CHAPTER FIVE

EMERGING THEMES

Introduction

The previous chapter discussed the findings from each data collection method used in the study of emotional states. Data from the initial data collection sources provided the researcher with an extensive list of emotions that the children in the sample experienced during Mathematics lessons. The emotions were able to be placed into four main levels: extreme positive, mild positive, mild negative and extreme negative. Each level signified an emotional state and was based on the intensity of the emotions found within it. As subsequent data was collected, it was found that the mild positive and the mild negative levels were able to be combined to form one level. The researcher called this level the neutral state or state of equilibrium. The three main levels then became the researcher's elementary model of emotional states. Descriptors and indicators were able to be devised for each level within the model.

This chapter will discuss a further refinement of the researcher's model of emotional states. Each level in the model will be defined and indicators of the emotional states will be provided.

In addition to the discussion about the model of emotions, Chapter Five describes the themes that emerged from the data. The chapter begins with a discussion of those themes.

The Themes

Five dimensions of Mathematics that have been discussed in the literature were used as an organising framework for the themes that evolved from the research. This framework was selected as a logical way to organise and present the data *after* they had been collected. The framework was not used to control data collection.

The first dimension of Mathematics related to testing as it had been discussed in the Cockcroft Report (1982), An Agenda for Action (1980), the Mathematics K-6 (NSW Department of Education, 1989) syllabus and the Mathematics literature. The second

dimension was the subject of Mathematics as it was embodied within the Mathematics K-6 (NSW Department of Education, 1989) syllabus and the literature on Mathematics and affect. The third and fourth dimensions dealt with children's' attitudes to, and beliefs about, Mathematics. An additional theme, language, was found to permeate all the other themes.

Overview of the Analysis

Three test-related themes (factors) were coded in the data: negative emotions, grades and time pressure.
The negative emotions category contained two sub-categories:
* non-verbal indicators of worry and cognition and
* physical reactions.

Three Mathematics-related themes (factors) were coded in the data: peers, Mathematics at home and Mathematics tasks.

The 'Mathematics tasks' category of the theme was found to contain the sub-categories of:
* bookwork/activities/tests/climate
* positive emotions and body language
* physical reactions and challenge.

The third and fourth dimensions, attitudes and beliefs also contained sub-categories.

The 'attitudes' theme contained the following sub-categories:
* the subject of Mathematics
* testing
* activities
* peers.

The 'beliefs' theme was able to be sub-divided into:
* Mathematics as a subject
* the teacher
* peers
* parents
* the self
* tests.

As the data was analysed it became obvious that some categories within the main themes were interrelated. For example the data on Mathematics as a subject contained elements that made it necessary to place the category in both the attitudes and beliefs themes. Similarly, while testing was a theme in itself, data from the research necessitated that it also be discussed under the heading of attitudes and beliefs. In order to gain a complete understanding of the themes that emerged from the study the researcher considered that it was essential to present each one under the headings to which they had relevance.

The following section will discuss each of the five major themes.

TEST FACTORS

Negative Emotions

The study of emotional states showed that the children in the sample experienced negative emotions during Mathematics lessons. Data to support this finding came from the children's discussion of the words they had circled on the self-response sheet, their discussion about the physiological reactions they experienced during Mathematics lessons, observable gestures and journal entries.

Negative emotions were often found to be associated with tests, especially written tests. The children may have developed an exaggerated idea of the importance of written tests because of the teacher's regular use of testing, and her use of test marks in reporting to parents. Knowledge of this may then have contributed to the creation of negative emotions during test sessions.

The unwanted side-effect of testing (the production of negative emotions), lends weight to Morris' (1981) argument, that if tests are used in Mathematics lessons, some form of positive reinforcement should be included in the lessons in order to counteract the effect of the negative emotions that are created during the tests.

The testing situation usually resulted in the children achieving scores lower than 100%. Many of the children in the class considered marks lower than 100% or 90% as a failure. The following extract from a journal illustrates the point.

B.R.: I feel sick and worried [before the test] I think my mark is very bad. 65% [the mark the child received]

However, some children were satisfied just to have passed a test as the following statement shows.

G.G.: Because then I know I've passed the test and I don't have to worry about a mark to tell me I've passed the test.

During the class discussion the researcher raised the issue of feeling nervous during Mathematics tests. Nineteen out of the thirty-one children in the class indicated that they felt more nervous completing Mathematics tests than they did completing tests in other subjects. The following reasons for feeling nervous were given by the children: not liking Mathematics tests, not being able to do the test, not knowing what would be in the test, having to show the test to their parents, being better at another subject, the possibility of getting a low mark, having to read out their marks to the teacher and the difficulty level of Mathematics compared to other subjects.

