A study of the benefits of reflection by journal writing in mathematical learning and attitudes in the primary school

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A STUDY OF
THE BENEFITS OF REFLECTION BY JOURNAL WRITING
IN MATHEMATICAL LEARNING AND ATTITUDES
IN THE PRIMARY SCHOOL

BY

SALLY EDMONDS B.A. (Ed.)

A Thesis Submitted in Partial Fulfilment of the Requirements
for the Award of
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USE OF THESIS

The Use of Thesis statement is not included in this version of the thesis.
ABSTRACT

This descriptive study examines journal writing for the purpose of identifying aspects of children's mathematical reflective ability. It was hypothesised that encouragement to engage with the process of mathematics by reflective writing would reveal and assist learning, and give children a vehicle through which they could express their attitudes about the mathematics they were learning.

The aim of this study was to find answers to the following question:

How does the keeping of a mathematical journal reveal children's understandings of the mathematics they are learning?

Other questions related to the study were:

• What evidence is there from the journals about children's attitudes to the mathematics they are learning?

• How do the journals reveal evidence of development in the children's understanding of the mathematics they are learning, and their ability to monitor their learning?

A class of 27 year six children was chosen for the study. Each child wrote a journal entry following each mathematics lesson for four weeks. After two weeks and after four weeks they also wrote about their reactions to the journal writing. Other data were collected through observational notes and the class teacher's written response to the use of the journals in her class.
The most interesting aspect of this study that became evident was the awareness of these children of the usefulness of the journals. Even in the early stages of the study, the children were conscious that something was happening for them in the course of journal writing. They were becoming aware of the value of reflecting on what they had been doing and they were enjoying their freedom to comment about their lessons resulting in a positive response to journal writing from all children. Evidence from the children's journals and their journal appraisals showed the growing, conscious engagement with their mathematical learning and, for some children, a realisation that there was more to mathematics than facts and procedures to be memorised. These children were beginning to be intrinsically motivated by the mathematics itself, rather than by how many calculations they had got correct. The journals also proved to be a valuable method of communication between the children and their teacher, especially for those children who did not talk much during class. As well as traditional testing, the teacher had gained another way in which to ascertain what the children understood (or misunderstood) about their mathematics and to be able to respond to it immediately.

There was also an interesting outcome of the combination of "hands-on" activities, discussion and written reflection. This series of events provided the largest amount of written evidence of mathematical understanding.

The use of journals for mathematics reflection grew from a shaky acceptance at the beginning of the research study to something which the children really enjoyed and could use to discover things about themselves as mathematicians and to communicate with their teacher. This arose from a small activity, which took very little teacher preparation, and occupied five minutes at the end of each lesson.
I certify that this thesis does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any institution of higher education; and that to the best of my knowledge and belief it does not contain any material previously published or written by another person except where due reference is made in the text.

SALLY EDMONDS

14 July 1993
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CHAPTER I

BACKGROUND, STATEMENT OF THE PROBLEM, AND PURPOSE OF THE STUDY

1.0 Background

Current accounts of mathematics teaching in schools suggest that mathematics is often considered by children to consist only of information given to them by teachers which they must remember and practise. Success is viewed as getting all calculations correct, and failure as getting them wrong. (Bickmore-Brand, 1990; Cobb, 1991; Kloosterman, 1991; Siegal and Borasi, 1992; Southwell, 1993). Pengelly (1991, p. 77) suggests that "over the ages mathematicians have struggled to restore thought and meaning to mathematics instruction, to provide alternatives to the formal and ritualistic mode of learning in most mathematics classrooms." There is also a perception that the mathematics learnt at school is only for school and it will be of little value in the outside world. Bickmore-Brand (1990) refers to the work of Pengelly who states "by and large, they (children) grow up believing quite firmly that school mathematics is something done in school that has no relationship with the rest of the world, and is certainly not anything needed for the rest of their lives" (p. 3).

1.1 The Problem

If this is the situation, then children spend much time either performing calculations and getting them correct or performing calculations and getting them wrong. In the classroom context this is the measure of "success". Thus children who make few errors have a positive attitude to, and believe they are good at, mathematics. However, they may have limited understanding of the ideas behind the calculations. Alternatively, children who make many errors have a negative attitude to mathematics and feel that they cannot learn anything at all about the subject.
The changing face of the workplace demands flexibility which often requires both literacy and numeracy (Wickert, 1989). It seems appropriate, then, to be seeking a way to make mathematics a more meaningful and relevant activity for as many children as possible, and in so doing perhaps encourage an intrinsic motivation towards the subject.

For many years there has been research about the connection between thought and language (Vygotsky, 1962; Bruner, 1968), and subsequently the use of writing in learning (Fennell, 1991; Swinson, 1992). Recently there also has been much investigation into the role of metacognition in learning (Rowe, 1988; Mildren, Ellerton and Stephens, 1990; English-Halford, 1992; Martin, 1992; Herrington, Wong and Kershaw, 1993). Metacognition involves being aware of cognitive processes and the control and regulation of them as well as the ability to consciously reflect on one's own actions. This can facilitate the understanding of the content being learned. Attitudes are also a part of metacognition and play an important part in mathematical learning.

1.2 Purpose of the Study

One possible way of investigating how children might become more involved with mathematics and how they might see it in a broader, more positive way is to look at their metacognitive powers. Through the reflection on what they are doing in mathematics the children may become more metacognitively aware and so improve their understanding of and attitudes towards mathematics.

Journal writing following mathematics lessons provides a medium through which time-lapse snapshots can be taken of children's thinking. Through these snapshots their mathematical understanding, its development and monitoring may become apparent as well as their attitudes towards mathematics.
The purpose of this study, then, is to examine how journal writing might facilitate children's understanding of mathematics and help them to develop more positive attitudes towards mathematics.

1.3 **Research Questions**

The purpose of the study was reformulated into research questions. The major research question was:

How does the keeping of a mathematical journal reveal and assist children's understanding of the mathematics they are learning?

Other related questions were:

- What evidence is there in the journals about children's attitudes to the mathematics they are learning?

- How do the journals reveal evidence of development in the children's understanding of the mathematics they are learning?

1.4 **The Significance of the Study**

The significance of the study is twofold:

1. It has demonstrated the possibility that a brief journal writing period at the completion of mathematics lessons may be beneficial to primary school aged children's mathematical learning and attitudes.

2. The study has shown the possibility that journals provide a means of communicating with children on an individual basis and thus enable prompt, effective feedback on their mathematical learning.
CHAPTER II

LITERATURE REVIEW

2.0 Introduction

In this review evidence from recent research into the role of language as a tool for reflection about mathematics are considered from a number of perspectives. Initially the research which has guided the way for a new approach to mathematics in school will be examined. Mathematics is increasingly being considered as a meaning making process and thus there is a need to encourage students to seek more understanding in their mathematics learning. The specific problems that arise in mathematics learning will also be examined.

Secondly, it is important to look at the roles of metacognition and reflection in mathematical learning, as it is through these that children can pursue more meaningful mathematics.

Thirdly, the research which looks at the way in which language is connected to thought and the making of meaning will be examined. The literature about the benefits of journal writing will be investigated because writing provides a concrete text in which to look at metacognitive behaviour and learning.

2.1 Mathematics Learning

For the purposes of this study, mathematics learning is looked at from the perspective of "school mathematics" and the specific problems in mathematics learning will also be considered.

2.1.1 "School" Mathematics

Mathematics in school in which children "do sums" judge their progress upon the number of ticks they get and often do not really understand what they are doing is
sometimes referred to as "school" mathematics. Children may regard it as only being useful in school (to please the teacher) and of no use in the real world. There is much evidence in the literature which reports this claim.

Pengelly (1991, p. 77) suggests that "it is time to move the attention away from the formal language (of mathematics) and make the ideas the focus of learning experiences." This stance on mathematics is supported in A National Statement on Mathematics for Australian Schools (1990) which states that "if you calculate without reflecting on what you have been doing, why you have been doing it, and what you have found, then your activity is likely to lose its sense of purpose and direction" (p. 17) and "mathematics can no longer be regarded as a 'chalk and talk' subject from the perspective of the teacher or as a 'textbook, pencil and paper' subject from the perspective of the students" (p. 22). English-Halford (1992, p. 125) also states that "in the past, school mathematics programs have tended to emphasise content at the expense of processes, resulting in fragmented and frequently meaningless learning." Southwell (1993) reports a survey in which the respondents (teachers and students) generally held the belief "that mathematics learnt in schools is mainly facts and procedures to be memorised" (p. 24). She adds "the emphasis on remembering the right answer is particularly alarming when there is so much emphasis in modern curricula on processes" (p. 294).

Pengelly (1991, p. 87) asserts that "our challenge as teachers is to find out what mathematics is really about. Only then can we establish an environment where children learn to think and work in a mathematical way." There are many more supporters for the teaching of mathematics to be more meaningful and to take place in a meaningful context in schools. Cobb (1991) expresses the view that there is, in many schools, what he calls a "folk belief" about mathematics, which is that mathematics is a set of rules which children apply to get the right answer. This folk belief about mathematics divorces "school" mathematics from the real world where much meaning is constructed. Kloosterman (1991) also states that many children
believe mathematics is only memorising and following rules. Siegal and Borasi (1992) sum up this trend towards more meaningful mathematics:

Within the field of mathematics education, the last decade has witnessed ongoing discussions.... These conversations have most recently found expression in several influential reports which represent the thinking of many people interested and involved in mathematics education (NCTM, 1989, 1991; NRS, 1989, 1990). The contributors to these reports are unanimous in criticizing the current emphasis in school mathematics on the acquisition of facts and technical skills. This kind of mathematics expertise, they argue, is no longer appropriate in our highly technological and ever changing world. Factual knowledge and proficiency with specific algorithms has become less important than the ability to pose and solve novel problems and continually learn new things both independently and in collaboration with others. (NCTM, 1989; NCR, 1989). (p. 21)

Beliefs about mathematics are influenced by the communities in which schools operate. Praeger (1993) suggests that the general community is not aware of the roles played by mathematics in the present world, and that many people who use mathematics are not recognised for doing so, and their job descriptions do not include mathematics. This distancing of the community from mathematics leads to many people being disinterested in or fearful of it. They have a perception of mathematics as being a collection of facts to be remembered rather than something which is meaningful. Praeger (1993) states that:

What we seem to be facing in the community is a lack of recognition of what constitutes mathematical reasoning and skills. This leads to a lack of confidence in many individuals' ability with mathematics, and often, rather sadly, to an antipathy towards mathematics. (p. 51)

In a survey of Australian adult literacy, (including numeracy), Wickert (1989) says that "one of the most disturbing results of this survey was that it revealed that approximately 70 per cent of the sample were unable to get at the ideas behind what they were reading" (p. 49). She adds that "literacy skills needed outside school are less structured. They involve a greater variety of materials and settings and are often used to accomplish practical tasks" (p. 37). Children need to be exposed to useful, meaningful mathematics at school so that they are more prepared for the real world. Wickert's research suggests that "poor experiences at school seem to be more
associated with poor performance on the quantitative scale" (p. 43). Wickert states "the restructuring of the Australian workplace and of the awards determining the pay and conditions of workers is about creating a flexible workforce.... To re-train, workers need to be confident about their literacy and numeracy skills" (p. 37).

The state of unappealing, unthinking mathematics is also recognised by the following researchers: Garofalo (1992), Bastow (1989), Moore (1991), Ross (1990) and Bradley (1990). To ensure more meaningful and relevant "school" mathematics, it is important to provide a means by which this quest can be attempted. The appropriate use of language plays a major role in the construction of meaning. Language can also play an important part in solving the problems of mathematics learning. This is discussed in the next section.

2.1.2 Problems in Mathematics Learning and Teaching

There is much evidence in the literature which demonstrates the unique problems which can arise in learning mathematics.

When children learn mathematics they can have problems with lexical ambiguities. Children have a wide variety of words in their vocabularies which may have different meanings in the mathematics classroom. Durkin and Shire (1991) provide many examples of this problem. For example, "we can use spatial words when describing arithmetical operations, such as 'adding up' (where the numbers are arranged vertically and the answer is required at the bottom)" (p. 76). Difficulties such as this occur throughout primary education and can even be seen in the secondary school. Durkin and Shire quote Bell's example "given 'Tottenham Hotspur was in 8th place and has moved up 3 places, where is it now?', many pupils responded 11th." (p. 76). Many children make errors when asked to rank items moving up and down a ladder or table. Research reported on by De Corte and Verschaffel (in Durkin & Shire, 1991) also finds that the mistakes children make with word problems are very often
due to "an insufficient mastery of the semantic schemes underlying the problems" (p. 129).

The research by Graeber and Baker (1991) examines the misconceptions that arise in mathematics. They refer to the work of Bell, Fischbein and Greer, (1984), Brown, (1981) and Greer, (1987), and say that "many people have misconceptions about multiplication and division that lead to difficulty in solving word problems" (p. 25). They also report that changing misconceptions is very difficult. These misbeliefs often begin with instruction that is based in experience with whole numbers such as: "multiplication always makes larger" (p. 36). Through written reflection, and the communication it establishes with children, the teacher can respond to these misconceptions at an early stage.

Garofalo (1992) quotes work from Kouba et al., 1988 and Sherrill, 1983 who have documented that children have difficulties solving mathematics word problems. Students can also have a range of strategies for trying to solve word problems. These strategies "put little emphasis on developing an understanding of problem quantities, relationships, and conditions" (p.37), and much emphasis on juggling number operations, inappropriately, but at times resulting in a correct answer. Students may not know any other way to approach work problems and will use these methods because they are easy and are seen as what the teacher wants. These beliefs then lead to difficulties with word problems.

Threlfall (1993) points out that "a child who is experiencing difficulties with calculation can usually be helped, but to do so it is helpful to discover what he/she is doing right as well as what he/she is doing wrong, in order to avoid giving assistance that is not needed" (p. 42). He reported a case where a child understood how to do division but was limited in the range of numbers he could manage because of poor tables. In this case he was assisted at the point of error rather than being given more instruction in how to perform the algorithm.
Through a meaning-based approach to mathematics teachers have an opportunity to help children to reflect upon what they are learning, to ascertain the things that they know and where any problems they have may lie. It is important that children learn to monitor their learning and seek help when they first encounter trouble. It is also necessary for teachers to communicate with children to ascertain these needs. Perhaps this is possible through the writing of mathematics journals.

2.2 Metacognition and Mathematics Learning

Through metacognition children can become more aware of themselves as learners and therefore more effective as learners. Metacognition is discussed in this section together with the benefits of reflection in the process of becoming more metacognitively aware.

2.2.1 Metacognition

Vygotsky (1987, p. 248) talks of the dynamism of verbal thought and states that sometimes "as Dostoevsky put it, a thought 'will not enter words'" (p. 249). He further explains that "verbal expressions cannot emerge fully formed, but must develop gradually. This complex process of transition from meaning to sound must itself be developed and perfected" (p. 222). These complexities of creating understanding through thought and words underlie the need for children to be supported in their quest to make sense of their worlds, and metacognition has a role in this quest.

Metacognition, as a term, is "used in discussions about control, regulation and awareness of an individual's cognitive processes" (Mildren, Ellerton, and Stephens, 1990, p. 356). Mildren et al. base their interpretation of metacognition upon the work of Flavell, who described it as having two parts—metacognitive knowledge and metacognitive experiences. "Metacognitive knowledge can be further sub-divided into the areas of person, task and strategy variables" (p. 356).
Mildren et al. (1990) also state:

It is also useful to recognise the distinction between children's reflective knowledge about their thinking processes, the self-regulatory procedures which involve on-line monitoring of performance and task related decision making, and students' beliefs and affective factors which impact on performance. (p. 356)

and add:

These various psychological and affective experiences can be described as metacognitive. They are metacognitive because they help to shape some cognitive endeavour in which the individual is engaged. ... This feature of Flavell's taxonomy is of great importance for it allows affective responses such as positive and negative attitudes and acquired beliefs to be seen as metacognitive in nature in that they work to constrain or promote mathematical activity and consequently mathematical thinking. (p. 357)

Herrington, Wong and Kershaw (1993) refer to Meichenbaum's definition of metacognition:

Metacognition refers to what a person knows about his or her cognitions (i.e. consciously aware of the processes and being able to relate them in some way) and to the ability to control these cognitions (e.g. planning cognitive activities, choosing among alternatives, monitoring and changing activities) (p. 186).

