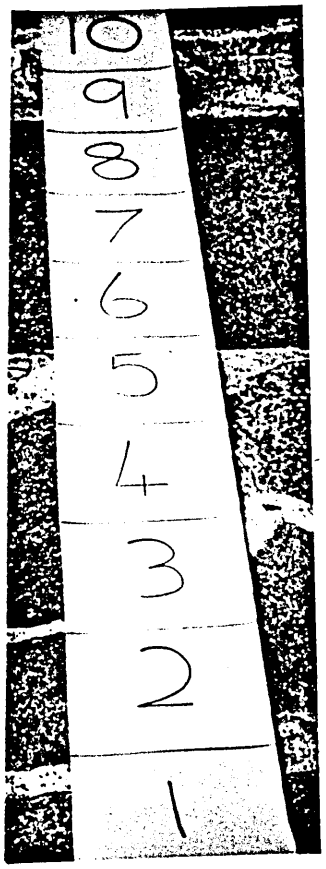
PLATE 3: Holding Numbers



WALKING NUMBERS

Walking Numbers are numerals written on 300mm wide lengths of vinyl sheet. It is a large floor number track with numerals in the range 1-10 or 1-20 on which children walk forwards and backwards. The tracks can begin at zero if desired.

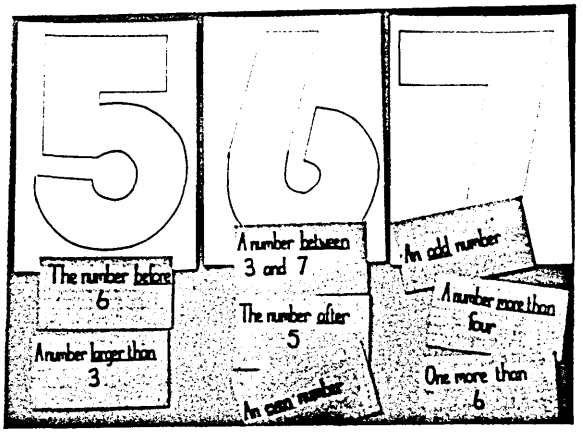
PLATE 4: Walking Numbers



FLOOR NUMBERS and ACTION CARDS

Floor Numbers are A4 sized pieces of card with numerals written on them. They are used in conjuction with Action Cards. Action Cards are smaller rectangles of card on which are written mathematical statements or questions, they are placed on appropriate Floor Numbers. Numbers are represented by words, numerals or quantity on the Action Cards. Some of the Action Cards have only one appropriate matching Floor Number whilst others have several. This suggests to the children that there is not always one 'correct answer' to questions.

PLATE 5: Floor Numbers and Action Cards

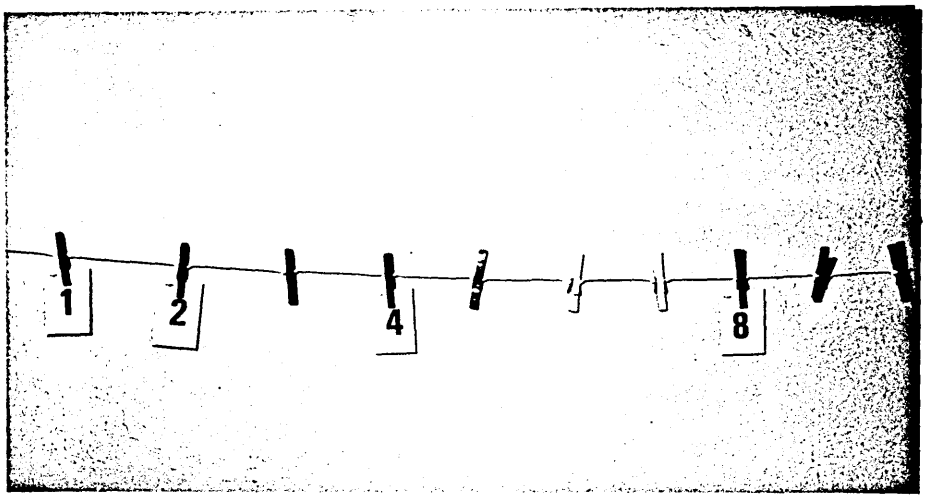


WASHING LINE NUMBERS

Washing Line Numbers are pieces of card showing numerals which are fastened to a clothes line with pegs. The numeral cards have a different colour on each side so that they can be reversed to highlight number patterns when pegged out on the washing line.