While discussing the negative emotions of worry, anger embarrassment and frustration in the group interviews and the class discussion, the cognitive evaluation, or 'cold' aspect (Mandler, 1984) of emotion was mentioned. It was verbalised by the children as "your mind goes blank".

For most of the children in the sample, their minds went blank when they did paper and pencil tests about which they were nervous. For some children, their minds went blank when they worked on the blackboard or did oral Mathematics tests. The reasons the children gave for their minds going blank were: being nervous, worried or scared, not paying attention, feeling embarrassed, wondering what their friends would think of them if they got the question wrong, not understanding the question, wondering if they knew how to do the question, wondering if they would get the question correct and forgetting what the teacher had said.

The following excerpt from a group interview provides one explanation for a girl's mind going blank.

J.S.: Um, like you get embarrassed [at being in front of the class] so you're like worrying about that so your mind is not um, thinking about the question.

The mind going blank was also found to be related to extraneous thoughts that entered the children's heads and prevented them from concentrating on a task. This finding indicated that some of the children may have been experiencing panic or Mathematics anxiety, which as Buxton (1981) has stated, has the ability to block thinking.

As several of the explanations for the children's minds going blank related to cognition the research can be seen to support the cognitive theorists perspective of emotion.

Frustration was a negative emotion that was found to be associated with the children being unable to solve a question on their test papers.

T.C.: I sometimes get f-f-frustrated well sort of when I, I'm I just get stuck.
Teacher: When you're stuck on something?
T.C.: Yeah, I just (pause of 2 seconds) yeah.

Worry was found to occur at any stage in the testing process: before, during or after the test. The following entries from two journals typify the children's feelings about written tests.

[A girl at table one]
26-8-94 Week 7 Before Test
1)I feel fritend and there is butterflys in my tummy.
2)I am thinking about how I wish maths was not true.
3)I hope I will get 95 or 100.

After
I feel releafedx releaved and sort of worried.

30-8-94
1)I think it was a hopeless mark.
2)I'm thinking of how hopeless it was.

[A boy at table three]

3-11-94
1)I am afraid to do a Maths test.
2)Don't know [How he feels]

[After the test]
3)I feel very, very, bad because it wasn't very easy.
4)Est: 60's

[After having received the corrected paper and achieving 60%]
1)I feel real bad.

Although the children were not asked to write down or discuss how they felt as they actually completed a test, data from the researcher observations and videotapes indicated that many of them experienced negative emotions as they were working. Frowns, and shrugs were recorded in those data collection methods.

Negative emotions, especially intense negative emotions, appeared to have more impact on the memories of the children in the sample than positive emotions. It was far easier for the children to give the researcher an example of a task in which they experienced negative emotions than it was for them to give her an account of a task in which they experienced positive emotions other than the extreme positive emotion. Even when a child was surprised by the low level of difficulty of the questions on a written test, or surprised to receive a mark higher than the one she/he expected to obtain, the pleasure of the occasion often appeared to be marred by the memory of the worry that was experienced during the test. The salience of negative emotions in children's memories adds substance to the theories on emotional memory that have been discussed by Lang (1994), Ortony et al. (1988) and Mandler (1984).

The study of emotional states provided very little data about extreme negative emotions. The small amount of data that was collected on this topic came from the interviews and the children's journals. The data suggested that extreme negative emotions were sometimes experienced during written tests in which the children thought they had done poorly.

Unlike Mandler (1984), who argued that the physiological reaction of an organism determined the intensity of the emotion it experienced, data from the research indicated that it was the unexpectedness of success or failure, the unexpectedness of being able to do or not do a task and the degree to which the task was appealing or enjoyable, that determined the intensity of an emotion. Evidence to support this finding was found in the children's discussions about the 'YES action' (See Chapter Three: Group Interviews and Class Discussion). The data on intensity supports Ortony et al.'s (1988) claim that global and local variables, such as unexpectedness, arousal and appealingness influence the intensity of emotions.

Non-Verbal Indicators of Worry and Cognition

By using three frames of reference (variety, frequency and duration of observable physical actions) the researcher believed that it was possible to distinguish between

actions that indicated worry and actions that indicated cognition. Where a child was seen to be one who had a personal habit repertoire that often involved facial touches, classifying an action as either a worry or thinking gesture became more difficult. It is possible that there were times during the analysis of the data when some gestures were wrongly classified. However, in the sample only three children were considered to have a habit repertoire which included a high frequency of facial touches. Consequently, the difficulty of classification did not prove to be a major problem. From the review of the videotapes, the researcher and the undergraduate independent observer constructed a mutually acceptable list of indicators of cognition and worry.