They add that "in learning mathematics the abilities to plan, monitor and evaluate one's learning and thinking are important strategies that can be developed in the classroom" (p. 186).

Martin (1992, p. 3) also suggests that metacognition is important in the classroom. He states that "the subject of metacognition is critically important" and is more than "thinking about thinking". He further states:

It is what we as teachers do with our students in mathematics ... when we say "How did you get that answer?" When a good teacher asks that question, that teacher is forcing that learner to go beyond the moment. It is a very important teaching strategy to help the students reflect on what they have done cognitively so that next time they encounter that kind of problem, they will be aware of what they can draw upon from their mental "tool kit". (p. 3)
According to Martin "metacognition is also a process by which one monitors oneself during the act of thinking. By forcing the learner to stand back from the process ... we make it much more reflectively cognitive than it might be by simply doing the task alone" (p. 3).

Rowe (1988, p. 228) states that "metacognition assists not only in the organised recall of previously acquired knowledge and experience, in learning and problem solving, but also in maintaining and strengthening of concentration, motivation, interest and self-esteem." She adds that "when students are not aware of how they go about tasks, they cannot formalise or generalise the skills they have acquired" (p. 226). Thus children do not transfer their knowledge from their lessons to other contexts or to the real world.

English-Halford (1992) reviewing cognitive studies in mathematics education refers to the "continued interest in student's use of metacognitive or executive processes" (p. 118). Wong is quoted by English-Halford as suggesting that "learners also need to apply higher level cognitive skills such as metacognitive strategies. These generalised strategies include those of planning, monitoring, controlling, selecting and evaluating cognitive activities" (p. 118).

2.2.2 Reflection

Reflection enables children to take a second look at what they have been exposed to, or what they have done during lessons. It is during this time that children can search for the value and meaning of what has been presented or experienced and where it might be used in the future. Reflection is a pathway to metacognition which is described by Rowe (1988, p. 227) as "those aspects of cognitive functioning which involve one's knowledge of certain cognitive processes, and one's ability to monitor, direct and control them, including knowing when and where to apply certain skills, rules or knowledge."
To make sense of the world all experiences are contemplated and organised into useful sets of knowledge which are then available for use at an appropriate later time. Southwell (1993,) suggests this when she compares the physical reflection of a mirror creating a parallel picture of the world to that of people creating a mental picture, also encompassing their feelings, of what has happened during an experience of everyday life. Southwell (p. 290) states that "the essential idea of reflection is returning in thought to some event of thought in which we have been involved and re-evaluating it in the light of the present situation". Southwell (p. 291) uses the model in Figure 1, adapted from Boud (1985), to explain reflection as a learning process:

![Figure 1  Southwell's model of reflection.](image)

A National Statement on Mathematics for Australian Schools (1990) supports reflection as a tool for mathematical learning stating that "learning requires action on the part of the learner and reflection about those actions and experiences", also adding that "If you calculate without reflecting on what you have been doing, why you have been doing it, and what you have found, then your activity is likely to lose its sense of purpose and direction" (p. 17). Southwell (1983) agrees with the statement referring to the very personal nature of reflection and the fact that it is consciously purposeful. "No-one else can reflect for a learner though another person may help that learner to reflect" (p. 291).
Camboume (1989), Baker and Baker (1990) and Pengelly (1991) all support the view that reflection for learning is beneficial. Wong (1992) further supports this view when he states "students must understand that reflection is necessary to make sense", and through this to "become effective learners: able to monitor when they understand or not" (p. 328). Pimm (1991, p. 20) takes this point further stating that externalizing thought through spoken or written language can provide greater access to one's own thoughts, (for oneself as well as for others), thus aiding the crucial process of reflection, without which learning rarely takes place.

According to Southwell (1993) the issue is "for the teacher to so promote reflection so that the limited and limiting beliefs can be changed and performance in mathematics enhanced" (p. 298). Wong and Herrington (1992) further support this view stating that "writing and concept mapping appear to be two very important techniques that students can use to elaborate, organise and reflect on their mathematical knowledge with the possibility that such knowledge will be better understood" (p.138).

It appears that children may sometimes learn other than that which is proposed by the teacher. Wong and Herrington (1992) state that "given the same mathematical experiences students often construct different meanings from their teacher's exposition and the activities they engage in" (p.130). Freebody (1991) argues that covert learning is imparted during teaching as part of the communicative interactions of the classroom. Teachers need to know whether this implicit learning from the discourse constructed between them and the children carries any misconceptions. Reeves (1991) suggests that mathematics is a social construction by the means of discussion between teacher and children during lessons. This construction of meaning, or discourse, can carry implicit meaning. Through reflection there is an opportunity for the implicit learning to be made clear to the teacher who is thus able to assist with children's misunderstandings or to extend their learning.
Freudenthal (1991, p. 107) is concerned that children do not reflect enough in school. When talking of a child in his research he states that "he accepts all he learns without any criticism, and in scholastic matters he never asks the question 'why?' " Freudenthal also adds "although later on I noted splendid examples of reflection in his diary, most of them related to mathematical experience though none of them to school mathematics" (p. 107). Freudenthal suggests that the school curriculum could match the child's algorithmic expertise but that there was little incentive for him to reflect on his experiences and thus relate his mathematics to reality. Reflection creates a meaningful atmosphere in which mathematics may become purposeful and interesting.

As discussed above in "School Mathematics (2.1.1), much mathematics for children is "doing sums" with little allowance made for the use of language--writing, reading and discussion. It would seem that reflection will improve mathematics learning, and journal writing is a method through which reflection can be cultivated. The role of language in mathematics learning is explored in the following section.

2.3 The Role of Language in Learning

In this section the connection between language and learning will be explored, followed by the use of language for learning mathematics. The use of journal writing as a means to facilitate learning, and to provide a means to look at the way in which children can learn, is then examined.

2.3.1 Language and Learning

The creating of meaning involves thought and the use of language. The research which demonstrates the role of language in learning comes from cognitive psychologists such as Bruner and Vygotsky who confirm the connection between thought and language. Vygotsky (1962) indicates this when he states that "a concept is formed not through the interplay of associations, but through an intellectual operation in which all the elementary mental functions participate in a specific
He adds that "this operation is guided by the use of words as a means of actively centering attention, of abstracting certain traits, synthesizing them, and symbolizing them by a sign" (p. 81). Vygotsky points out that:

The relation of thought to word is not a thing but a process, a continual movement back and forth from thought to word and from word to thought... Thought is not merely expressed in words; it comes into existence through them. Every thought tends to connect something with something else, to establish a relation between things. Every thought moves, grows and develops, fulfills a function, solves a problem. (p. 218)

He adds "intellectual growth involves an increasing capacity to say to oneself and to others, by means of words or symbols, what one had done or what one will do. This self-accounting or self-consciousness permits a transition from merely orderly behaviour to logical behaviour, so called" (p. 5).

Bruner (1968) extends this to include the use of language in teaching as a way to exchange ideas, and also "the instrument that the learner can then use himself in bringing order into the environment" (p. 6). Bringing order to the environment is particularly important in the mathematical context because "the simplicity of a mathematics curriculum rests upon the history and development of mathematics itself" (p. 71) and this can present problems for its learners if they do not seek to make that meaning for themselves.

McGinley and Kamberelis (1992) conducted a study investigating the use of writing by ten-year-old children to function socially and politically. They state that "we came to realize that we had initially underestimated the rich and diverse ways that children use writing to understand and transform themselves, their social relationships and their worlds... We were struck by the simplicity of the program that helped the children connect writing with their development as individuals" (p. 337). Morris (1989), in discussing the use of writing to learn, states:

The research work of Britton (1975), Douglas Barnes (1971), and Nancy Martin (1976) suggests that writing can be a valuable instrument for learning. Writing can be one way by which learners come to terms with
new information so that it can be accommodated into their present state of knowledge. (p. 164)

Walshe (1981) also recognises the value of writing in order to learn:

A further great advantage [which] has emerged almost by accident: *the Journal is proving to be a powerful medium of learning*, not only of learning to write but of every learning in every subject area. Teachers can therefore adopt a new teaching strategy, suggested by the slogan, 'Journals across the curriculum!' (p. 167)

Writing therefore serves a very useful role in the clarification and organisation of ideas. In the following section the use of language in mathematics learning is explored.

2.3.2 Language and Mathematics Learning

In recent literature there is much evidence that language facilitates mathematics learning. A National Statement on Mathematics (1990, p. 19), for example, states that "mathematics learning is likely to be enhanced by using and developing appropriate language" and that "students should learn to use language as a tool for reflecting on their mathematical experiences and hence their own mathematical learning." The Statement adds further:

*Explaining to oneself, 'putting it into words', can be a powerful means of working through and clarifying ideas. Mathematical concepts are not developed in the absence of mathematical language. Students are likely to develop mathematical ideas more readily when they have clear ways of labelling and talking about their experiences.* (p. 19)

Wong and Herrington (1992), in the course of reporting on research in learning strategies state that "the few studies reviewed here share a common enthusiasm of using writing as a mode of learning" (p. 137).

*Writing is a part of literacy which is intertwined with the other modes of language; talking, listening and reading. Journal writing provides a means of reflecting about mathematics, however, the other modes of language are also very important. Cambourne (1989) looks at these connections in the following way:*
Literacy is a word which describes a whole collection of behaviours, skills, knowledge, processes and attitudes. It has something to do with our ability to use language in our negotiations with the world. Often these negotiations are motivated by our desires to manipulate the world for our own benefit. Reading and writing are two linguistic ways of conducting these negotiations. So are talking, listening, thinking, reflecting, and a host of other behaviours related to cognition and critical thinking. (p. 3)

The importance of language is noted by Reeves (1990) who states that "the use of oral language as an essential component of any mathematics education has been advocated by mathematics educators everywhere" (p. 91). Reeves (1991) also suggests that "the need is to find out just what individuals are thinking by allowing opportunities to express ideas through alternative recording strategies that are more appropriate to the student learner" (p. 310). According to Reeves (1991) children learn to think mathematically when they have 'pictures for the mind' and can contextualise their mathematics. From the social context, through language, children can construct their own mathematical meaning. McIntosh (1988) emphasises the importance of discussion between the child and the teacher and among children. He also mentions the value of recording and reporting in mathematics learning.

Interaction is one of the premises of natural learning theory described by Semple and Stead (1991). Social interaction occurs in all modes of language. Although it has been accepted as valuable in the teaching of language for some time, it is only recently that this information has made its presence felt within the mathematics field (p. 132). Semple and Stead also state that "a transactional approach is fast replacing the transmission approach" and "to this end we actively encourage children to work together in exploring interests, ideas and problems" (p. 132). This interaction is encouraging children to construct their own mathematical meaning. Cobb (1991) supports this view that "students construct mathematical knowledge for themselves" (p. 8).

Semple and Stead (1991, p. 132) describe the theories of Bruner and Vygotsky who confirm that children are active learners who learn particularly well in social interaction with a more experienced person. They call attention to "Vygotsky's
zone of proximal development which refers to the 'gap' that exists for an individual between what she is capable of doing alone and what she can achieve with help from someone more knowledgeable or skilled than herself" (p. 132).

Fennell (1991) states that "to write as one learns mathematics seems natural" (p. 40). He supports the view that thinking occurs when children write, and has suggested that problems should be written by primary school children. Fennell's project of letter writing about mathematics between student teachers and primary students seemed "to indicate that elementary students do benefit from letter writing experiences. The students felt that their progress in writing and mathematics improved as a result of the project" (p. 49).

Siegal and Borasi (1992) in a study which examined the role of reading in mathematics instruction found that "'reading to learn' experiences built around some basic concepts may contribute to a better understanding of the mathematic content" (p. 31).

Leino (1988) considers that "the only efficient way a pupil has of learning mathematics is to meaningfully reconstruct the basic concepts of mathematics" (p. 41). He adds that teachers can provide many things that will foster mathematics learning but they are not able to "give the pupils ready-made concepts for mathematics" (p. 41). Children need to use language to construct their own concepts. Mathematical information can be inefficiently learnt, in a manner which seems to be easy, although this mechanical approach to learning "usually becomes boring to teachers as well as pupils" (p. 42).

A study of relevant literature by Swinson (1992) found that there was much support for writing activities during mathematics lessons. Swinson reviewed literature which suggested that writing enhanced children's learning, allowing them to reflect upon their experiences, and enabling them to investigate, clarify and extend their thinking. There was also some literature reported by Swinson which supported writing as beneficial for the teacher and student relationship. He also presents the research
Bell and Bell, Miller, Kanyon, Borasi and Rose, Ellerton and others who all support the importance of writing as an aid to mathematical learning. Swinson states that:

The value of writing activities has been recognised by curriculum designers as an effective aid in teaching mathematics. This is demonstrated by the many current mathematics curriculum documents which contain statements suggesting that teachers should use writing activities in the mathematics programs. (p. 40)

These documents include those of the Queensland Department of Education, 1987; the Ministry of Education, Victoria, 1988; the New South Wales Department of Education, 1988; and the Australian Education Council, 1990.

If writing is to be useful in leading children along the pathway to thinking, useful, enjoyable mathematics, then it may also be beneficial as an aid to help them with the particular problems that mathematics learning has.

2.3.3 Journal Writing

Mildren, Ellerton and Stephens (1990) used journals to examine children's metacognitive behaviour. They refer to Ellerton's studies (1986, 1988) which suggest:

"that writing allowed children to express their own ideas, and that children's perceptions of mathematics could be explored through an examination of the mathematical problems and letters which they had written about the mathematics they were doing. Such an argument recognises the important influence that mathematical experiences, beliefs and feelings can have on the development of mathematical skills and understandings. (p. 358)

Another argument put forward by Mildren et al. is that writing is review orientated and therefore it demands that the learner articulates what she or he has learnt. They quote the work of Bell and Bell who "see a parallel between the composing process and the problem process, because both activities require critical decision making about what is known and what is unknown and how to apply knowledge to arrive at some conclusion" (P.358).

Gordon and Macinnis (1993) also used journals to investigate children's mathematical learning because writing clarifies thinking and it reveals the thinking and
reasoning used by children. "Thus, students and teachers both discover and clarify meaning" (p. 37). Gordon and Macinnis refer to the work of the theorists and researchers such as Vygotsky, Halliday and Britton to support their research. They also state that:

Through the journals, we as teachers began to understand better what was happening in the classroom by "listening" and observing in a more focused way. As a result of this watching and listening, teachers and students became a community of learners. Just as Santa (1988) suggested, we could fine tune our craft by analyzing the performance of the students more closely, observing and reflecting on the teaching; thus we could make informed instructional decisions on the basis of the observations. (p. 37)

Waywood (1992) found that journal writing "enhances students' mathematics learning -- but the processes engendered by journal use happen over years" (p. 40). He also states in Journal Writing and Learning Mathematics (c. 1992) that:

At the heart of the process is the use of prose to review, reflection, and integrate concepts....Mathematics is richer than a collection of algorithms, and writing must be a contender for a way of accessing this richness....The key difference between a workbook and a journal is the degree of involvement required of the student. (p. 3)

Journal writing to assist learning has also been reported by Reid, Stillman, Rainer and Ayling in "Writing in Schools" (1989). Reid found "the writing encompassed reflection, preparation, evaluation, long-range planning and most important for me, lots of time spent theorising, sorting things out I'd read....The more I wrote, the more I became involved" (p.117). Stillman suggests that "journals provide a way for people to talk to themselves on paper....We should write because there's always something to discover, and the privacy of a journal provides the best place for finding out" (p. 121). Rainer says of her journal "it has helped me find solutions to so many potentially shattering experiences, that now just touching the book gives me a sense of comfort, security, and well-being" (p. 122). Ayling refers to Holt's description of writing:

Good writing, writing that is a true extension and expression of ourselves, helps us to know ourselves, to make ourselves know to others, and to
know them. It gives us a way of getting hold of our thoughts and feelings, so that we may think about them, learn from them, build on them. It can help us break out of the closed-in quality of our own experience, and share that experience with others. (p.132)

Ayling suggests that this sort of writing can be achieved through the use of journals "at the same time they learn, by simply using language, since language generates ideas as well as representing them" (p. 132). Journal writing therefore may have a role to play in the learning of mathematics.