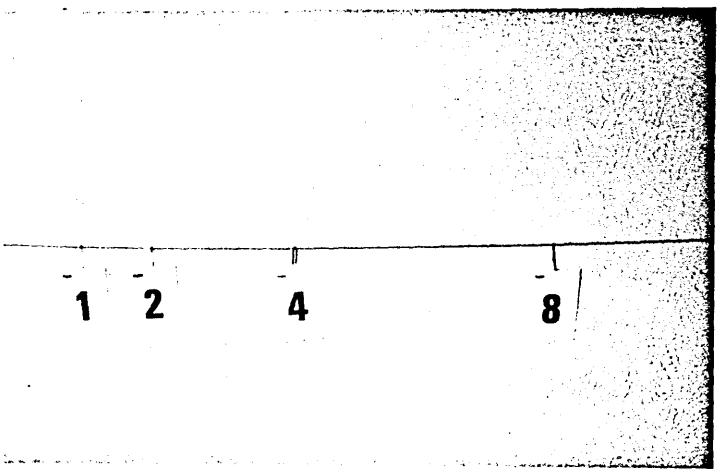
There are two types of clothes line, that which has pegs permanently attached and that which has no pegs attached.

PLATE 6: Washing Line Numbers



Washing Line Numbers with pegs attached

PLATE 7: Washing Line Numbers

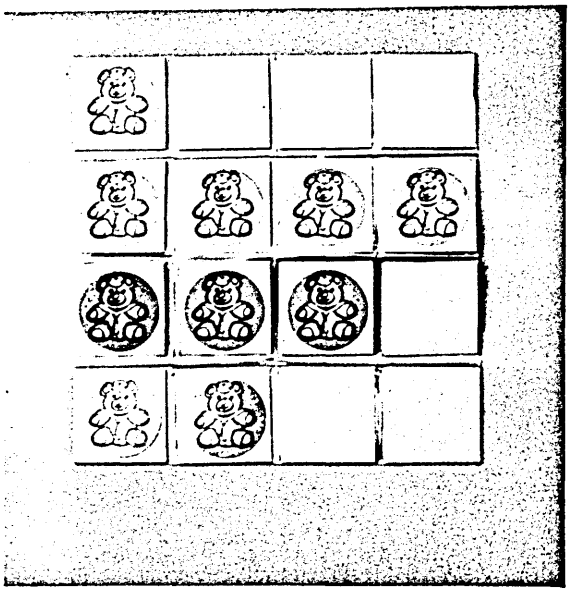


Washing Line Numbers without pegs attached

FLAP JACKS

A Flap Jack (Thomas and Wilson 1983) is a square consisting of sixteen smaller squares trapped between two layers of transparent sticky back plastic. Some of the squares have pictures on them. The Flap Jack can be folded in various ways in order to show different quantities to the children.

PLATE 8: Flap Jack



A 'Ten' Flap Jack

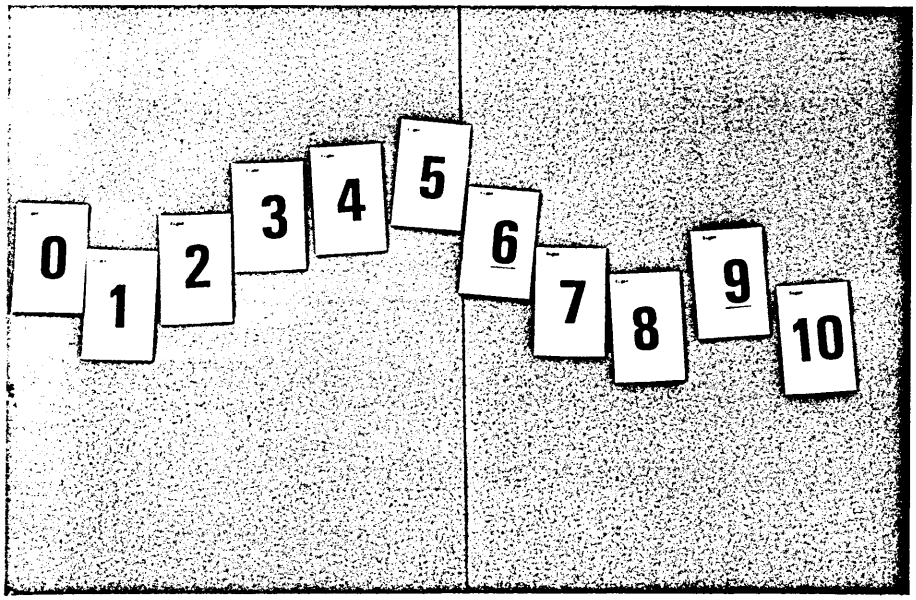
References

Thomas,A. and Wilson,D. (1983) "Flap Jacks" Booklet 1 in the series "Maths Activity in the Early Years" Eigen Publications

NUMERAL CARDS

Numeral cards are 50mm x 70mm pieces of card on which are written numerals, usually in the 0-10 or 0-20 range. Each child has a set of cards to ensure that everyone takes part in the activities.