Indicators of cognition that were recorded during the research included looking heavenwards, staring at an object or person, blinking frequently, wrinkling the brow, tapping a finger or an object against a part of the face or mouth or against an object, having the fingers lightly touching the lips, cheek or another part of the face, resting the fingers between the lips or teeth, resting the cheek or forehead on a hand which was either clenched or open, muttering to oneself and using the hands or fingers to assist in counting or working out a problem.

Actions indicating cognition were seen to be long or short in duration and were sometimes performed in combination with another action. Many thinking actions were ones which could have indicated worry. For example, when a child was thinking about an answer her/his hand, finger or an object held in the hand was often seen near or in the mouth, to the side of the head or on the forehead. Only by looking for other indications of worry, such as the frequency of the occurrence, the variety of actions and the amount of time spent performing the actions, could thinking actions be distinguished from worry actions.

Worry actions involved a large number of self-adaptor and object-adaptor actions. To qualify as a *worry* gesture an action had to have been performed for a prolonged period of time and had to have been carried out in combination with several other self- or object-adaptor actions or facial expressions. To enable worry gestures to be distinguished from random actions or thinking gestures they also needed to have occurred frequently throughout the course of the task.

Indicators of worry that were observed in the sample included: sucking, biting or tapping the fingers or an object against a part of the head or face or against another body part or another object, biting the fingernails, scratching the body (especially in the head and neck region), touching or holding the nose, rubbing the eyes, brushing the hair away from the

face and forehead (especially pushing it behind the ears or up from the forehead across the top of the head and down towards the back), wringing the hands, twisting or turning an object such as a ring, bangle or necklace, twisting a piece of clothing, resting the hands on the cheeks, forehead or jaw, jigging in the seat, jigging the legs, frowning, grimacing, poking the tongue slightly between the lips, licking or biting the lips, having the mouth gaping, pulling faces and wrinkling up the nose and mouth.

Ortony et al. (1988) have stated that even though it is important to identify characteristic behaviours associated with individual emotions, the behaviours should not be considered to constitute the emotion. In the research, the non-verbal gestures that indicated worry were not considered to be the emotion. The analysis of the data from the research also supports Ortony et al.'s (1988) claim that behaviours result from particular emotions and are determined by the way individuals construe the situations in which they find themselves. This finding further reinforces the role of cognition in an emotional experience.

Banbury and Hebert (1992) argued that when there was a contradiction between the non-verbal and verbal message, the non-verbal message should be taken as being the most reliable. Evidence to support this idea was found in the research. While analysing a videotape of a written test, a female student who classed herself as a low-worry student for paper and pencil tests, was seen to exhibit signs of extreme worry as determined by the researcher's three criteria. The variety, frequency and duration of the girl's actions indicated that she was highly anxious about the test. The child's journal entry for that day supported the researcher's observations of her behaviour.

> Journal entries
>
> Before Test
> [Thinking] 1)How well I will go in my maths test.
> [Feeling] 2)I feel happy.
>
> After Test
> [Thinking] my make (mark)
> [Feeling] I feel worried about my make (mark)

The girl's body language was in strong contrast to that of the boy beside her. M.K. had ranked himself at 'two' (slightly worried) on the worry scale for paper and pencil tests yet his object- and self-adaptor actions and facial expressions were minimal compared to those of his partner. The boy's journal entries for that day were as follows:

Before Test
[Thinking]1)What my marks are going to be
What B.G's marks are going to be
[Feeling] 2)I feel nervous and glad

After Test
[Feeling] very nervous
[Thinking] I am thinking about Peers Support

After getting the test back
[Feeling] I feel bad
[Thinking] What we're going to do next.
What J's going to say

The boy's actions, or lack of observable actions, fit with Sowder's (1989) finding that emotional responses are not always visible.

Physical Reactions

As the literature on the emotions, anxiety and test anxiety had discussed visceral and somatic responses, the researcher wanted to explore the issue in the individual and group interviews. The second question of the individual interview asked the child if she/he had ever experienced a bodily reaction when she/he did Mathematics. The responses to this question revealed that a number of physical sensations were experienced by the students. The same question was asked during the group interviews. The children either repeated the responses they had made during their individual interview or did not make additional comments.

The most enlightening discussion about physical reactions came from the grade three children's group interview. The following extract is a part of that interview.

Teacher: Next question. Some of you mentioned that you get physical feelings, like you sweat or your heart beats quickly. [Pupils: Mmm] Do you have any comments?
J.S.: Yeah. I get this real funny feeling ....
[F.L: I don't]
J.S.: ... in my stomach. It goes real funny.
T.H.: I go all shaky.
Teacher: Hold on. Right. T. goes all shaky. You [indicating J.S.] get a funny thing in your stomach.
[Pupils all talking at once]
J.S.: I don't know if I'm nervous or something or if I'm happy.