2.4 Conclusion

Given the current research about the state of "school" mathematics, the role of language in learning, the benefits of being metacognitively aware and the unique problems associated with mathematics learning, this literature indicates that it is appropriate to extend research into the benefits of more meaningful mathematics. Journal writing provides a means by which to take time-lapse snapshots of metacognition through which children's learning may be investigated. The writing of the journals could help children to extend their knowledge of themselves as learners and so facilitate a better understanding of, and attitude towards, mathematics.
CHAPTER III

METHODOLOGY

3.0 Introduction

The literature review suggests that it is important to look at reflective processes of children learning mathematics. This is borne out by Cockcroft (1982) in his report "Mathematics Counts" which inquired into the teaching of mathematics in primary and secondary schools in England and Wales. He states:

The primary mathematics curriculum should enrich children’s aesthetic and linguistic experience, provide them with the means of exploring their environment and develop their powers of logical thought, in addition to equipping them with the numerical skills which will be a powerful tool for later work and study. (p. 84).

Cockcroft further states:

The overall aim must be to develop in children an attitude to mathematics and an awareness of its power to communicate and explain which will result in mathematics being used wherever it can illuminate or make more precise an argument or enable the results of an investigation to be presented in a way which will assist clarity and understanding. (p. 96)

This view is also shared by A National Statement on Mathematics for Australian Schools (1990) which claims that "a challenge for education is to develop the attitudes and knowledge which will enable students to handle familiar tasks easily and efficiently and also to deal with new or unfamiliar tasks" (p. 12).

The practice of using a journal provides a method of examining children's reflective processes and their understanding of the mathematics they are learning.

3.1 Research Questions

The aim of this study was to seek answers to the following question:

How does the keeping of a mathematical journal on a regular basis reveal and assist children's understanding of the mathematics they are learning?
Other questions related to this study were:

1. What evidence is there in the journals about children's attitudes to the mathematics they are learning?

2. How do the journals reveal evidence of development in the children's understanding of the mathematics they are learning and their ability to monitor their own learning?

3.2 Descriptive Paradigm

Because this study is looking at understanding and reflection by children, a descriptive design was deemed the most appropriate. It is evident that, when studying children's achievements in mathematics, there is a need to investigate more than the quantitative part of the subject, and also to look to the feelings, conscious awareness and processes involved in learning mathematics. Miles and Huberman (1984) support the use of qualitative research stating that "qualitative data are attractive. They are a source of well-grounded, rich description and explanation of processes occurring in local contexts" (p. 21).

LeCompte and Goetz (1982) also say that "by admitting into the research frame the subjective experiences of both participants and investigator, ethnography may provide a depth of understanding lacking in other approaches to investigation" (p. 32). They further support this view stating that "the naturalistic setting in which ethnography normally is conducted both facilitates on-the-spot analysis of causes and processes and precludes precise control of so-called extraneous factors. The interrelationship among such factors generally constitutes the focus of ethnographic concern" (p. 33). Morgan and Smircich (1980) state researchers "must move to investigate from within the subject of study and employ research techniques appropriate to that task" (p. 498).

As the intention of this study is to investigate how journal writing might facilitate metacognition, reflection and better understanding of mathematical processes and
concepts, it was deemed that the most appropriate research methodology to provide such information would be qualitative description.

3.3 Qualitative Methodology

Qualitative or naturalistic inquiry involves a form of processing which is similar to that for ethnographic inquiry. Ethnography demands the collection of data on many variables for an extended period of time, in a naturalistic setting, where the researcher has not controlled for any variables (Gay, 1990, p. 209).

Gay also states:

The unit of observation in an ethnographic study in education is typically a classroom, or even a school. Rather than, for example, studying the teaching-learning process by collecting test scores before and after some treatment, the ethnographer works more inductively by observing many aspects of the learning environment and attempting to identify factors associated with effective and ineffective environments. The rationale behind the use of ethnography is the research-based belief that behaviour is significantly influenced by the environment in which it occurs. (p. 210)

It is because of the importance of the environment that every effort was made to provide "thick description" of the research setting.

As soon as the data starts to be collected in ethnographic research, formal analysis begins, and is nearly finished when the data collection is complete. In this study some categories were selected at the commencement of the research to assist in the classification of the journal writing, which classifications would in turn answer the research questions. As the study progressed more categories were employed when the need became apparent.

3.4 Sources of Data

In this section the five sources of data used for the research study are described.
3.4.1 Reflective Journals

In this study there are several sources of data which serve to complement each other. The most detailed source is the journal entries (which may record understanding and attitude) written at the completion of each mathematics lesson during the research.

The practice of using a journal to reflect about mathematics lessons provides a window through which children’s understanding and attitudes may be viewed. Children actively construct their own meaning from the world around them and in so doing utilise the four modes of language; speaking, listening, reading and writing. These modes are interconnected and writing evolves in conjunction with the other three modes. The concrete text also provides an opportunity for further refinement through conscious reflection and re-reading.

Journals were used by Mildren et al. (1990) to investigate children’s metacognitive ideas. Their choice of this method of looking into children’s learning activity and attitudes was based upon the fact that there is support for writing in mathematics education generally. Mildren et al. quote many sources that support the view that writing promotes an awareness of one’s own thinking.

3.4.2 Researcher’s Observational Notes

Another source of data is the notes taken by the researcher during the lessons, and also during the writing of the journals. These notes recorded details of the children’s attitudes towards mathematics, and their understanding, development and monitoring of their mathematical learning.

3.4.3 Teacher’s Appraisal of Journal Writing

At the completion of the research study the class teacher wrote an appraisal of the journal writing and the children’s reaction to it. This source too provides evidence
of the children's attitudes to mathematics, and their understanding, development and monitoring of their learning.

3.4.4 Children's Written Appraisals of the Journal Writing

Two weeks into the study, and at its completion (see Appendices 9 & 10), the children wrote appraisals of how they thought the journal writing had benefited them. Again this provided evidence with which to address all of the research questions, although it had been expected that most of it would relate to the children's attitudes.

3.4.5 Writing Ability

To gather some evidence about the children's writing ability a sample of approximately one page was collected from them at the start of the study. This was to ascertain whether writing ability would have any impact on the production of the journal entries and therefore influence the evidence which would answer the three research questions.

3.5 Validity

The validity of the study is examined in this section.

3.5.1 External Validity

In order that the findings may be useful for comparability with other similar contexts, "thick data" were collected about the setting, the children, and the methods of data gathering. This will show in what ways the sample would be representative of the larger primary school population.

3.5.2 Internal Validity

Internal validity refers to the objectivity of the findings. Although there is a subjective element to qualitative research it can be minimised by looking at the research questions using different sources of data. This is known as triangulation.
3.5.3 Triangulation

Data were collected for triangulation from: (a) the journal entries, (b) the researcher's observational notes, (c) the teacher's written observations, and (d) the children's written appraisals of the journals after two and four weeks of the study. The teacher was extremely busy, and so her observations were of a very general nature, and the researcher's observational notes on any one child were sparse because of the difficulty in observing 27 children. The children's appraisals contained much information, although most of it was related to attitude. This was to be expected because they were not reporting on individual lessons while writing the appraisals. It may have been better to have focussed on fewer children in order to gather more detailed information. For example, a tape recording of the lessons followed by stimulated recall of what the children thought they were doing during the session would have provided better evidence for validity. However, due to the large burden this would have placed upon the class teacher, it was decided to use the evidence as described above.

3.6 Reliability

To establish reliability of the data which would enable the replication of the classifications of the children's written journal texts, they were categorised twice by the researcher. The first categorisation was during and at the end of the data collection and the second approximately one year later. Inter-rater reliability was also sought when two independent raters coded the same 25 per cent of the journal entries at the same time as the researcher's second categorisation was conducted. The codings were then compared.

3.7 Ethics

Written permission was obtained from the Ministry of Education, the principal of the school and the class teacher to conduct the research. To maintain anonymity, pseudonyms were given to the children and teacher taking part in the study.
CHAPTER IV
DESIGN OF STUDY

4.0 Research Setting and Participants

The research was conducted in a metropolitan primary school. There are approximately 220 children attending the school. Those families with children at the school would most likely work in the city or surroundings, or a nearby university. There were also many children who came from other districts. Their parents work at the large hospital in the vicinity and were able to drop them off on the way to work and also to make use of after school facilities in the area. There are many professional people among the school parents.

The study was carried out in a Year Six class of 27 children. It was the first year the teacher had taught Year Six. She had previously been a Junior Primary Teacher. She used concrete materials and tried to relate mathematics to everyday life; practices which are common in the Junior Primary school. She also encouraged the children to become involved with their schoolwork by requesting substantiation of answers, by facilitating the sharing of the children's ways of thinking about problems, and by allowing time for discussion (see Appendix 4). The researcher was present as a participant observer, introducing the research to the children but then taking the role of a support teacher. It was important to become involved with the children as they worked, in order to demonstrate that they were performing important, useful work that would provide data for the research.

The research was conducted in November and December which is a very busy time in the school year. The class teacher was involved in revising work in all subjects and testing the children in preparation for the end of the year reports. Therefore no new mathematics was being introduced to the children which may have limited any development of understanding being shown in the journal entries. The fact that the
teacher was so busy also restricted the time that she was available to comment on the
journal writing and the children's response to it.

The classroom context reflected the teacher's approach to teaching. The
children were friendly, outgoing, happy and polite and obviously encouraged to be
responsible for their own learning and conduct. On the researcher's first visit to the
class the children conducted themselves in a pleasant manner during the long
conversation with the teacher. One child interrupted the conversation and was quickly
attended to and sent away to contemplate the problem she had posed about her
silkworms. In other words the children had the freedom to be responsible for
themselves and were always encouraged in this direction. The classroom, although
somewhat crowded, contained many teaching aids such as construction equipment,
games and charts. The children always had something that they could be doing.

The class was described by their teacher as being competent at mathematics.
Some children were a little slow to grasp new concepts but there were many who
were eligible for the extension programme provided by the Ministry of Education (see
Appendix 4). Due to the time constraints on the teacher when she was coping with
the end of the school year demands no information about mathematics ability was
available. It would have been interesting to compare the children's journal entries with
their mathematical ability but it was not an essential part of this study which only
sought to describe their reflective powers.

4.1 Baseline Writing Data

A piece of writing was also collected from the children to give an indication
about their ability to express themselves. All children were given several topics on
which to write and a time limit in which to do so. The pieces of writing were assessed
using Diederich's Analytic Procedure for Evaluating Writing Samples (see Appendix
3) and the results were graphed. This procedure was developed by Diederich
following comprehensive gathering of information from teachers and subsequent
analysis by a varied group of people, both academic and non-academic, and was accepted for use by the National Council of Teachers of English, Illinois (Diederich, 1974). For this reason it has been deemed valid for the purposes of this study. Two pieces of writing are usually collected from children and these are then assessed by two people, however, as this study did not seek to assess the writing ability of the children, only one writing sample was assessed as a general indication of the children's competence in this area. The writing in this study was to be used for communicating about mathematics, so it was appropriate that this evaluation procedure gave least emphasis to the mechanics of writing: grammar, sentence structure, punctuation and spelling and emphasised such things as organisation, relevance and development of ideas. The graphed results agreed with the teacher's comments that none of the children were in need of particular remediation. It showed, however, that two children, John (2) and Sam (8) were having some problems with writing but they were still able to convey their messages and feelings clearly (see Appendix 7). The results are apparent in Figure 2.

![Figure 2. Results of writing evaluation based on the results of Diederich's analytical procedure](image)

Thus the children in the class in which the research was carried out had good average writing and mathematics ability. Their teacher encouraged them to be
responsible for their own learning and also allowed much discussion to assist their learning (see Appendix 4).

4.2 Access

After the research had been explained in detail, permission to conduct the research was sought from the Ministry of Education, the school principal, and the class teacher. Written permission was granted by the Ministry of Education and the school.

4.3 Procedure

The children were given a manila folder and loose A4 sheets stapled into weekly sections on which to write daily journal entries immediately following the mathematics lesson prepared by the teacher each day. The journals were written for four weeks, with the exception of two days when the teacher was absent. The advantage of having weekly sections was that it was possible to take the most recent journal entries away and leave the remainder with the children. This allowed the children to take ownership of the journals, become more involved with them and therefore write the best possible responses to their mathematics.

4.4 Pilot Study

At the beginning of November, 1991, journal writing was piloted for a week's duration in a similar school and year level to that of the final study. This trial was undertaken prior to the commencement of the research study in order to ascertain the effectiveness of the responses written as being appropriate to the answering of the research questions. The children were given a booklet containing five sheets for the journal entries and a front cover (see Appendix 1) outlining briefly the purpose of the study and some questions that might be useful in helping the children write. A second page (see Appendix 2) gave examples of children's mathematical journal writing taken from the work of Mildren et al. (1990, p. 362), for example, "There was a problem, we
couldn't work out what area meant". This was necessary because the children had just come back from a camp and there was no opportunity to explain in detail what was required of them. New tasks can take time to be learned and for children to feel comfortable with them, and as this sort of writing was new to them it was felt that the examples would help them get straight on with the task in hand. The examples were not used in the research study. If the study was going to show any development of learning or attitudes, it would be necessary to have a baseline of the children's first entries without any support from the sort of examples given in the pilot study.

It was evident from the pilot that it was not an optimum time to conduct a study seeking to find evidence of the development of mathematical learning as it was a time of revision, testing and reporting. This tended to encourage comments about the mathematics being easy or boring, as shown in the following examples; "I don't understand why people who find it easy can't go on", "I find that the maths the Education Department has set up ... is quite unchallenging" and "very boring because we've done a lot of it". There were few entries referring to what the children had learnt, although examples of this sort of response had been given to the children. (See Appendix II) Perhaps it was easier for the children to express their attitudes rather than what they had learnt, as discussion of what is learnt involves engagement with the mathematics at a different, deeper level. It was felt that the small amount of evidence of mathematical understanding and its development in the journals was compensated for by the children's willingness to write, and to express their feelings about mathematics.

The trial study demonstrated that data containing evidence of learning and its development might be limited in the research study. It was felt that this was due to the time of the year in which the study was conducted. However, due to the time limitations within an Honours programme it was not possible to change the time of the research study to address this problem.
There had been some concern by the researcher that the study may have interrupted the class routine to an unacceptable degree, but the trial journal writing proceeded smoothly despite time restrictions due to other school commitments. This suggested that the longer time period of the research study would probably also be without problems.

4.5 Data Collection Procedure

For the data collection it was decided that it would be of most benefit if the usual mathematics programme continued so that the evidence obtained would give an indication of what was happening in a normal school situation. For this reason, the teacher, Miss A, taught all of the lessons, and the researcher became a participant observer, assisting children where possible while also taking notes about the lesson itself and the children's reactions to the lesson. In order to gain the confidence of the children and their enthusiastic engagement in the study, the researcher needed to interact with the children as much as possible. The children were accustomed to requesting assistance when confronted with problems and it was very difficult to ignore them in order to spend more time observing from a distance. This unfortunately diminished the amount of observational time which was to provide evidence for triangulation, and hence validity of the evidence being collected. However, it was felt that more useful journal writing was being obtained in this way and that good relations were being maintained with the children and their teacher.