PLATE 9: Numeral Cards



APPENDIX 9

DESCRIPTION OF ACTIVE WORD PROBLEMS

Action Problems	Page 66
Static Problems	Page 68
References	Page 69

KING and QUEEN PROBLEMS

King and Queen problems involve children in acting out word problems using stand-up cardboard King and Queen figures with a basket of red and green apples (plastic counters). The figures are based on the characters appearing in "Lets Go Maths" produced by Granada Television which was watched by the children. They are enlarged photocopies of the pictures found in the Teacher's Notes which accompany the programme. The outlines were coloured in and stuck onto card. A wooden block was fastened behind the figures to make them stand upright. The word problems included categories referred to in research by Riley, Greeno and Heller (1983) and Carpenter and Moser (1982). The Problem categories included those which involved some movement or ACTION to obtain a solution and those which were STATIC. The numerical results were of secondary importance to the ability of the child being able to interpret the word problem by acting out what was happening using the models. Some of the problems had a range of possible solutions, whilst others had but one answer. It was important to allow discussion between the children as what was happening in the problem. The types of problems were:

ACTION PROBLEMS

Change (Result unknown)

1 The King had 3 apples
The Queen gave him 5 more apples
How many apples does the King have now?

2 The King had 8 apples
He gave 5 apples to the Queen
How many apples does the King have now?

Change (Change unknown)

3 The King had 3 apples
The Queen gave him some more
Now the King has 8 apples
How many apples did the Queen give him?

4 The King had 8 apples
He gave some to the Queen
Now the King has 3 apples
How many apples did he give the Queen

Change (Start unknown)

5 The King had some apples
The Queen gave him 5 more
Now the King has 8 apples
How many apples did the King start with?

6 The King had some apples
He gave 5 apples to the Queen
Now the King has 3 apples
How many apples did the King start with?

Equalising

7 The King had 3 apples
The Queen had 8 apples
What could the King do to have as many the Queen?

8 The King has 8 apples
The Queen has 3 apples
What could the King do to have as many as the Queen?

9 The King has 8 apples
The Queen has 4 apples
What could the King do to have as many as the Queen?

10 The King has 4 apples
The Queen has 8 apples
What could the King do to have as many as the Queen?

Inequalising

11 The King has 4 apples
The Queen has 4 apples
What could the King do to have more than the Queen?

12 The King has 4 apples
The Queen has 4 apples
What could the King do to have less than the Queen?

STATIC PROBLEMS

Combine (combine value unknown)

13 The King has 3 apples
The Queen has 5 apples
How many do they have altogether?

Combine (subset unknown)

14 The King and the Queen have 8 apples altogether
The King has 3 apples
How many has the Queen?

Compare (difference unknown)

15 The King has 8 apples
The Queen has 5 apples
How many more has the King?

16 The King has 8 apples
The Queen has 5 apples
How many less has the Queen

Compare (compared quantity unknown)

17 The King has 3 apples
The Queen has 5 more apples than the King
How many has the Queen?

18 The King has 8 apples
The Queen has 3 less apples than the King
How many has the Queen?

Compare (referent unknown)

19 The King has 8 apples
He has 5 more than the Queen
How many has the Queen?

20 The King has 3 apples
He has 5 apples less than the Queen
How many has the Queen?

Part-part whole (subsets)

21 The King has 8 apples
3 apples are red, the others are green
How many green apples has he?

22 The King has 3 green apples and 4 red apples.
How many apples has he altogether?

References

Carpenter,T.P. and Moser,J.M. (1982) "The Development of Addition and Subtraction Problem-Solving Skills" in Carpenter,T.P., Moser,J.M. and Romberg,T.A. (Eds) "Addition and Subtraction: A Cognitive Perspective" Lawrence Erlbaum Associates:New Jersey

Riley,M.S., Greeno,J.G. and Heller,J.I. (1983) "Development of Children's Problem-Solving Ability in Arithmetic" in Ginsburg,H.P. (Ed) "The Development of Mathematical Thinking" Academic Press:New York