Teacher: Right.
T.H.: I get butterflies.
Teacher: You can't tell? [looking at F.L]
T.H.: In a race in swimming I get butterflies.
Teacher: Right. Same as when you ..[looking at F.] And you get nothing?
F.L.: No.
M.S.: I get shaky and nervous.
Teacher: You get shaky and nervous. Do you get anything [indicating G] G?
G.G.: Not really.
Teacher: Not really.
S.M.: Um, I get shaky sometimes and sometimes I feel um, like, feel um, err, this yukky stuff like when I have this eye drops and it tastes like it's going down my throat.
Teacher: And you get that same taste in your throat
S.M.: Mmm.
Teacher: ... when you get nervous or upset in a Maths lesson? Is it just for lessons or just tests? *
J.S.: I reckon it's just tests.
Teacher: Just for tests J.? [she nods] Just for tests M.? [he nods]
G.G.: Mm, I don't know.
Teacher: G. doesn't know. [pupils laugh]
G.G.: Sometimes for tests.
T.H.: Probably tests.

* The child had mentioned in his individual interview that he had these reactions during tests.

The majority of the children in the sample stated that they had experienced physical reactions during Mathematics lessons. Asked when the reactions had occurred, the overwhelming response was "during tests". The children stated that physiological responses could occur at any stage in the testing process. One child, however, stated that she only experienced a physical reaction when she had to work at the blackboard.

From the individual and group interviews and the class discussion the researcher found that the children experienced the following physical reactions: "butterflies in the stomach", "a stomach ache", "a bit sick in the stomach", "funny in the stomach", "a funny feeling in the stomach", "shaking in the stomach", "a fast heart", "a hot heart", "getting hot", "sweaty", "shaking", "shaking hands", "shaking all over", "shaking legs", "a bit of a headache", "a migraine", "cold", "cold and hungry", "a yukky taste in my throat" and "not being able to breathe properly'. Many of the physical reactions that were discussed by the children had been recorded by Byrd (1982) in her study of anxiety.

Statements about physical reactions that were taken from the children's journals included: "I feel sick", "I feel really sick", "I feel I have butterflies", "I feel sick and worried", "And now I have butterflys and scard", "I feel sick in the stumice", "I feel really scared and I have butterflys in my tummy" and "I feel really hungry". These reactions support Mandler's (1984) notion of the 'hot' aspect or gut reaction of emotion.

Physical reactions mainly occurred during Mathematics tasks in which negative emotions were experienced. However, negative emotions were sometimes found to occur before tasks that the children enjoyed or ended up enjoying. Whether or not those emotions were accompanied by physical reactions remains unknown. The researcher failed to follow-up that line of inquiry.

[Feelings before activity] 1)I feel a bit nerves (nervous)
[Thoughts before activity] 2)I think the activity fun
[Feelings after activity] 3)I am feeling o.k.

Journal entries showed that 70% of the grade four girls and 75% of the grade three girls experienced physical reactions during written tests, while 50% of the grade four boys and 66% of the grade three boys experienced physical reactions during written tests. The gender component was not investigated in detail in the research because of the small sample used in the study. (Sample size was then recognised as a limitation of the research.) However, a cursory glance at the above statistics indicates that the girls in the sample were more likely to be experiencing a physical reaction before a written test than the boys. The issue of gender and the experiencing of physical reactions needs to be investigated in future research in which larger samples are used.

The majority of the physical reactions that were discussed by the children occurred when they experienced the negative emotions of worry, nervousness, fear and being rushed. For example, during the first administration of the questionnaire a child circled the words 'clever', 'interested' and 'nervous'. When asked in the individual interview when she felt nervous, her reply was "before tests". The child also stated that when she was worried she would "shake all over".

Some expressions of physical reactions that could not be classified as being a manifestation of either a negative or a positive emotion were recorded in the group interviews and in the journals.

[Group Interview: Before Test]

J.S.: I get this real funny feeling in my stomach. It goes real shaky. I don't know if I'm nervous or something or if I'm happy.

[Another statement by the same child. Again she is talking about how she feels before doing a test. J.S. is a high-achieving Mathematics student who enjoys all Mathematics work including tests.]

J.S.: I don't feel nervous at all. I just get a funny feeling that I don't know what it means.

[Journal entries]

R.A.: 1) I feel funny and can'nt wait to start [before activity]
2) I think it is fun. [after activity]

Both J.S. and R.A. could be considered to be experiencing excitement. In the above examples, 'excitement', a positive emotion that was expressed as "a funny feeling" and "I feel funny", could be assumed to contain an element of worry, a negative emotion. This however, was denied by J.S. The idea of a negative emotion having a beneficial effect is similar to Mandler's (1989) claim that stress can sometimes be helpful, and to Byrd's (1982) argument that stress can be facilitative. This finding from the research indicates that it should not always be assumed that worry needs to be eliminated from children's' experiences. The same idea has been discussed in the research by Thompson and Thompson (1989).