It had also been intended to model useful types of writing for the journal to provide a scaffold to help the children construct their entries. However this presented a problem for the researcher because of the way the mathematics programme was organised. The teacher, Miss A, believed that it was best not to plan too far ahead, and thus the researcher did not have access to the lessons that were coming up in order to prepare a suitable model of writing. This would have involved questions related to the content of the lessons. The children enjoyed responding
emotionally to the lessons so that this was not an area which needed modelling. However, it was difficult to demonstrate writing that displayed understanding and monitoring of learning. This was evident in a lesson such as long division. The children spent the lesson doing long division problems and the (non-)understanding of the algorithm was therefore demonstrated in their classwork. If they had made a mistake, they knew in which part of the problem it was, but it was pointless to write the whole algorithm out again in their journals. In this case the children would have needed far longer to fine tune their understanding and write down what was happening at each part of the algorithm, perhaps with the assistance of concrete materials. This was not possible in the short time allocated to the journal writing.

4.6 Introduction of the Journal

A week before the study was due to begin, a visit was made to the class in which the research was to be conducted in order to prepare the children for the commencement of the study. The researcher introduced the journal to the class using notes placed on the blackboard and allowing discussion of each one. Emphasis was placed on the following points:

- that the journals may be of help to the children's learning.
- that it was important to be an independent learner although this may take much effort.
- that the journal would be looked at by the teacher and the researcher, but that it was to be the student's own property.
- that the journal was a way of communicating with the teacher.
- that there was not a lot of time for writing after the lessons, therefore drafting was not necessary and writing errors such as spelling were not the principal focus of the journal.
These points were emphasised because it was important for the children to have a reason for writing and for them to be involved with their own journal. This would ensure the best possible journal entries from them.

The type of information that would be appropriate for the journals was also discussed. This included a description of the mathematics lesson, what the children had learnt during the lesson, whether they had any problems or difficulties and how they felt about the lesson. The following questions were placed on the blackboard for the first lesson:

- What do you know?
- What don't you know?
- Does my work make sense?
- Did I enjoy maths today?

They were not displayed again because some children are restricted by a framework of writing such as this (Mildren et al., 1990). The trial study showed that some children tended to answer each question in a very abrupt way, showing an approach to the task of "getting it over and done with" rather than getting involved at a deeper level. Although examples of journal entries taken from the study of Mildren et al. were given to the children in the trial study, this was necessitated by time constraints and they were not used for the research study because the purpose of the study was to examine how the children would develop journal writing skills.

The children were given constant feedback during the journal writing from the teacher and the researcher, and also by the researcher in the form of written responses in their journals. This helped to take the place of the modelling of the journal writing, and the children were assisted at their own individual level of understanding. The diverse nature of the lessons made it difficult to focus in depth on the revealing of learning. For example, for the children to think about and explain what they had learnt about long division, except for including information about how
they 'did the sum', was not possible in the short allocated journal writing time. Some children were able to write about the mathematics that they had learnt, although for others it did not seem possible. They could perhaps have needed more help to focus on the mathematical ideas and guidance in writing about them, which was not possible with the time allocated for writing. In view of the complexities of the tasks presented to the children, they were therefore encouraged to write what they could at their own level. The teacher and researcher also shared what were deemed as 'good' entries among the whole class. In this context it is considered that everything possible was done to assist the children with their writing.

The children wrote in their journals following each mathematics lesson for four weeks. As already described they were given support about what to write about. They were also encouraged to show their personal 'voice' in their writing so that they would honestly describe their feelings about mathematics. After two days of writing the teacher thought that a time limit of five minutes in which to write would help to focus their attention on the task. This was necessary because of the time limits placed on the mathematics lessons by other activities such as French lessons and a fitness programme.

4.7 A Typical Lesson

A typical lesson began with a whole class interaction on the focus of the lesson. The children were encouraged to work things out for themselves; "I'll give you a couple of minutes to work it out for yourselves," and then given support to continue; "let me give you a clue before you start," and "the pie graph might look like this." As the lesson progressed the children were always encouraged to keep investigating, "play around--how are you going to make the pie into degrees?" and "I know these are easy--but what is really happening? What are you understanding?" After the children had worked on the task for some time, the teacher would share any work that would help children who were having problems with comments such as "a couple of people
had a breakthrough and remembered." The children were free to talk throughout the lesson. Before the journal writing the teacher would conduct a whole class discussion about the focus of the lesson and would draw attention to what sort of writing would be useful in the entries, "what sort of things can we write about?" This was also done by sharing some of the entries that had already been written, for example "I'm going to write down things people have written down. Listen carefully for any ideas." The children were comfortable with this classroom atmosphere and there was little off-task behaviour.

4.8 Student Appraisals of Journal Writing

Halfway through the study the children wrote an appraisal of the journal writing (see Appendix 10). They were told at the beginning of the lesson to think about what the journals had meant to them. The writing of the appraisal was done following the journal writing for that day. Although it was emphasised by the researcher that they should write whatever they wished, the following questions were placed on the blackboard to be used as a guide.

- What do you think of writing journals?
- Did it help you think about the maths you were learning?
- Did you like being able to say what you thought of the mathematics?
- Did it help you to understand something, or realise that you didn't understand?
- Did you enjoy it? If you didn't, was it helpful to your learning?

At the end of the study the children wrote another journal appraisal with the help of the same questions (Appendix 11). They were also asked to comment upon whether they would use journals in a teaching situation themselves (Appendix 12), and how they would use them. It was hoped that this would focus their attention on what they had learnt from the journal writing.
4.9 Teacher Appraisal of Journal Writing

The teacher also wrote an appraisal (see Appendix 5) of the journal writing, and this provided another view of whether the children had benefited from using the journals. The researcher took observational notes where possible during the course of the study, although the effectiveness of this was diminished by involvement with the children on a one-to-one basis during the lessons.

Thus, the evidence to ascertain the benefits of journal writing arises out of the journals themselves, the children's appraisals after 2 and 4 weeks, the teacher's appraisal of the use of journals and the researcher's observational notes.
CHAPTER V

DATA ANALYSIS

5.0 Introduction

In this and following chapters the conventions below have been employed for the sake of brevity and ease of reading:

- the children's spelling and punctuation errors have been left as they were written.
- each child has been allocated a pseudonym, for example, Joan.

The data were all gathered during November and December, 1991. Data were not collected on two days, Monday 18th and Wednesday 20th November 1991 as the class teacher was on sick leave. On these days, the lack of data on the tables has been denoted by "a" (absent). This affected the "half-way" point of the study which was taken to be half-way through the number of days on which the journals were written.

5.1 Categories

Children's journal writing for mathematical learning needs to be carefully guided (Waywood 1992, p. 36). For this reason, and also to guide the initial sorting of the data, five initial categories for data analysis were devised and assigned a coding. These categories and codings were:

- Writing that revealed understanding ................................................. UR
- Writing that revealed attitude to lesson as:
  - Positive ........................................................... A+
  - Neutral ............................................................ A
  - Negative ......................................................... A-
- Writing that revealed monitoring of learning ................................. ML
Following are examples of these categories that were evident in the data:

**UR** "If the triangles base was three and height was three the rectangle would turn into a square" (Chris)

**A+** "OK I confess my journal is part of me it really helped me along in my maths" (Fiona)

**A** "It was OK I suppose" (Sonia)

**A-** "I hate maths, I really do" (Fiona)

**ML** "I still don't know how to look at degrease in a straight line"

(Joan)

As analysis of the data began it became clear that some of the entries in the journal would be better suited to new categories, and the following emerged:

- Writing that described the lesson activity ......................................... DA

- Writing that stated the activity had been done, with no description of it. e.g. "I/we did ..."). ................................................. DD

- Writing that would assist the children's understanding if feedback was provided ................................................................. T

Perhaps these categories became necessary because of the data collection situation. It was close to the end of the school year so that no new mathematical topics were being introduced, and the lessons consisted of revision and testing. Consequently there were many journal entries that just described the activity which had been done. The following are examples of this sort of response (DA). "Today we reviewed percentages. We used a sheet with the old state budget." (Chris), and "we learnt about probability on shapes and coulers ... and we had turns piking shapes and coulers then we made a group of 8 and talked about probabiliys." (Sam).
Responses were further reduced by many children to stating which activity had been done with no further description (DD), such as "We did pie graphs (Greg), "today we did pie graphs they were fun but hard to understand at first" (Kelly), and "today we used blocks to solve division questions" (Luke). These responses tended to fall short of any investigation into the mathematical concepts behind the activities. This may have been because the lessons being presented had been taught before, and the pathway to understanding forgotten in the time since the introduction of the mathematics to the children. The responses may also have been limited by the fact that the lessons were confined to a set length of one hour, and the journal writing was squeezed into approximately five minutes at the end of the session. The researcher knows from experience in responding to some journal entries that to explain in writing what is happening mathematically can be very time-consuming. This was revealed in a response to Sara who wanted to know how to work out 2.5 divided into 4.83. With this time factor taken into consideration perhaps the children didn't have enough time to pursue meaning, and resorted to the simpler responses.

It may also have been that the children would have benefited from scaffolding to guide their journal writing. The guiding questions in the pilot study, and also in the study of Mildren et al. (1990), were found to inhibit some children from engaging with the writing task as they answered in a very abrupt way and did not really do any reflecting about their mathematics. However questions of a more open ended nature such as "Why do you think your teacher has chosen this activity for today's lesson?" or "What do you think your teacher really wants you to remember from today's lesson?", together with the modelling of answers to them, may be useful in enticing children to think more deeply about what they have been doing.

The category "Writing that would assist children's understanding if provided with feedback" (T), arose because feedback is an important part of assisting learning. The sooner feedback is given the more impact it will have, perhaps preventing misconceptions from becoming settled. Leslie's response "I don't understand it at all
except I think you are supposed to times it by 100 ... but I don't know WHY we do that" is a good example of this category. It could also overlap with the category of monitoring of learning (ML). This sort of entry demonstrates the value of the journal writing in facilitating communication between children and teacher.

5.2 **Validity**

Triangulation of data was possible when there was evidence from:

1. The journal entries
2. The journal appraisals (after 2 weeks and after 4 weeks)
3. The teacher's written comments
4. The researcher's observational notes

Triangulated data were evident when analysing parts of the study such as attitude. It was noted by the teacher, the researcher, in the children's journals, and in the journal appraisals. This was also true of the general feeling about the benefit of the journals.

What was a problem in this study was the lack of triangulation of the details of (non)understanding and monitoring of learning. Specific details, such as that of mathematics concepts, were not mentioned in the appraisals. The teacher's comments were very general, and the researcher's observational notes were sparse for reasons mentioned in 4.4. This study analysed the journals of all 27 children in the class. It was impossible, within the scope of this study, to observe more than a few children at once, or perhaps tape the class proceedings to provide triangulation. Data about mathematics concepts and understanding that had more validity would be better collected from a much smaller sample of children, where there would be more opportunity to focus on what they were actually doing and saying by observation and tape-recording. However, the larger number of journals analysed did provide interesting information that could be the focus of more in-depth studies.
5.3 Reliability

The reliability of the coding system for the categories was tested when the researcher coded the complete set of data on two separate occasions after an interval of almost one year.

There were 486 journal entries, with 388 categories made in 1991 which matched the 1992 allocations. Although this appears to be a large discrepancy (98 entries), the different categories, when analysed, fell into the following groups which showed only a slightly different orientation to the data after this long interval:

<table>
<thead>
<tr>
<th>Description</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entries added to '92 categorisation</td>
<td>65</td>
</tr>
<tr>
<td>DD and DA used in '91 but not '92</td>
<td>18</td>
</tr>
<tr>
<td>DA interchanged with DD and vice versa</td>
<td>6</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>9</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>98</strong></td>
</tr>
</tbody>
</table>

Many of the category entries that were added to the 1992 data analysis were probably due to the fact that the analysis had not been rechecked in 1991, and there were omissions such as attitude, or whether the activity had been described or just "done". These occurred where there was overlap between the categories. There was also the discrepancy between the "described activity" and the "did activity" categories in the 1992 analysis. The category which was the more evident in the entry was the one that was assigned to that entry.

A formula was used to determine the percentage of reliability:

\[
\text{\% Reliability} = \frac{\text{No. of agreements}}{\text{No. of agreements + no. of disagreements}} \times 100
\]

Despite the discrepancies already described, the result of this was 80%.

5.3.1 Inter-rater reliability

The reliability of the coding system was further tested when two teachers coded the same 25% of the data (120 journal entries) at approximately the same time.
as the researcher coded the data for the second time. One was the teacher of the class in which the research was carried out and the other a colleague not connected with the research study.

Of the 120 entries there was complete agreement of all of the codings (A, ML, UR, DA, DD & T) between the researcher and the two inter-raters on 41 entries. The percentage reliability was again calculated and it was found to be 34%. Although this was a low percentage of complete agreements between the three coders, most entries had two raters in agreement. It was not possible within this study to spend more time with the inter-raters to clarify where differences occurred. They were both full-time teachers, and although it was possible for the researcher to relieve in their classes while they coded the data, a meeting to discuss the codings further would have to have been during out of school hours. It was felt that enough demands had already been made on their time. The comparison of the codings is set out in Table 1.

Table 1 Inter-rater comparison.

<table>
<thead>
<tr>
<th>Category</th>
<th>3</th>
<th>2</th>
<th>0</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>102</td>
<td>16</td>
<td>2</td>
<td>120</td>
</tr>
<tr>
<td>ML</td>
<td>85</td>
<td>35</td>
<td>-</td>
<td>120</td>
</tr>
<tr>
<td>UR</td>
<td>101</td>
<td>19</td>
<td>-</td>
<td>120</td>
</tr>
<tr>
<td>DA</td>
<td>97</td>
<td>23</td>
<td>-</td>
<td>120</td>
</tr>
<tr>
<td>DD</td>
<td>92</td>
<td>28</td>
<td>-</td>
<td>120</td>
</tr>
<tr>
<td>T</td>
<td>99</td>
<td>21</td>
<td>-</td>
<td>120</td>
</tr>
</tbody>
</table>

Table 1 shows the number of agreements between the raters on the individual categories. There were only two cases where there was no agreement of the codings between the raters. The codings where there were agreements between the three raters were in the majority. Correspondingly, codings with only two raters in agreement were not very numerous. This indicates a reasonable reliability in the circumstances.
CHAPTER VI

RESULTS AND DISCUSSION

6.0 Introduction

In order to help make links between data the contents of lessons is set out in Table 2.

Table 2 Lesson Topics

<table>
<thead>
<tr>
<th>Week 1</th>
<th>Week 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mon 11.11</td>
<td>Mon 25.11</td>
</tr>
<tr>
<td>Tue 12.11</td>
<td>Tue 26.11</td>
</tr>
<tr>
<td>Wed 13.11</td>
<td>Wed 27.11</td>
</tr>
<tr>
<td>Thu 14.11</td>
<td>Thu 28.11</td>
</tr>
<tr>
<td>Fri 15.11</td>
<td>Fri 28.11</td>
</tr>
<tr>
<td></td>
<td>&quot;Ninetyseven Prime&quot;</td>
</tr>
<tr>
<td></td>
<td>Problem Solving</td>
</tr>
<tr>
<td></td>
<td>Problem Solving</td>
</tr>
<tr>
<td></td>
<td>Algorithms</td>
</tr>
<tr>
<td></td>
<td>Construction</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Week 2</th>
<th>Week 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mon 18.11</td>
<td>Mon 2.12</td>
</tr>
<tr>
<td>Tue 19.11</td>
<td>Tue 2.12</td>
</tr>
<tr>
<td>Wed 20.11</td>
<td>Wed 4.12</td>
</tr>
<tr>
<td>Thu 21.11</td>
<td>Thu 5.12</td>
</tr>
<tr>
<td>Fri 22.11</td>
<td>Fri 6.12</td>
</tr>
<tr>
<td></td>
<td>Area</td>
</tr>
<tr>
<td></td>
<td>Area</td>
</tr>
<tr>
<td></td>
<td>Area</td>
</tr>
<tr>
<td></td>
<td>Money Calculations</td>
</tr>
<tr>
<td></td>
<td>Long Division</td>
</tr>
</tbody>
</table>

The results are discussed under the different categories which have been established. Subheadings have been used within these categories to describe other aspects of the data which were found to be significant.

6.1 Evidence of Mathematical Understanding

There were few "Understanding Revealed" (UR) codings from the analysis. Of the total of 468 daily journal entries there were 60 in which this category appeared. These are set out in Table 3.
As can be seen from Table 3 there was little variation between the total for each of the four weeks if the two missed days in week two and the two testing days are taken into consideration. The two testing days produced only one UR coding.