J.S.'s denial that she was nervous could have resulted from her belief that nervousness was an unpleasant sensation, and because she was not consciously feeling nervous, she must not have been experiencing that emotion.

The beneficial effect of worry was raised by three other children during the course of the research. Extracts from interviews with groups three and four illustrate this point.

Group Three

Teacher: So you're saying what she said, that even though you don't like them [tests], they're [the tests] necessary so you know how you're doing in Maths?
J.C.: Wouldn't that be horrible! [Not being able to work out your bills when you got older.]
Teacher: Last comment on that one. Yes?

K.B.: Well, the Maths, it's it's, it's good to do but for some people, they dislike it real bad and something and people who like it, like most people in this classroom like it except B.G., he doesn't try and ...
J.B.: He doesn't like it.
K.B.: .... He doesn't try so he doesn't, sort of like it.
Teacher: OK.
S.B.: He doesn't really worry about it. He's, he's so used to getting lower marks all of his life he's just totally forgotten about worrying.
K.B.: He's totally bombed out!

Group Four

Teacher: No, really? OK. Next one. Would you feel better about Maths, if we only did one or two tests a year?
M.S.: (quietly) It's better doing the tests then, cause it makes you try harder.
Teacher: Makes *you* try harder. Some people might not, but at least you try harder.
M.S.: Yeah.

Grades

As well as negative emotions and physical reactions, most children expressed concern about the grades they thought they would get when they did paper and pencil tests. Several issues about grades evolved from the research.

One of the most common comments made by the children about their grades was that worry about marks dominated their thoughts during written test periods. This again can be seen to highlight the idea that cognition plays a part in the experiencing of emotion. A journal entry illustrates the point.

J.C.: 1)I feel OK but I have butterflys.[feeling] 2) What mark I will get.[thinking about] 3) Est: 90's [estimated mark]
After Test
1)It was OK.
(After test was returned)
It's OK, I'd prefer a higher mark.

When the children were asked to explain why they had circled the term 'worried' on the modified Clarke (1987) self-assessment sheet, many of them stated that it was because they thought about the marks they would get for written tests, and those thoughts worried them.

[Class Discussion]

L.G.: I get, ah, I get um, worried (pause) thinking that I'm going to get a low mark.

Concern about marks occupied some children's thoughts because they knew their parents would see their test papers.

[Class Discussion]

M.F.: Um, because you, because you have to show it to your parents.

Data collected from the class discussion, the group interviews and the journals indicated that many children did not like to have their marks made public.

K.B.: Um, when you [the teacher] read, sometimes you read the marks out. It's, it's embarrassing.

[Journal Entry]

R.A.: I think Mrs Reddy did not have to read my mark.

[Group Interview]

Teacher: Any other comments to make about Maths?
M.S.: When you're [the teacher] marking the tests you put the marks down straight away in your book.
Teacher: Instead of getting you to call them out?
J.S.: Yeah.
M.S.: Cause it makes it a bit easier.
J.S.: Then, and then someone doesn't get embarrassed .....
T.H.: Embarrassed.
J.S.: .... with what their mark is.
Teacher: OK.
M.S.: If they get a low mark. Like forty.

Fear of being laughed at and embarrassment were the two reasons given by the children for not wanting to have to call out their marks to the teacher. The children's dislike of calling out their marks adds weight to Clarke's (1992) statement that assessment is a high profile classroom activity.

The data about embarrassment and being laughed at also supports Wood's (1982) argument that being laughed at during Mathematics lessons should be discouraged as it could lead to the development of anxiety in children. Being laughed at because of the marks obtained in written tests did occur in the class as the following extract from a group interview shows.

S.B.: M.K. sometimes laughs at us because we don't get it all right.

Marks lower than those that the child wanted often made her/him feel disappointed with herself/himself. When this happened regularly it appeared to effect the child's self-esteem and her/his beliefs about her/his Mathematical competence. The child's attitude to Mathematics also appeared to be influenced by the marks she/he got on tests.

Group Interview

(This child usually scored grades lower than 50% on Mathematics tests.)

K.B.: And, the other half is that like (pause of 4 seconds) I'm not good at working out I'm not good at hardly anything. Like I'm hardly good at Spelling. I'd rather do that sort of thing but Maths, I wish it wasn't invented.

Journal entry

Before test

J.B.: 1) the vidio camera (what he was thinking about)
2) Like I'll get less than 50% (how he felt)

After Test

I feel hopless and misrable (how he felt)
The vidio camera (what he was thinking about)

One child in the class stated that she was embarrassed when her neighbour got higher grades than she did. Another child stated that her continual high marks made her feel "that, I feel that I'm too good at Maths".

The class discussion investigated the children's preference for the type of grading system used by the teacher for written tests. The awarding of a letter 'S' to signify the child had passed the test or 'US' to signify failure, was discussed along with the traditional system of being given a numerical grade. Despite the prominent place of marks in the children's thoughts and the apparent connection between marks and negative emotions, twenty-eight of the thirty-one children in the sample stated that they preferred to get a mark instead of a letter. The reasons the children gave for this preference were: "the grade

tells you exactly where you fit in", 'a letter doesn't tell you as much", "the mark tells you what you have to work on, how many questions you got wrong and what each question was worth", "there's more variety in marks", "letters are boring", "it is quicker to look at a mark than to add up ticks", "marks quickly tell you how you have done", "ticks could be confusing" and "you can compare your mark to someone else's".

When the children were asked if they liked to know how their mark compared to the marks of others, twenty-nine of the thirty-one children stated that they did. It appeared that the desire for quick feedback, which provided the child with an indication of her/his position in the class, was the main reason for the preference for grades over letters.

The two children who preferred letters to grades gave the following reasons for their choice: "I know I have passed the test" and "I don't have to worry about a mark". One child in the class suggested that letters and grades be given alternately.

The children in the sample considered the marks they gained in written tests to be a significant form of feedback about their Mathematical ability. The fact that the children regarded test marks with such high esteem, indicated that their beliefs about assessment were very stereotyped. The importance of assessment procedures in providing children with feedback is an issue that has been discussed by Masters and Doig (1992).

Time Pressure

Morris (1981) suggested that Mathematics anxiety could be reduced by eliminating timed tests and blackboard work from class activities.

To the children in the sample, time was an important factor in written and oral tests. The time component of oral tests appeared to be more significant than the time component of pencil and paper tests. However, data from the class discussion indicated that for most children, the time factor for tests did not influence the *degree* of nervousness that they experienced.

[Group Two's Discussion]

M.K.: Well, the ones that you read out, they're, they're the hard ones for me. They don't give me much time to think, but on the big ones [pencil and paper tests] you can take about five minutes on one question and go through the other ones real quick.

[Group Three's Discussion]

B.R.: I only like Maths tests [pencil and paper tests] because you get more time to work out the questions.
Teacher: Than you normally do?
B.R.: In mentals you have to think quickly and I don't like thinking quickly ... [Pupils laugh]
Teacher: OK.
B.R.: .... in Maths.

The time factor also became significant when children had to stop a task before they had completed it. When this happened the negative emotions of frustration, anger and worry were often experienced.

The analysis of the data from the research shows how important it is for teachers to give children adequate time to complete Mathematics tasks. This appears to be particularly true when the children know that their work is going to be evaluated. Not allowing children to complete work could lead them to assume that Mathematics is a subject in which they should expect a great deal of frustration. If frustration was experienced regularly, then children's dislike of the subject or their wish to avoid it, would be understandable.

The Cockcroft Report (1982), An Agenda for Action (1980) and the Mathematics K-6 (NSW Department of Education, 1989) syllabus have all stated that the excessive use of pencil and paper tests should be avoided. During written tests many children in the sample experienced negative emotions and physiological reactions. Testing also appeared to contribute to some children's dislike of Mathematics (See Attitudes later in this chapter). These findings support the recommendations about testing that have been made in the above documents.

MATHEMATICS SYLLABUS FACTORS

Three categories that relate to the subject of Mathematics as it has been embodied within the Mathematics K-6 (NSW Department of Education, 1989) syllabus, were found in the data. The categories were: peers, Mathematics at home and Mathematics tasks. The task category was found to contain the sub-categories of bookwork, activities, climate, tests, positive emotions and 'body language', physical reactions and challenge. Each of the categories and sub-categories is discussed in the following section.

Peers

The majority of children in the class stated that they had no gender preferences when it came to choosing a work partner for a Mathematics task. However, video data indicated that when the children were given a choice, they tended to participate in a task with someone of the same gender, or work with a small group of children whose gender was the same gender as theirs.

Mathematics at Home

Data from the group interviews revealed that when children had to do Mathematics tasks set by their parents, they often felt resentful of the subject. Where this was not actually stated it was able to be deduced from the tone of voice in which the children spoke. Mathematics done at home often came to be considered a punishment.

[Group Interview]

M.P.: And when I don't get any homework my dad just says "learn your tables or something".
T.C.: (laughs) Yeah. That's what my dad says.
L.G.: If I do something wrong in the house I have to write out my tables like twelve to ten.

Twenty-five of the thirty surveys that were sent home to parents were returned to the researcher. The responses to the question about using Mathematics at home as a form of punishment, found that none of the parents considered extra Mathematics work set at home to be a punishment. It would appear that the children's perception of having to do Mathematics at home and that of the parents was very different.