Most children did not pursue an explanation of the mathematical ideas behind the activities. This is what the "Understanding Revealed" category was required to do. The following examples demonstrate that understanding of the ideas has occurred: "Today I played a game called Prime Numbers. It was fun, but weird because you were in the twenties and you could not get out" (Kelly), "If the triangles base was three and height was three the rectangle would turn into a square." (Chris), "Today we used area. My initials used 56cm although I didn't use 91 of the 150 cm squares." (Fiona) More details of the "Understanding Revealed" category follow.

Although this section arises straight out of the principal research question, minimal evidence of the revealing of mathematical understanding was exhibited. The
research was conducted towards the end of the school year, and the class involved was revising their year's work. The lack of the introduction of new topics may have diminished the purpose for writing about the mathematics that was now so familiar and automatic to the children. This may have resulted in little evidence of mathematical understanding. Another problem was the limited writing time. A five minute session of journal writing was perhaps not long enough for the children to think about the lesson as well as to write about it. Perhaps children need to use journals over more extended periods of time to develop this skill. It may also be that the cognitive demands of writing about mathematics understanding could be very difficult for children of this age.

6.2 "Understanding Revealed" after reflection through discussion and writing

It was interesting to note that the two days with the highest number of "Understanding Revealed" codings were following lessons that encouraged reflection about the activities through both discussion and subsequent writing. They also involved the manipulation of concrete materials. It may be that the handling of the materials, the talking about the activities and the process of writing about the activities lead to a clarity in understanding that the children were able to express. The first of these topics was a game called "Ninetyseven Prime" and the second was a series of activities on area.

6.2.1 "Ninetyseven Prime" (Third Monday of the Study)

The first lesson was a game called "Ninetyseven Prime", the essence of which was to move forward if the die took the player to a composite number. If the die took the player forward to a prime number, then the player had to remain where he/she was. The first to reach 100 was the winner. The game was very popular (Table 8), only one child expressing a negative attitude towards it; "I wouldn't call it fun" (Luke). Consequently there was much enthusiasm in the discussion of what prime and composite numbers were and where they were most prolific between 1 and 100. This
situation (third Monday of the study) also generated the fourth largest amount of journal writing (counted in lines) during the study (see Table 4), perhaps suggesting that discussion facilitated the writing about mathematics.

Table 4  Children's Daily Total of Lines Written.

<table>
<thead>
<tr>
<th></th>
<th>Mon</th>
<th>Tue</th>
<th>Wed</th>
<th>Thu</th>
<th>Fri</th>
<th>Mon</th>
<th>Tue</th>
<th>Wed</th>
<th>Thu</th>
<th>Fri</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Michelle</td>
<td>7</td>
<td>4</td>
<td>5</td>
<td>8</td>
<td></td>
<td>11</td>
<td>7</td>
<td>5</td>
<td>9</td>
<td>8</td>
<td>18</td>
</tr>
<tr>
<td>John</td>
<td>7</td>
<td>6</td>
<td>8</td>
<td></td>
<td></td>
<td>0</td>
<td>6</td>
<td>5</td>
<td>8</td>
<td>9</td>
<td>95</td>
</tr>
<tr>
<td>Greg</td>
<td>6</td>
<td>5</td>
<td>7</td>
<td>3</td>
<td>5</td>
<td>8</td>
<td>8</td>
<td>5</td>
<td>4</td>
<td>2</td>
<td>24</td>
</tr>
<tr>
<td>Chris</td>
<td>14</td>
<td>9</td>
<td>11</td>
<td>6</td>
<td>9</td>
<td>0</td>
<td>6</td>
<td>13</td>
<td>12</td>
<td>20</td>
<td>105</td>
</tr>
<tr>
<td>Pia</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td>2</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>68</td>
</tr>
<tr>
<td>Kelly</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>3</td>
<td>2</td>
<td>9</td>
<td>8</td>
<td>10</td>
<td>5</td>
<td>11</td>
<td>212</td>
</tr>
<tr>
<td>James</td>
<td>9</td>
<td>-</td>
<td>5</td>
<td>-</td>
<td>-</td>
<td>7</td>
<td>7</td>
<td>6</td>
<td>7</td>
<td>-</td>
<td>18</td>
</tr>
<tr>
<td>Sam</td>
<td>7</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>4</td>
<td>7</td>
<td>5</td>
<td>7</td>
<td>9</td>
<td>7</td>
<td>50</td>
</tr>
<tr>
<td>Carl</td>
<td>11</td>
<td>7</td>
<td>7</td>
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<td>225</td>
<td>184</td>
<td>153</td>
<td>250</td>
<td>196</td>
<td>232</td>
<td>199</td>
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</tbody>
</table>

6.2.2 Activities on Area (Fourth Monday, Tuesday and Wednesday of the Study)

This topic was spread over three days. There were four activities to be completed with a partner on the first two days. On the third day discussion groups were formed to reflect on the activities, and a group leader was appointed to report back to the remainder of the class.

These lessons on area demonstrated the potential for revealing mathematical meaning by writing. However, they were in contrast to "Ninetyseven Prime" which had created engagement with the mathematical ideas through enjoyment and discussion.
It was more difficult for the children to become involved with the activities on area, and through these, with the mathematical concepts. This may have been because the activities were seen as "below" a year six class as expressed by Susan; "That wasn't the most wonderful thing I've ever done. The next thing wasn't fascinating, it was (frankly) quite boring." Russell was also unimpressed with the lessons; "I felt that the whole thing was a waste of time because I did not learn anything and it wasn't interesting. Today's maths was most boring." The activities were:

- comparing the area of two leaves,
- calculating the surface area of constructions made with 1cm cubes,
- making various triangles on a Geo-board with a 3cm base,
- calculating the area of initials on squared paper.

These sorts of activities are often done in the earlier years of primary school.

The teacher's instruction was: "You work out what to do." Some children found this difficult, and were reluctant to begin the activities (Pia, Joan). There was also a reluctance to begin recording what they had found out, resulting in this part of the lesson being set for homework for the children who had not finished.

McGregor (1992) states that "it is not easy to talk or write about mathematical ideas" (p. 195). The children did find this was a difficult task and perhaps resorted to proclaiming that the lessons were boring because of it: "Miss A was angry with our group because we said everything was boring." (Lynne), "I didn't like it much but Miss A gave us a lecture" (Sonia), and "at first we thought we learnt ABSOLUTELY NOTHING! But then we looked a little deeper" (Greg). The atmosphere of the classroom appeared to be negative and there were many frustrations within the groups discussing what the activities had been about, and although there was a lot of talk, much of it was not about the topic. The teacher was also frustrated with the negative attitude prevailing among the children, and told them so quite firmly, with the result that many of them responded as Greg had.
done and "looked a little deeper". Fiona also reflects upon Miss A's comments:
"As Miss A said, we can make our work as easy as we want ... or we can make it
more interesting by writing up more about what you are doing at the time." (Fiona)
The classroom atmosphere become more positive.

The frustrations of the "boring" lessons and the difficult discussions behind
them, the children were now in a position to consider what they had learnt, and to
record it in their journals as shown by the following comments coded as
"Understanding Revealed":

"If you have a base of three and a height of three the rectangle becomes a
square." (Jane)

"we found out that if you have a big triangle and you fold it in half, you
expect it to be half, it is, but before I thought it wasn't because I'd turn it
upside down." (Susan)

"All shapes have the same volume when using the same blocks." (Chris)

"and found that any four sided shape (regular) could form two triangles if
you put a line from corner to corner." (Greg)

Not only did this discussion day have the greatest number of codings in the
"Understanding Revealed" (UR) category, it also stimulated the greatest amount of
writing - 358 lines (see Tables 4,5), and perhaps the greatest amount of reflection.
Table 5 shows a comparison of the two topics which generated the two highest
number of "UR" codings. Attitude is also considered in relation to them. A+ refers to
a positive attitude, A a neutral stance, and A- a negative attitude.

Table 5  Category Comparison with Number of Lines Written.

<table>
<thead>
<tr>
<th>Date</th>
<th>Lesson</th>
<th>UR</th>
<th>A+</th>
<th>A</th>
<th>A-</th>
<th>Number of lines</th>
</tr>
</thead>
<tbody>
<tr>
<td>25/11</td>
<td>Ninetyseven Prime</td>
<td>9</td>
<td>22</td>
<td>2</td>
<td>1</td>
<td>250</td>
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<td>2/12</td>
<td>Area Activities</td>
<td>3</td>
<td>15</td>
<td>4</td>
<td>1</td>
<td>244</td>
</tr>
<tr>
<td>3/12</td>
<td>Area Activities</td>
<td>2</td>
<td>15</td>
<td>3</td>
<td>1</td>
<td>239</td>
</tr>
<tr>
<td>4/12</td>
<td>Area Discussion</td>
<td>13</td>
<td>22</td>
<td>0</td>
<td>0</td>
<td>358</td>
</tr>
</tbody>
</table>
As can be seen from Table 5, there was a high number of "Attitude Positive" (A+) codings for the "Ninetyseven Prime" game as already discussed in 6.1.1. This positive attitude was slower in developing in the topic of "Area". However, as the children began to search for meaning and were more comfortable with discussing and reporting what they had done, then the positive codings increased. There were 22 A+ codings on the final day. The negativity and difficulty the children displayed in carrying out the activities may be reflected in the low number of "UR" codings on the 2nd and 3rd December and the lower number of "A+" codings. However, it seems that through their struggle to find meaning in the "boring" lessons, and the obligation to write about, discuss and to re-write about them on the final day may have allowed the children to become aware of, and interested in, the ideas behind the mathematics. This was the day with the highest number of UR codings and the third highest number of A+ codings. The enjoyment and need for discussion in "Ninetyseven Prime" appeared also to assist in the development of this awareness.

It would appear that a combination of a group "hands-on" activity together with a focussed discussion and follow up journal writing may result in a greater awareness of the mathematical ideas within the lesson, clarity of knowledge about them and an intrinsic interest in the subject.

6.2.3 Writing competence and "Understanding Revealed"

Britton, Burgess, Martin, McLeod and Rosen (1971, p. 44) suggest that "some things are remembered more clearly and fully from the written record than from the spoken word." They also state that "it does seem probable that under some circumstances that the act of writing actually assists the operation of the memory."

It is interesting to consider the writing ability of the three children whose journal writings were coded with the most "UR" categories (see Table 3). Chris was a quiet worker in class. His journal entries were quite long and he often focussed on the mathematical points of the lessons. His explanations were also assisted by diagrams,
of particular note being the recording of division using Multibase Arithmetic Blocks. Unfortunately, his writing ability was not assessed at the commencement of the study as he was absent the day the baseline data was collected. However, his attendance at the government schools' extension programme (Primary Extension and Challenge) required that he had performed well in general academic testing, including writing ability.

Kelly (6) and Tiffany (26) both scored above 75% in Diederich's Analytic Procedure for Evaluating Writing Samples (see Figure 2) at the beginning of the study. Their writing was very detailed and because of the meticulous recording of the activities, it was possible to see that they understood the mathematics they were learning.

It would appear that these three children were perhaps assisted by competent writing ability to express their mathematical understanding. They may also have been more developmentally advanced. The shortness of the study, and the limited amount of writing time each day, may have restricted the production of substantial evidence to support this. Perhaps writing to help clarification of mathematical meaning needs more time, maybe as a part of the lesson rather than at the end of it. When children had spent considerable energy in completing their mathematics during the lesson, it was unreasonable to expect them to re-write it all in a separate journal entry, and it was probably therefore only the competent writers who managed to do this during the study. However, given more time and practice in writing journals, and support in knowing what to write about, all children may be able to obtain more mathematical meaning through their writing.

6.3 "Did Activity" (DD) and "Described Activity" (DA)

As discussed in the Data Analysis chapter, it became necessary to allocate categories to the abundance of journal entries in which the children did not appear to focus on the mathematical ideas of their lessons and therefore did not reveal
understanding about them in their writing. Some journal entries were very minimal, "We did (activity)" and were coded as "Did Activity" (DD), and others gave a fuller description of the activity and were coded as "Described Activity" (DA). Table 6, which indicates the spread of the DD and DA codings (together with the "Understanding Revealed" (UR) codings), shows that there was no clear pattern in the distribution of these categories over the duration of the study.

Table 6  Category Distribution - "Did Activity" (DD), "Described Activity" (DA) and Understanding Revealed (UR)

|        | Mon | Tue | Wed | Thu | Fri | Mon | Tue | Wed | Thu | Fri | Mon | Tue | Wed | Thu | Fri |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Michelle |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| John    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Greg    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Chris   |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Mia     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Kelly   |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| James   |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Sam     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Cail    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Doug    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Sara    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Russell |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| John    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Lyne    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Jane    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Susan   |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Luke    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Stephen |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Soma    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Jade    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Tiffany |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Scott   |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Thomas  |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Richard |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Did Act.|     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Und. Rev.|   |     |     |     |     |     |     |     |     |     |     |     |     |     |     |

This information does not appear, on the surface, to be demonstrating that the children's learning has been assisted, or that evidence of understanding has been revealed, developed or monitored. Some sections of the study however do seem to indicate that some benefits have been gained, as is discussed in the following sections. It was difficult to gauge an overall trend of the benefits of mathematical
writing when the lessons presented to the children were so varied. On the other hand, the fact that they were varied revealed the children's differing reactions to the discrete topics.

6.3.1 Testing Days (Tuesday 19 and Friday 22 November 1993)

The highest number of DD codings occurred when the children wrote in their journals following the test on the second Friday (22.11) (see Table 6). It may be that the children were focusing only on the result of the test, and whether the test was easy or hard for them, and were not particularly interested in what the test may have disclosed about their own learning. The following writing supports this view:

"Today we did a maths test and a probability test. The probability test was easy. The maths test was quite easy too." (Pia)

"We did tests today. They were easy." (Scott)

"We have tests galore today, it was easy I mean really easy... I can't really explain the easy ones they were just too easy." (Eryn)

"Today we did a Test on probability. It was very easy," (Thomas)

The least amount of journal writing also occurred on the two test days (see Table 4) perhaps also indicating a lack of engagement with the mathematics. Here is an opportunity for a teacher to become aware of the children's limited outlook on testing and to note that the children have their minds driven in only one direction, that of the test score. The evidence is provided by the journals. It is understandable that children are very interested in their test scores, but journal writing may assist them to make the most of this often missed learning opportunity. Some children have realised that journal writing helps them discover what they don't know before they have a test. "It helps me think of some of the mistakes I've made and how to resolve them." (Russell). Perhaps many children do not realise that they need to clarify what they did not know when they have had a test, and the sooner this is done the better for their learning.
6.3.2 Money Calculations (5.12.1993)

Another day which had a high incidence of DD codings was on the final Thursday (5.12). The lesson was about money calculations and taken from the "West Australian Mathematics" book. The algorithms for long division, addition, subtraction and multiplication most probably had been internalised by the Year Six children and therefore, as Tiffany writes "There isn't much to write about." This would perhaps account for the many entries such as Tiffany's beginning to her journal entry on this day "Today we did some maths sums from our W.A.M. book it was quite easy. There were sums like..." These many DD entries therefore did not reveal understanding of the mathematical content. This sort of mathematics may have been so well known to the children that it had been internalised by them. Thus to write about mathematical ideas may have seemed to the children that they were stating something that they thought was too obvious. Stemming from this could also be a lack of engagement with the mathematics and conscious awareness of the place value system. It may be that this is mathematics in the comfort zone for many children. Computation has a very necessary place in mathematical learning and as such it has quite a lot of emphasis in the primary school. These children seemed to be at ease with what they were doing and recorded positive attitudes (see Table 8) to this lesson. For a more extensive discussion of "easy" and "difficult" mathematics see 6.5.