Mathematics Tasks

Bookwork/Activities/Tests/Climate

Classroom Mathematics tasks in which the negative emotions of nervousness, frustration, anger and embarrassment were created, could be construed as the ones that children found threatening to their self-esteem. An extract from a group discussion illustrates this assumption.

S.B.: Um, you get nervous because when you're just about to go out, your mind goes blank and then you get it wrong and everyone starts laughing.

During the group interviews several children in different groups expressed a preference for being in their present class compared to the class in which they had been placed the previous year. When asked to explain the reason for their preference, the responses given by the children related to the Mathematics tasks in which they participated, the enjoyment of those tasks and the amount of Mathematics they considered they were learning.

J.M.: Yeah. I'd rather, prefer this class cause you learn more.

M.F.: Yeah, um, I prefer this Maths because um, last year it, all the, all the um, um, all the Maths que, questions wasn't changed any different but here it changed. It, it was changed diff, different and I can and I can do um, do, do both ways, sort of. (giggles) At least I'm trying.

J.C.: Well, when we, last year we only did a couple of Maths tests and um, we did our books more than Maths tests, like we had these blue books.

J.B.: I like the Maths that we do this year because you get more fun out of it sort of thing.

Hands-on activities and even tests were viewed by some children in the sample as being preferable to, and more enjoyable than, repetitive and/or easy work in books or on stencils. Harder work, regular testing and a greater quantity of Mathematics seemed to give children the idea that they were learning a lot.

The use of multiple data collection methods provided evidence for the importance of classroom climate in determining children's' enthusiasm for Mathematics. They also provided support for the claims made in the literature (McLeod, 1992) about the importance of using more than one data collection method in qualitative research.

The analysis of the data from the individual interviews lead the researcher to conclude that the children were *unhappy* about being in their present class. Questions posed during the interviews had focused on the emotions that the children most often experienced and most easily recalled during Mathematics lessons, as well as the physiological reactions they underwent. Data from the interviews revealed that negative emotions were the ones the children easily remembered and that these, like the children's physiological reactions, were most often experienced during written tests. However,

later data collection methods in which a range of Mathematics tasks were discussed or observed (for example, the videotapes, group interviews and researcher observations), indicated that the children *enjoyed* being in their present class. That the classroom climate was conducive to learning was a deduction made from the large amount of verbal and physical interaction and on-task work witnessed in the videotapes and researcher's observations, and from the predominance of positive affect displays seen in the videotapes. The contradiction found in the data highlights the importance of using multiple data collection methods.

Positive Emotions and Body Language

The videotapes, the group interviews and the children's journals provided the researcher with the largest amount of data on positive emotions.

The majority of visual indicators of positive emotions occurred during Mathematics activities. When the children participated in Mathematics activities they occasionally displayed the 'YES action'. However, displays of this type were rare. One outburst of the extreme positive state resulted in a girl turning her body from side to side for approximately four seconds. No other child was seen to exhibit a whole body action during the display of great pleasure. The girl's actions support Mandler's (1989) claim that emotions are situation specific. Additional support for this was found in the different emotions experienced during Mathematics tasks. For example, enjoyable activities or success at a difficult task tended to produce positive emotions and/or the extreme positive reaction. A written test or a difficult task tended to produce negative emotions.

Journal entries that were made about the activities in which the children participated contained statements such as "I feel great", "It felt good" and "I feel excellent".

Videotapes of the activities showed the children displaying smiles and laughter, and having a great deal of interaction with a partner or with group members. Such interactions contained animated conversation, friendly bantering ('mucking around') and playful gestures such as covering a partner's eyes or tugging on a sleeve.

When the videotapes of the activities were reviewed by both the researcher and the undergraduate observer it was noted that the children's hands rarely went near their faces. It was also noted that there were few self- and object-adaptor actions and a great many alter-adaptor gestures. These were witnessed in the bantering and playful

behaviour of the children. Such behaviour always occurred with someone of the same gender. The large number of alter-adaptor gestures that were observed during the activities were in strong contrast to the self- and object-adaptor actions that were noted during test periods or during the completion of tasks that the children found difficult.

Facial gestures also changed according to the tasks in which the children were participating. While the videotapes of tests revealed a high frequency of frowns, grimaces and puzzled looks (negative affect displays), the videotapes of the activities saw a predominance of smiles and grins (positive affect displays) being displayed.

From these observations the researcher concluded that the number of self- and object-adaptor actions and negative affect displays exhibited by the children during Mathematics activities were determined by three factors. The factors were: the difficulty level of the task being performed, the amount of worry the task created in the children and the level of enjoyment the children experienced while performing the task.