It would be interesting to know how many children in the study were consciously aware of the underlying idea behind these "sums"--place value. The researcher found that her knowledge was extended, and interest awakened, when assisting children during lessons and in written responses to the journals. Journal writing in this case could perhaps receive a little more direction from the teacher to encourage children to think of what is happening when they are adding and subtracting, although it may seem "old hat". This may encourage children to be more involved with the mathematics they are using and learning, and encourage a more intrinsic motivation to pursue the meaning behind the activities.
6.3.3 Tiffany and Chris

It is interesting to note that only two children received codings other than DD for their journal entries on the second testing day (second Friday, 22.11). Tiffany described parts of her test "the first one was about probability and had things like what is the probability of choosing a circle if there are 3 circles in a group of 7." This was coded as DA. An "Understanding Revealed" (UR) coding was recorded for Chris "If the shaded part is taken away what shape is left? Unfortunately I put triangle when it should have been a quadrilateral" (see Figure 3).

![Figure 3 Chris's Triangle](image_url)

The complete journals of these two children were coded with high rates of DA and UR categories. Chris had the top number for DA--11 and UR--9 and Tiffany had the second top for DA--9 and third top for UR--7. Correspondingly, Chris had the lowest (4) and Tiffany the third lowest (6) DD count of these codings. It would have been interesting to compare the test results of these children to the remainder of the class. It may have been that both children had above average mathematical ability. These children were probably of above average writing ability (see 6.2.3), and they also did the fifth and sixth highest amount of writing throughout the study (see Table 4).

It would appear from the Chris's and Tiffany's journal writing that they were willing to engage thoughtfully in, and to become more aware of, the mathematics they were learning. It takes more effort to describe an activity (DA) than to report that "We did (activity)" (DD). Children who often used the DD category may have done so because they believed that mathematics was learnt by rote and was not a subject for understanding. It may also be that to record the mathematical ideas (UR) takes more conscious effort thus allowing a greater depth of understanding. For these reasons
journal writing may be benefiting Chris's and Tiffany's mathematical learning, and with more time, might have provided benefits for the whole class.

6.3.4 Prevalence of "Described Activity" (DA) Category

The topics in the study in which the DA codings were most numerous were the game "Ninetyseven Prime" on Monday - week three (25.11), and "Area" on Monday and Tuesday - week four (2, 3.12) (see Table 6). These activities both included working with someone else, or in a group, which may have stimulated a greater knowledge about and awareness of the mathematical content resulting in more detailed writing from the children. For "Ninetyseven Prime" there appeared to be a connection between the number of DA codings with the UR (understanding revealed) codings. There was the highest number of DA codings, and the second highest number of UR codings on this day. There were five entries where the codings coincided. Here, then, is an indication that the combination of a "hands-on" activity, with the opportunity to participate with others during the activity, discussion during and after the lesson, and the knowledge that they were going to record a journal entry, may have encouraged a greater conscious awareness and understanding of the mathematics in these lessons. Britton et al. (1971) suggest that "an essential part of the writing process is explaining the matter to oneself--and that is a highly idiosyncratic affair." (p. 28) They also mention the need for a time of incubation for the writing to assemble "in-head" and on the page. Perhaps the combination of the above experiences provides opportunities for clarification of learning in mathematics.

There was also a connection between the DA and UR categories on the topic of "Area" (see Tables 6,7) although this was less readily apparent.
On the first two days of the topic the second and fourth highest numbers of DA codings were recorded. (These were the days of group activities.) In contrast, there was a minimal UR response, one on the 2.12 and two on the 3.12. Following the discussion of the activities and reporting back to the class on the third day (4.12) the DA codings fell to 3 while the UR codings rose to the highest for the study (13). It may be that there is a progression from writing which is coded DA to writing which is coded UR which could indicate that an awareness of mathematics is developing when there is sufficient time for reflection. Once again, here there is the combination of experiences possibly leading to a deeper understanding of the mathematics. In this case it was perhaps an intrinsic interest in the mathematics evolving over the three days of sometimes frustrating participation in the lessons. (This is described in more detail in 6.2.2) The mathematical understanding was revealed predominantly on the third day and so had taken longer than the understanding revealed for "Ninetyseven Prime" where maybe the joy of the game had facilitated focussing onto its mathematical features on the same day. Not all mathematics can be taught through games, and so the interest generated by an organised engagement with the lessons through the use of concrete materials, discussion and journal writing may benefit children's understanding of and attitude towards this subject. A National Statement on Mathematics for Australian Schools (1990, p.15) states as one of its goals that "as a result of learning mathematics in school all students should ... gain pleasure from mathematics and appreciate its fascination and power." This is possibly being stimulated in the children with the aid of journal writing.

Table 7 Category Comparison with "Area"

<table>
<thead>
<tr>
<th>Date</th>
<th>Lesson</th>
<th>DA</th>
<th>UR</th>
<th>DD</th>
</tr>
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<tbody>
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<td>2.12</td>
<td>Area Activities</td>
<td>15</td>
<td>1</td>
<td>11</td>
</tr>
<tr>
<td>3.12</td>
<td>Area Activities</td>
<td>13</td>
<td>2</td>
<td>12</td>
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<tr>
<td>4.12</td>
<td>Area Discussion</td>
<td>3</td>
<td>13</td>
<td>21</td>
</tr>
</tbody>
</table>
6.4 Attitude (A+, A, A-)

The children in this study were more than willing to write about their attitudes to the mathematics they were learning, thus providing much data for analysis. It is perhaps because of the personal nature of this part of the writing that it was an easy task for them to perform, resulting in the good response in their journals. It may also be that there was a yearning to express personal thoughts about mathematics which was possible through the journals but not generally in a busy classroom. Access to the teacher is understandably limited in a class of 27 children. Often time is a pressure in classrooms and possibly expression of personal attitudes is confined to language instruction. Teachers may not have even considered this aspect of children's mathematical learning. Miss A comments (see Appendix 5) "At first I felt the children may get bored with writing the journal every day for a month. However they seemed to enjoy expressing their thoughts.... I have gained experience in having the journals done in my room. It really does give an idea about the children's confidence, preferences and academic progress." This appears to support the notion that mathematics is not usually considered in a personal way in the classroom.

Cockcroft (1982, p. 101) states that "during every mathematics lesson a child is not only learning, or failing to learn, mathematics as a result of the work but is also developing his attitude towards mathematics." Journal writing may be a means of facilitating expression of these attitudes and therefore making teachers more aware of what their children are thinking and feeling. They are then in a position to act immediately on this information. Miss A monitored what the children were writing as they wrote, and often spoke to them at this point.

6.4.1 Evidence of Attitude Towards Mathematics

Writing that conveyed evidence of the children's positive, neutral or negative attitudes was tabled, and the results counted (see Table 8). This gave an indication of general attitudinal trends in the class. The overwhelming response was that of a
positive attitude. Of the 397 codings from the children's journals specifically relating to attitude, 328 were positive, 42 neutral in nature and 27 were negative. It was interesting to note that the number of categories denoting a neutral attitude declined from 24 to 18, and the negative from 19 to 8 from the results collected halfway through the study (up to and including the third Monday) to those collected at the end of the data collection period. The positive responses increased by 5 during the same interval.

Table 8  Category distribution - "Attitude" (A+, A, A-)

| Mon | Tue | Wed | Thu | Fri | Mon | Tue | Wed | Thu | Fri | Mon | Tue | Wed | Thu | Fri | Mon | Tue | Wed | Thu | Fri |
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| 2   | 0   | 1   | 1   | 1   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   |
| 1   | 2   | 3   | 2   | 4   | 1   | 1   | 2   | 2   | 4   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   |

Fiona's responses from her Journal Appraisals (after 2 and 4 weeks) support the evidence of a positive attitude to mathematics: "OK I confess my journal is part of me it really helped me along in my maths." and "I'm improving every day in maths and language." Joan echoes Fiona's responses: "Yes, I enjoyed writing what I thought because I know what I am writing and (it) helps me to revise the work I do." Eryn expressed a change in attitude: "I have changed my mind I don't think they're (the activities on "Area") boring anymore. I think it's interesting." Luke gave a very clear
indication of his reaction. He began the activities on "Area" with a "fairly boring and easy" approach, but commented "The main thing I learnt was that you can make things as boring or exciting and challenging as you want." on the third day.

6.5 "Easy" and "Difficult" Mathematics

Mildren et al. (1990, p.360) state that, in their study, "many of the responses reflect relationship between attitude and belief." Many children may believe that to be successful at mathematics it should be easy for them to do and they should be able to get it all correct. Loveridge (1992) in a study on the attitudes of nine-year-olds supports this view:

Although many children said that they enjoyed mathematics, this positive attitude seemed to be mostly due to the sense of well-being engendered by getting many answers correct. No one responded in a way that suggested mathematics was regarded as an exciting activity which could be used to solve real problems, both in and out of the classroom. (p. 114)

This approach to mathematics was borne out in the study. There were 70 responses stating that the children liked mathematics because it was easy (see Appendix 8). "I liked maths because it was easy." (Leslie), and "gest what I got seven out of seven isint that grat." (John) were examples of these responses. Children possessing these beliefs about mathematics have a very restricted view of the subject and may think of it only as being useful in the school. They may be only concentrating on the end product (the answer) rather than on the process of getting there. This also adds the anxiety factor to the fear of being incorrect. "Doing" mathematics without meaning can influence children's learning for a long time.

Bastow (1989) states that "as one of the examiners for Mathematics III for the last six years, I have found the most frustrating and sad thing is that many students are so busy thinking about the steps of the algorithm that they are unable to, or will not, relate their answer to the original question." (p. 1). Through the children's journals the teacher can see what the children's attitudes are to mathematics they are learning and then have an opportunity to direct them in a more meaningful direction.
There were fewer (49) responses expressing negativity because the mathematics was too easy and not challenging enough (see Appendix 9). These responses were expressed by Stephen, "It presented no mental challenge at all" and Luke, "Math today was better ... because I actually think". These children have a good "stance" on their mathematics, and through reflection have pin-pointed why they are not happy with their mathematics learning. They want to explore and to be challenged. Their teacher can be made aware through their journal writing that they wish to be extended in their mathematics learning. It may be that they do not look deeply enough into their mathematics, and when skimming the surface of the content of their lessons think that they are boring. This, too, becomes apparent to their teacher during journal writing.

6.6 Teacher's Influence

It is interesting to note that the children's teacher, Miss A, makes every effort to encourage the children to search for meaning: "One of my aims is to make the children independent learners who will 'have a go' at solving problems." (see Appendix 4). This is supported by her classroom comments such as: "I can see someone's not thinking", "Who can tell me how their brain is working?", "Did anyone work it out a different way?" and "Some people might do it differently" (see Appendix 6). Miss A's encouragement and teaching style have produced a class which is positive about its mathematics and yet some of this same class appears to be restrained by a belief that mathematics is best when it is easy, and can all be correct, as detailed in 6.5. Through the journals it can be seen by the teacher that some children still have a limited approach to the mathematics, and the children may also have the opportunity to change their stance towards mathematics learning. In a classroom where independent mathematics learners are not encouraged to the same extent as the study class, journals could possibly help the teacher become more aware of the sort of mathematics climate that prevails in that class, and to have a chance to reflect on his/her teaching practices. At the same time the children may be
providing information that will help the teacher decide on a pathway of learning that will directly relate to their interests and problems.

6.7 **Position taken by children on the mathematics they were learning**

Another aspect of viewing the data can be to select individual children and to follow their progress. Greg's and Fiona's cases will be discussed following some background to the class situation.

It was evident from observations of Miss A's teaching, and from her own comments, that she is very aware of how children learn (see 6.3.3). She also commented "I try to make my maths lessons relate to everyday life and to allow the children to take a 'problem-solving approach', ie lots of exploration, explanation and exploration. My lessons usually contain much talk as I feel the oral aspect helps to get the new concepts/problem-solving techniques. I also feel that peer tutoring is a powerful tool ..." (see Appendix 4). The discussion of "Ninetyseven Prime" (6.2.1) and "Area" (6.2.2) support the suggestion that this approach to teaching does assist children’s learning.

However, even though Miss A was cognisant of the children’s learning, and what she believed they could achieve, she still appreciated that there was additional useful information in the journals:

I have gained experience in having the journals done in my room. It really does give an idea about the children's confidence, preferences and academic progress. I feel the journal has been a powerful educational tool which has enabled me to see who may need more help, or who may need a morale boost. (see Appendix 5)

It is possible through the journals to "see" the children's approach to their learning of mathematics.

6.7.1 **Greg's Case**

Miss A states that "we have three students from Asia whom I have found to be very good at the technical aspects of maths, but are not as confident when it is not
straightforward." One of these students, Greg, says of division with M A B "I didn't add anything to my knowledge or understanding of division. I feel like I've just got very confused today about division." This comment perhaps shows Greg's conflict: he can do division, and knows that he can get it right as an algorithm, but he found it very difficult to relate the algorithm to the M A Bs, and was very reluctant to search for meaning in the activity. This could have been because he didn't believe that "playing" with blocks was a sensible thing to do, especially when it was difficult. (The researcher, although having studied mathematics to Leaving standard, also found it required a lot of thought to explain this activity to those children who needed help.)

Greg commented in his journal appraisal (after 2 weeks) that "what would be clear to me would not be clear to someone else. This severely diminished the benefit of expressing my own thoughts, and someone else trying to interpret them." This comment shows the mismatch between his idea of mathematics and that of his teacher, who, with this additional information, may be able to bridge the gap.

Over its duration the journal also shows Greg's changing stance towards his mathematics. On 27.11 he documents his belief that useful mathematics for him is "sums": "The sums were interesting and there came a satisfaction from all being correct." On 28.11 the mathematics lesson was not so straightforward and Greg was reduced to tears of frustration looking at number patterns. Neither his teacher nor the researcher was able to help him, nor even to talk to him. He was however able to write in his journal "Some were quite hard such as: 1,2,4,5,7,_,_,_,13 (I haven't figured it out yet)" and that both the activities "were very interesting". Perhaps he was starting to look for meaning despite it being a frustrating search at times.

In the final week of the study following activities on area, Greg commented on the final discussion "At first I thought we learnt ABSOLUTELY NOTHING! but then we looked a little deeper and found ...". Lynne supported Greg's discovery commenting "Greg's group did really well." Greg's journal appraisal (after 4 weeks) stated "From my last comment on the journal some things have changed ... I'm starting to enjoy it
now because there have more recently being (the maths) more complicated and there is more to write about. Before there was nothing to write about (for me) and therefore the journal wasn't that useful at that time." The mathematics probably was not more complicated, but Greg's attitude may have shifted thus allowing him to search a little deeper into his mathematics. His position on mathematics has changed. Through the journal Greg's teacher is able to "see" his changing situation and can give him appropriate support and encouragement, and is also able to monitor this change over time.

6.7.2 Fiona's Case

Fiona, too, shows a change of position. She is a creative girl, which is shown in her ability to vent her feelings against mathematics in poetry:

<table>
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<th>I hate maths</th>
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<td>It gets really boring</td>
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<td>By the end of the lesson</td>
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The teacher raves on
About add and subtraction
This stupid old maths
Don't have no attraction.

I hate maths
I really do
I get really bored
How 'bout you

I get frustrated, bored
Hungry and sick
'Cause this stupid old maths
Just will not click.

It may be that Fiona, who had come from another school, is only used to using algorithms; "some maths I really enjoy like addition and subtraction but I don't like problem solving." She also wrote on 14.11 "I hate maths it never clicks." Perhaps Fiona is also looking for the creative and meaningful aspect of mathematics, as she does with her writing, and is confused by her belief that mathematics is 'doing sums':
"I don't know why I get confused with all this stuff." Fiona is worried about her mathematics performance as expressed in this comment on 19.11: "I hate tests because I find easy questions difficult because it all builds up in my brain." On 21.11 she shows a change of attitude when recording detail of division with Multibase Arithmetic Blocks. "Today we had division with blocks for once we had fun. It was really easy and it clicked perfectly." Her attitude change is also recorded in the journal appraisal (after 2 weeks): "(my journal) really helped me along in my maths. I can now look back on it and see what I did. I now think about my maths and I won't go blank."

Fiona's increasing positivity continued: "I would never have imagined that we could combine numbers with fun.", and "I enjoy listening to other peoples problems because it can help you out in your work." Her comments in the journal appraisal (after 4 weeks) confirm this: "I'm improving every day in maths and language. Thanks to my journal I've really thought about my work."

6.7.3 Summary

To summarise, both Greg and Fiona believe that mathematics should be algorithms, and that success is getting them right. Greg was happy in this belief, but it restricted his progress to understanding the much wider field of knowledge that mathematics has to offer. Fiona was very unhappy with her belief, which created an anxious student who could not perform well. Through the journals Greg is starting to see the benefits of looking more deeply into the meaning behind the activities, and Fiona is pleased to know that this is what mathematics is all about, and is starting to relax and to think about what she is doing. Oral communication may also have aided these ends, although thinking is further refined in order to write. Thinking has to occur before writing begins, and therefore journal writing ensures that everybody reflects upon what they have been doing. Some children may not contribute to an oral discussion, or even be able to talk to a teacher, perhaps if they are upset. For example Leslie says "I was stuck with my hand up for more than half an hour. Not kidding." For them, journal writing may be a welcome means of expression and
communication. It is the outspoken children, and the children with problems that tend to monopolise a teacher's time. Time is also a factor which prevents teachers from having as much communication with children as they may wish. It is possible, however, to read the journal entries quickly while the children are writing, and so respond appropriately, and quickly, to their needs. Children can pinpoint what their needs are. These needs may not be obvious to the teacher, who may, otherwise, only be able to glean such information by lengthy conversation with, and observation of, the child.

6.8 "Monitoring Learning" (ML)

Table 9  Category Distribution - "Monitoring of Learning" (ML)

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This category received only a few (64) codings throughout the study. There was a drop from 39 to 25 codings from the first half to the last half of the study. A contrast to "Understanding Revealed" (UR) was found on the three days of "Area" (see Table 3). There was only one "Monitoring Learning" (ML) coding during this topic. This was surprising because it had been thought that perhaps there may have
been more monitoring of learning leading to the day with the highest number of UR codings on the third day of "Area". It may be that the monitoring of learning took place during the discussion and was not therefore evident in the journal writing, although the evidence of learning was there. This was also borne out by the low number of ML codings on the "Ninetyseven Prime" day on which much discussion occurred. This contrasted with the day of the second highest number of ML codings when the children were requested to work in silence. Perhaps in this case the monitoring of learning occurred at the writing stage because there was no discussion, (when it may have happened on other occasions), on this day of problem solving.

Journal writing may therefore act as a safety valve ensuring that children do reflect about their mathematics even when there is insufficient time for talking during and after a lesson. It may also ensure that less talkative children also reflect about their mathematics which they may not do in a group situation. Perhaps the journals could be written as homework when there is insufficient time during the school day for any reflection.

The days that had the highest number of ML codings were on the topics of Percentages, Pie Graphs, Degrees, Problem Solving and Long Division. These codings are exemplified by the following:

"But when we had to do the same thing with $150 million, it was hard and boring because I didn't really understand." (Susan)

"I sort of understand it but I would like to do it so I CAN understand it." (Pla)

"... but I didn't exactly understand the process of getting the percentage of the pie graph so could you please explain it to me." (Doug)

"Today we did about digrease. I do not understand but I tried. I still don't know how to look at digrease in a straight line," (Joan)

"I didn't understand how to use the protractor to work out how many degrees." (Lynne)

John, who has trouble writing was pleased to be able to communicate for a purpose, "I had a littil bit of trabil on one three-fifths of the children at the match whey boys how many were there?", and in so doing was focussing on his mathematics.
There did not appear to be any other features binding these topics together, although they required quite a lot of calculation through a number of steps which may have been difficult for some children. The children were also able to focus on the part which they couldn't understand, or where they came to a point of difficulty, and to express this in their writing. For example, problems in using a protractor were mentioned, and also working out the percentage of a pie graph. These two examples made up only part of the total lesson but may have prevented the children having the satisfaction of getting the right answer. Although this may have been a great frustration to them, the journal writing ensured that they could voice their concerns and perhaps also think about the total lesson and the magnitude of their problems within it. Likewise, their teacher was able to focus quickly onto their problems.

6.9 "Teacher Assistance" (T)

Table 10 Category distribution - "Teacher Assistance" (T)

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As can be seen from Table 10 this category did not produce very many codings, however, as discussed in the data analysis (see Chapter 5), it was felt that these comments were too important to be treated in a general way, as the children seemed to need support in some way as soon as possible. For example, Greg, who had been extremely upset and unapproachable during the lesson on number patterns (problem solving) was able to write about what he had done, and specify "Some of them were quite hard such as: 1,2,4,5,7,_,_,_,13". It was a relief to know that Greg was able to write in his journal and was therefore able to be assisted, both at the point of difficulty and also attitudinally. It may have been that he was too embarrassed to admit he could not do these problems although he was usually good at most mathematics, and so he found it hard to discuss them during the lesson. It was suggested that he did not need to write in his journal that day because he was so upset, but he still wished to record an entry. Perhaps this helped him come to terms with the situation. It was seen later in the study that he was beginning to look more deeply into his mathematics (see 6.7.1), and perhaps realising that it is allowable to make mistakes and take risks.

Lynne was upset because she was embarrassed when her group had been reprimanded by Miss A. "Miss A was angry with our group because we said everything was boring." Lynne had not agreed with her group and was able to express this in her journal and receive immediate positive feedback from her teacher.

Susan commented after a problem solving lesson "I got confused because if I got the answer straight away, I'd think there was something wrong with me cause I got it right. I don't really like problem solving. It gives me a headache. It gets about 3 out of 100." This was on the day when the children were requested to work in silence and it may have also added to Susan's lack of confidence "I found it harder doing it by myself." She was not happy having to rely on herself. This information may not have become apparent without her journal writing, but it was now valuable to her teacher who was able to offer more support immediately. Miss A in her general comments on
journal writing (see Appendix 5) confirms this: "It [journal writing] really does give an idea about the children's confidence, preferences and academic progress."

In a class of many children even basic attention to some quiet, "doing the right thing" children can be overlooked as shown by "I was stuck with my hand up for more than half an hour. Not kidding." (Leslie). Leslie's journal was providing a very useful mode of expression and also making her mathematics problems explicit "I don't understand it at all except I think you are supposed to times it be 100 it goes in one 200 it goes in twice and so on. But I don't know WHY we do that. I am really quite confused." Leslie's journal appraisal (after 2 weeks) supports its usefulness to her: "It does help me think of my maths better and sometimes makes me understand what I am doing. It was very helpful." During the four weeks of the study Leslie was often away sick. The journal may well have been a valuable device to help her fill in the gaps and to increase the amount of personal communication with her teacher.

Another student who had some writing placed in this category was Russell: "Today's maths was alright. We did several activities which were not very interesting. I do not know why Miss A chose such activities. I felt that the whole thing was a waste of time because I did not learn anything and it wasn't interesting. This feeling only occurred to me. I hope for something more interesting in the next maths lesson." He also wrote "Today's maths was most boring. I could learn nothing which I really should. I hope we could get something more interesting. I thoroughly did not enjoy the lesson. I think that journals are not that useful because we have brains ourselves. Also considering the fact that we are young we can remember a lot of things." (Russell then left school early to return to his country of his birth for the holidays.)

Both Russell and Greg had culturally different backgrounds to most of the class. This may have given them both a view that mathematics was doing algorithmic work and getting it correct. In his journal appraisal (after 2 weeks) Russell confirms this "(journals) help me think of some of the mistakes I've made and how to resolve them. The most important thing that a journal does is help us correct and learn new
or old equations." Miss A also supports this observation with "we have acquired three students from Asia whom I have found to be very good at the technical aspects of maths but are not as confident when it is not straightforward." (see Appendix 4) As already described (in 6.7.1), Greg was widening his horizons, but Russell's attitude may well be a hindrance to him, preventing him from looking more deeply into mathematics. In Russell's case the journal entries provide concrete evidence of his attitude which can be used for discussion with him, the principal, and his parents.

In summary then, the teacher was able to focus on trouble areas very quickly. These trouble spots included severe frustration, lack of confidence for problem solving, lack of attention or ability to be heard during lessons, and attitudes which could restrict mathematics learning.
CHAPTER VII

CONCLUSIONS, LIMITATIONS AND RECOMMENDATIONS

This study sought to describe the benefits of reflection by journal writing in mathematical learning and attitudes in the primary school. The results acquired have shown that there are considerable benefits from this activity.

7.0 Conclusion

7.0.1 Children's Attitudes Towards Mathematics

The most significant finding of this study was the revealing of the children's attitudes towards learning mathematics. There was evidence in their journals, journal appraisals, teacher's comments, and also from observational field notes, that the children showed a positive attitude towards their mathematics most of the time. This seemed often to have been because the mathematics was easy and they were getting all their calculations correct. Over the duration of the study there was a slight increase in the number of positive journal entries and a corresponding drop in the number of negative and neutral entries.

7.0.2 Children's Stance on Mathematics

That the children were enjoying the mathematics they were learning was obvious. However the approach they were taking to learning mathematics, or their stance on mathematics, also became apparent both to the children themselves, and to their teacher, through their journal writing. The journal entries showed the children's thinking, and thus some children's change in stance, over the duration of the study. The entries showed that some children were beginning seek the underlying ideas of the mathematics they were learning, and no longer regarded mathematics as enjoyable just because it was easy. They began to see that difficult mathematics could be enjoyable and that some seemingly boring activities had some interesting
ideas behind them. An appropriate stance towards mathematics benefits children's learning because it allows them to gain a clearer understanding of their mathematics at their own level. Because of the belief of many children, and of people in the wider community, that mathematics consists only of "school mathematics", it is very useful that children clarify their stances towards mathematics, and also that this information is known to their teachers. In this way discourses may be developed between children and teachers to encompass a wider approach to the world of mathematics. Most children responded positively to the journal writing during lessons and were enthusiastic in praise of the writing in their journal appraisals, so it would seem that this is a way of working towards a good stance towards mathematics.

7.0.3 Revealing of Understanding Through Reflection

It had been hypothesised that the journal writing would reveal evidence of mathematical understanding, development and monitoring of learning. There were general indications of the potential of journal writing to reveal this sort of information, although there were not many codings in this study, and it was difficult to support them, in other than a general way, from other sources. When the children had a series of three lessons on area it appeared that the combination of a "hands-on" activity and discussion provided the pathway for them to record more entries that contained understanding in their journals. The discussion component of this series of lessons also appeared to diminish the amount of monitoring of learning in the journals, which was in contrast to a day of working in silence which showed the greatest number of "monitoring learning" codings. It may be that if monitoring of learning occurs in journals when there is an absence of discussion, then this would be of benefit to those children who are reluctant talkers. The effort required to participate in a discussion may well detract from any engagement with the mathematics being learnt, whereas the reflective journal writing could perhaps develop these children's confidence in their knowledge.
7.0.4 Children - Teacher Communication

The children's learning was assisted by the communication established through the journals. The teacher participating in this study kept in touch with the children's mathematics as they wrote, and provided immediate feedback on an individual basis. This was evident through the journals, the teacher's written comments, and through observational notes. Feedback allowed guidance for attitudinal problems as well as pinpointing any areas of mathematical concern and responding to the children's own reported concerns and questions. The journals also provided a concrete text which the teacher was able to use for evaluation of the children's progress.

Mathematical journal writing provided time-lapse snapshots upon which teachers could reflect on the way children were thinking and to respond to them on an individual basis. The journals also demanded that there was reflection on the part of the children, thus providing a safety net for reluctant or anxious learners. Through this reflection there was greater thoughtfulness by the children, who awakened to the wider scope of mathematics and in so doing benefited their mathematical learning.

7.1 Limitations

One of the limitations of the study was that the research was carried out towards the end of the school year when revision and testing of the children was taking place. The consequence of this was that little new work, which may have elicited recording of development and monitoring of learning more explicitly, was being presented to the children. The children may also have responded to more support in this sort of writing. In a study on mathematical journal writing Gordon and MacInnis (1993) encouraged two types of writing, one which was open-ended, as in this study, and one to respond to the teachers' prompts:
"A typical question given to students to investigate their thinking was:

(1) 0.5  (2) 0.42

Which is larger? Why? Are they the same? Why?" (p. 40)

This sort of scaffolding may well have drawn out more evidence of mathematical understanding and its monitoring in this study.

The duration of the study may have restricted the amount of evidence of learning. With additional time children may become more competent at reflecting through journal writing.

The children in the study were all competent writers and enjoyed writing. This may have been the reason for the positive attitude to the journal writing, rather than it arising from a positive relationship with the mathematics they were learning. It may also have been that the children were reacting positively to the extra attention being paid to them with an additional person in the classroom.

The children's teacher made a special effort to ensure that children were thinking and reflecting during her lessons. This is evident in some of her comments such as "I can see someone's not thinking", "who can tell me how their brain is working?", and "did anyone find any other ways to do things?" This preparation for writing may have made it easier for this particular class to respond well to the journal writing, although the research study may have encouraged her to do this.

Due to the restriction of time because of the busy classroom schedule it was not possible to have very much discussion with the children's teacher. She may have been able to provide more evidence of what progress she had seen in the children.

There was a lack of evidence for triangulation which may have been supported by taping of the lessons, and follow up interviews with the children. This would necessitate observing only a few children.
7.2 Suggestions for Future Research

Although this study had various limitations, it did suggest that an insight had been gained into the way children felt about the mathematics they were learning. This information appeared to be of significant value to the children themselves and to the teacher of the children. Much recent research reports on the value of conscious awareness and communication for learning. However, in a busy classroom this is difficult to achieve, especially on a one-to-one basis. This descriptive study showed enough promise that, by means of a short writing time at the end of each mathematics lesson, children were beginning to engage more meaningfully with their mathematics learning, and that their teacher was more aware of what was happening with their thinking through the journal communication. A further study, with a larger and more varied sample of children over a longer period of time, could be undertaken to ascertain whether these benefits could be brought to other contexts by this type of journal writing.

Perhaps journal writing may be a first step in encouraging teachers to gain an insight into what is happening during children's thinking, and to seek to connect their practice with theory. Lovitt (1993) suggests that a metaphorical bridge, constructed simultaneously from both a theoretical and a practical end, would help teachers apply theory in the classroom. He states:

It is hard to clearly separate the roles of teachers and theorists, perhaps particularly so with respect to constructivism with its emphasis on the pupil and the teacher actively constructing a personal theoretical framework in which their beliefs are embedded and which in turn guides their actions. (p. 37)

A study of what teachers learn from their children's journals may show if this is of value in promoting an interest in the work of theorists, and through this give them a "framework for justifying their actions ... and confidence and support for their intuitions" (p. 36).
It would be interesting to find out whether more scaffolding, as mentioned above in "Limitations" (7.1), of their journal writing would help children get to the ideas behind their mathematics. This would require more focus on the mathematical content of the lessons. A multiple case study could reveal richer and more in-depth information about this aspect of children's learning. Of interest too would be mathematical ability, and whether writing would assist children to progress at their own level.

The journals provide concrete evidence of what is happening in the mathematics classroom and in the children's thinking. A study of what is happening when journals are shared with parents may reveal useful information. It may be that this could help break down the belief in "school mathematics" in the wider community and help in the construction of a useful mathematical discourse between the parents and children.

7.3 Concluding Statement

This study suggests that mathematical journals may have the power to encourage children of all abilities to develop good attitudes towards mathematics and in doing so, to assist them to clarify their thinking and create for themselves a picture of relevant, interesting mathematics. It would seem that a combination of activities with concrete materials, discussion and reflection by writing helps in this process. The journals also provided a means of close communication between teacher and children which enabled immediate feedback to assist learning and also information for evaluation.


Stillman, P. (1989). Keeping a journal. In Deakin University Book Production Unit (Eds.), *Writing in Schools* (pp. 118-121). Geelong: Deakin University.


APPENDIX I

Introduction to pilot study.

Year Six: thank you for participating in this study. It is believed that thinking about what, how we learn helps our learning. With that in mind I have set out below some questions & examples to help you write about your maths. I am interested in what you have done & think so please use I (not we) when you are writing. It may not be easy to do but I will appreciate everything that you can write.

Mrs Edmonds.

The following questions & examples are only guidelines- you may write as you wish.

What did I understand?

What didn't I understand?

What did I do to make sure my work made sense?

Did I enjoy today's maths?

Was today's maths difficult? challenging?

P.s. for examples
Examples of writing for pilot study.

These are only examples - so please expand them with your own ideas.

Today I did shapes out of our grid. It was good.

I have a major problem. We’re doing too many fractions. I’m sick of them.

I learnt the real meaning of parallel lines. It means that the lines have to be the same distance apart.

Why can parallel lines be in squiggle lines?

Parallel lines are only when the distance is the same between each line.

Today I learnt about distances. One of them was long. It was really hard.

There was a problem, we couldn’t work out what area meant.

Today I did more work getting used to it now.

I have learnt more about figuring out stuff. I like that.

I learnt that if you read what you have to do, you do it right.

I learnt nothing new today because it was too easy. Why don’t we do more challenging things in maths?

Ref: Mildren et al. (1999)

When do I get to do hard stuff like 1000 x 60000?
### Appendix A

#### Diederich's Analytic Procedure for Evaluating Writing Samples

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<tr>
<td>Organization, relevance, movement</td>
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<td>Style, flavor, individuality</td>
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Scoring: 1—poor  2—weak  3—average  4—good  5—excellent

Total \( \times 5 = \) [Blank]

Total \( \times 3 = \) [Blank]

Total \( \times 1 = \) [Blank]

**Total Grade**: [Blank] %
APPENDIX IV

Comments on the children in Year 6 by their teacher

The children in this class are all quite competent in the maths area. There are no children who are "remedial" only those who are a little slower to grasp new concepts. A total of five children go to PEAC (Primary Extension and Challenge) and we have varied the children who go each term because of the high percentage of eligible children in the class.

I try to make my maths lessons relate to "everyday" life and to allow the children to take on a "problem solving" approach i.e. lots of exploration/explanation/exploration. One of my aims is to make the children independent learners who will "have-a-go" at solving problems. My lessons usually contain much talk as I feel the oral aspect helps to get the new concepts and the problem solving techniques. I also feel that peer tutoring is a powerful tool - the children are more likely to be on the same wave length. We have acquired three students from Asia whom I have found to be very good at the technical aspects of maths but are not as confident when it is not straight forward.
APPENDIX V

Comments on the Journal Writing by the teacher

At first I felt the children may get bored with writing the journal every day for a month. However they seemed to enjoy expressing their thoughts (they are a group of children who do like writing). I have gained experience in having the journals done in my room. It really does give an idea about the children's confidence, preferences and academic progress. I feel the journal has been a powerful evaluation tool which has enabled me to see who may need more help or who may need a morale boost.
List of the teacher's comments noted during lessons

I can see someone's not thinking.

Who can tell me how their brain is working?

Did anyone find any other ways to do things?

Where do we use probability in real life?

Did anyone work it out in a different way?

You know I like you to talk about maths.

I'm going to write down things people have written down, listen carefully.

Let me expand and show you how I did that.

I always look at the zeros. Some people might do it differently.

Let me give you a clue before you start.

What are we actually doing?

Some people got this wrong in the test and I want to illustrate why.

I know these are easy - but what is happening - what are you understanding?

Can you tell me ways of knowing which are the prime numbers.

It's good to see you saying you don't understand.

Your mind puts it into your language.

Who'd like to demonstrate how your mind is working?
APPENDIX VII

Children's Writing Samples

JOHN No 2

29.4.91

today number probo, it was easy, instead for
one number it was the easy but I put
down the next number after the proble,
we goin the same so it will fit in
and just wait a got 7 int. that graf

5.12
Mother book we were doing the normal
same I got up to number seven. I'm
slow but I got them all right.
and it was miss fact I was
slow not mine but I like easy

SAM - No 8

Today is Tuesday today we did two things. One
of them was the geogrid we made triangles and
our initials on squared paper. And found out
how many squares we used up. It was very
interesting fun. I didn't have any problems

Diagram

\[
\text{Diagram}
\]

DM
APPENDIX VIII

Examples of the category of Attitude Positive because “it was easy”

1 Michelle ... it was quite easy. (14.11)
   It was quite easy once you got the hang of it. (6.12)

2 John It was a bit esay ... (13.11)
   ... and gest what I got seven out of seven isn't that grat. (28.11)
   ... but I like esey work. (5.12)

3 Greg ... so easy everyone has a good chance of getting 100%. (22.11)

4 Chris ... easy when you get the idea of it. (14.11)
   Luckily for me they were easy. (22.11)

5 Pia ... one was quite easy. (28.11)

6 Kelly ... it was fairly easy. (22.11)

7 James It was easy and fun. (21.11)
   ... but actually quite simple. (22.11)

8 Sam It was easy. (19.11, 21.11)

9 Carl Most were quite easy ... (22.11)

10 Doug It was pretty easy. (19.11)

11 Sara I like maths because it is easy (11.11)
   ... it was simple. (19.11)

12 Russell The problem was pretty easy. (26.11)

14 Joan The pie graph was easy. I enjoyed it. (26.11)
   They were all easy and I got them all right. (5.12)

18 Leslie I really liked it because it was easy and fun. (2.12)
19 Eryn  I found them really easy it was really fun. (5.12)
26 Tiffany I didn't enjoy it - probably because it was a bit hard. (15.11)
30 Richard We enjoyed it especially me because I could do it easily. (13.11)
APPENDIX IX

Examples of the category of Attitude Positive "because it was challenging"

3 Greg  I learnt from trial and error, mostly error ... somehow I finally caught on. (15.11)

5 Pia  I sort of understood it but I would like to do it so I can understand it. (14.11)

7 James  Although it was fairly difficult it was fun to work out. (27.11)

10 Doug  I do not understand some so I would like to study it a bit more. (13.11)

11 Sara  Too easy. I need something more challenging to do. (14.11)

22 Luke  Math today was better ... because I had to actually think. (12.11)

... but the harder and more challenging they got the more fun and exciting they were. (6.12)

23 Stephen  I really enjoy problem solving because it involves a different level of thinking. (26.11)

It presented no mental challenge at all. (2.12)

I believe studying relationships in our work is a lot more fun than doing it. (4.12)

Today I got what I wanted - something harder. (5.12)

26 Tiffany  It was fun doing the challenging one because you really have to use your brain. (6.12)
APPENDIX X

Comments from the children's Journal Appraisal after two weeks of writing

1 Michelle  I like writing in the journal because it helps me think about what I learnt every morning.

2 Andrew  At first I thought that the idea of having a journal would be a long boring session of writing but it has turned out to be good and I like the idea of your being able to put down your proclam. I neither thought I say this but it is fun.

3 Greg  To me I have found no benefit in keeping a journal. I did partially enjoy the chance to express myself, but something what would be clear to me would not be clear to anyone else.

4 Chris  I think that writing journals can be quite interesting.

5 Pia  I am enjoying doing this journal. If I don't understand I can look back to see whether I had a method.

6 Kelly  I think the journals are very good because they help you learn more about what you have learnt because you are thinking about your maths. I liked writing about what I did because it gave me confidence for the next time I did maths.

7 James  I thought writing the journal was a good idea although it wasted time during maths. Writing the journal made me think about what we really learnt in the lesson. I like the thought of being able to express what we really thought about maths.

8 Sam  I don't think the journals helped me to understand maths.

9 Carl  I didn't find that the journal helped me understand things. I always think about my maths. The journal didn't improve that.
10 Doug ... it gives you a chance to express your feelings. I really enjoy writing this every morning.

11 Sara Sometimes it was helpful because while you were writing it, it helped you understand it even more. But sometimes I just didn't feel like doing it because either - the maths gave me a headache or the maths was hard and made me feel like I didn't want to do anything.

12 Russell I think writing journals are relatively fun. It helps me think of some of the mistakes I've made and how to resolve them.

14 Joan Yes I enjoyed writing what I though because I know what I am writing and helps me to revise the work I do. I like it because I know what I don't understand. It was fun.

15 Lynne Writing these journals has helped me to think about maths: the values of it; how we use it; and the ideas behind it. At first I thought doing journal was a big pain in the neck. But now I am better at it ... I enjoy it more. Unfortunately we will soon be stopping.

16 Jane Writing a journal helped me to understand the maths. I would like to do another maths journal next year.

17 Susan It sort of helped me with what I was leaning. It's also easier to tell someone/something about what you've just learnt. I did like to say what I thought of the maths instead of cramping it up inside and being stressed to the max! Sometimes writing a diary was a bit of a drag.

18 Leslie I think writing journals is a bit boring ... but still it helps me explain my thoughts of maths better. And it sometimes makes me understand what I am doing. I liked being able to say if I HATED it or if I LOVED it. It was very helpful.

19 Eryn ... it helps me understand what we did because if I didn't understand I wouldn't be able to write about it. It also helps when you write because
sometimes I just click and realise what I did wrong. If I hate it I get it out of inside and it makes me feel better.

20 Fiona  
O.K., I confess my journal is part of me. It really helped me along in my maths. I now can look back on it and see what we did. I like being able to write down things (plus it takes up some maths time). I now think about my maths and I won't go blank.

22 Luke  
Writing this journal has in some ways helped me understand math a bit but not much.

23 Stephen  
This journal does help me understand my maths more because it lets me put it in my terms, terms that I can absorb better. It helps contribute to let me see it in a clearer light.

24 Sonia  
I'm going to tell the Truth. I didn't enjoy writing the journal and it was a nuisance having to hear the dreaded words IT'S TIME TO DO THE MATHS JOURNAL!!! I hate maths journals.

25 Jade  
away

26 Tiffany  
... it helps me remember what I did wrong so I can get it right next time. I enjoy being able to say what I think about maths.

27 Scott  
No, these journals did not help with some parts of math. Sometimes they confused me. I did enjoy saying what I thought of maths.

29 Thomas  
I think that these journals have made me check if anything was wrong. I liked saying that I enjoyed it or not. So other people can see if I enjoyed it.

30 Richard  
My journal helps people to know what I am learning, thinking and what I know about maths. It helps me remember what I learnt in the last two weeks when I read it and it was very helpful. I like being able to tell
people about my achievements. When I read what I wrote, it helps me to feel more about learning maths.

31 David  Had not started at the school.
APPENDIX XI

Comments from the children's Journal Appraisals after four weeks of writing

1 Michelle  ... I feel that journals help you understand what you had learnt better. I also like writing in the journal because it helps me express what I really thought about each maths lesson.

2 John  ... but at first I thought this would be just another bit of work ... but I loved it.

3 Greg  ... some things have changed, firstly I'm starting to enjoy it now because there have more recently been (the maths) more complicated and there is more to write about.

4 Chris  ... let you say exactly how you feel or what you did.

5 Pia  Hi, in the last few weeks I have been learning a lot more than I used to. Writing these journals helps me learn. I know much, much more than I used to.

6 Kelly  I enjoyed them a lot and they helped me understand what I did and the problems I had.

7 James  At first I didn't like the idea of writing a journal but now I recommend all students to write a journal on the things you learnt. It helps you think about what you have just learnt. It also enables you to express how you felt about what you are learning.

8 Sam  It helped me to write down because it helped you understand maths.

9 Carl  It has been most interesting writing my Maths Journal the past 4 weeks and I'm sure I've learnt a lot. It was good being able to express my problems, failures, success etc.

10 Doug  I think it is easier to go over a subject, it makes you think about what you're doing. The journal writing has helped me understand long
division a bit more. Sometimes it's good to share how you feel
especially when you're frustrated.

11 Sara

The journal is now easier to write. Doing a journal made me realise a lot
about what things I liked in maths and what I have most trouble with. It
let me write down my feelings. I enjoyed writing the journal.

12 Russell

away

14 Joan

... it's good because it helps me really think and if I write something I
really don't understand I could question myself "What really is the
meaning?"

15 Lynne

away

16 Jane

It was hard to write about the maths the first couple of days but after
that it got easy and fun.

17 Susan

Writing a journal has also helped me figure out and understand maths
problems because it is always easier to say or write it to
someone/something than to get it told to you.

18 Leslie

away

19 Eryn

At first I didn't enjoy doing the journal but then when we kept going I
decided I liked writing down what I thought of things and I liked it a lot. I
learnt a lot more.

20 Fiona

I'm improving every day in maths ... Thanks to my journal I have really
thought about my work.

22 Luke

I think it might of helped me understand things better but I think it would
of helped more if you did it throughout the year. It has helped me to
think and remember what I learnt. It also tells the teacher what we
need to do more work on.
23 Stephen  I really thought this journal was great! ...It really helps me learn when I'm writing about it. It helps my maths when I put it into terms that I can interpret with ease. I thought this journal would be the most boring thing on earth. I was wrong.

24 Sonia  I've changed my mind about journals. They are quite fun. Well, it didn't help me with my maths but I do enjoy expressing myself.

25 Jade  away

26 Tiffany  ... because if you make a mistake and you knew what the mistake was, the journals could probably help you get it right next time. It is fun.

27 Scott  Sad - about no more journals. Fun - journals. Radical - the way I found out formulas using the journal.

29 Thomas  This short month I think I realised I have really improved e.g. in tables, problem solving etc. And mostly because of this diary. I look at my work to see what to write - that means checking my work.

30 Richard  The journal has help me a lot when I read it. I have learnt many new things. It is easier to read the journal than to remember what things we had done. The journal makes me think about what I am writing and I can think over the problems when I have time. It is easier to figure out problems in this journal than in the brain.

31 David  I have only been here 2 weeks but I think writing journals is a very good idea. I think it helps you understand once you have done it.
APPENDIX XII

How children would use journals in a class they were teaching.

1 Michelle  ... at least twice a week, but mostly for them to write in whenever they feel they want to. I think this is because I feel that journals help you understand what you had learned better.

2 John  ... I would let my kids have half an hour every week to right down every thing they learnt and was not sure about every week.

3 Greg  ... whenever we start or finish a topic. Also people who wanted could write in it at any time.

4 Chris  If I was a teacher I would use journals whenever we do maths. I would tell the class to keep them on their desks and whenever they have a problem they can write it in their journal so the teacher knows how to and what to help the child with.

5 Pia  If I was a teacher I will tell them to do the journals everyday because they have it fresh in their minds.

6 Kelly  I would use them almost every day for kids that had maths problems.

7 James  I would make my students write in their journals when they wanted to or had a problem because it would help them understand what they were doing.

8 Sam  away

9 Carl  Each kid would write notes, problems etc after each maths lesson and each lesson would be something from a book ... so could venture further on.

10 Doug  I'd do it everyday, just as now. (Journals are really helpful).

11 Sara  ... but only once a week, because I've found that sometimes after maths you don't really have much to write about but other times you do.
I'd do it for a whole year because doing it for 4 weeks wasn't really enough because the last week I knew more to write about because of knowing what other people wrote and after a while it sinks in.

12 Russell
away

14 Joan
I'd like it every day then you know what you did.

15 Lynne
I would use the diaries for maths to help the students learn maths and help them think about maths a bit more.

17 Susan
I'd do a journal probably the same as this, because it is enjoyable.

18 Leslie
away

19 Eryn
I would only use it when I don't think the kids understood the maths. The other times I would use it was after something new so they would understand it a bit more.

20 Fiona
I would give my children journals not only for maths but for language as well.

22 Luke
I would get the class to write journals not everyday and not only for math.

23 Stephen
(Nothing was written.)

24 Sonia
I'd give a journal to every person and then say that they had four weeks and they had to write in their journals 17 times so they could do it whatever day they pleased.

25 Jade
away

26 Tiffany
I'd use the maths journals every day because it helps the students express their thoughts.

29 Thomas
I would use the journals once a week.
30 Richard  I will give the journal for my students to write in only when they had trouble, learning something and how the journals help them.

31 David  I would use it to try and make the pupils understand the problems more easily. I would use it every two days, because if you write every day it becomes a bit boring. I think it is a good place to show when you think something should be changed or set out in another way.