Difficulty level was thought to be associated with a cognitive component which determined whether or not the child found the task worrying or stressful. Enjoyment was considered to be an affective component. Difficulty level and enjoyment appeared to be the two main factors or conditions that influenced children's attitudes towards Mathematics tasks and the emotional states that they experienced. Many examples of the significance of enjoyment in determining the children's emotions were obtained from the group discussions and the journal entries.

[Extract from group three's discussion]

J.C.: Like, and if we do more Maths like that chocolate [pupils giggle] it'd be a bit better than the others, like if we did measuring and stuff like that it'd be better.

K.B.: Cool. I like measuring.

[Journal entry]

L.G.: 1) The teacher told us our job.
2) I went outside to make my 30 cm square.
3) I put 1 stick in each corner and wraped red wool around it and blue bows at the front and a stick in the middle with a red and blue bow. I thought it was fun, excellent and interesting.

Data gained from the videotapes, the researcher's observations and the children's journals lead the researcher to assume that the children had developed specific attitudes to Mathematics activities. This assumption supports Hart's (1989) finding that a child's attitude to Mathematics could in part be deduced from her/his emotional reaction to the subject.

Physical Reactions

When children discussed the positively valenced words they had circled on the modified Clarke (1987) self-response sheet they reported that no physical reactions accompanied the emotions. This was in complete contrast to the visceral and somatic responses which accompanied the negative emotions. Whether or not a physical reaction accompanied the children's show of elation is unknown. The design of the study did not provide an opportunity to follow up that line of inquiry.

In the individual interviews the children were asked the following question: "Is the way that you feel when you do a Maths test different from the way you feel for every other type of activity in Maths, like this [constructing 3D shapes]?" Most children responded in the affirmative for this question. When those children were asked to explain the difference between the two situations they stated that they experienced some sort of physical reaction during the tests but not during the activities.

Challenge: Ease/Difficulty of Task

During the course of the research several children made reference to the degree of difficulty of the work they did in Mathematics.

The children who discussed the difficulty level of tasks stated that being given easy work to complete made Mathematics boring, while work that was too difficult or too challenging, was overwhelming. In both instances the end result was the same - the children began to dislike Mathematics.

J.B.: Sometimes I like having easy things to do and sometimes I like having hard things.
S.B.: True. Sometimes the, the challenge is too much.
B.R.: True.
Teacher: How do you feel when it's too much? When you think it's too hard and that it'll never work out?
S.B.: Ah, not scared. It's not frustrated.

Teacher: Do you ever feel like giving up?
S.B: Yeah. All the time!

S.B.'s statement, that "Sometimes, the the challenge is too much", could be seen to support Ortony et al.'s (1988) claim that failure to cope increased the intensity of an emotion.

The children in the sample discussed the 'YES action' in relation to having achieved success in a difficult task or in one in which they felt challenged. Success in easy work did not cause the children to respond with the 'YES action'. This finding could account for the rarity of the action (Thompson and Thompson, 1989). It could also be used to support the claim that children's work needs to be appropriate to their level of development. If children are to enjoy Mathematics then they need to feel challenged but not overchallenged.

Difficulty level was found to be the main factor that determined whether or not children enjoyed a task. When children did not find their Mathematics work too easy or too difficult (challenging), it was considered to be enjoyable.

FitzSimons (1994) stated that TAFE students enjoyed a task that was challenging. The findings from the study of emotional states suggests that this was also true for the children in the sample.

ATTITUDES

The literature review in Chapter Two revealed that the term attitude is most frequently used to mean the predisposition to respond in a favourable way or an unfavourable way to an object, person, activity or idea (Hart, 1989). The researcher also interpreted the word in that way.

The individual and group interviews, the class discussions and the journal entries provided data that could be classed as attitudes towards Mathematics, testing, Mathematics activities and peers. Each of these will now be discussed.

The Subject of Mathematics

The most frequently mentioned and emphatic attitudinal statements made by the children related to the subject of Mathematics. The group interviews provided many examples of children's attitudes to Mathematics. Some of them showed a dislike of the subject.

K.B.: I totally dislike it.
B.R.: I don't know why I don't like it. I just don't.
T.C.: I hate it.

The teacher's regular use of testing could have influenced the children's attitudes to Mathematics. Therefore findings from the research could be seen to support Mandler's (1989) argument that poor attitudes to Mathematics are the consequence of students' unhappy early experiences in the subject. However, during the class discussion sixteen of the thirty-one children expressed attitudes which showed a liking for the subject. For example:

R.A.: It's great.
C.D.: It's cool!
N.A.: I like it. I like to be challenged.
J.S.: It's awesome.

The liking or disliking of Mathematics was an issue raised during the follow-up class discussion. Through a show of hands the children were asked to indicate if they really liked Mathematics, if they liked it a reasonable amount or if they could not tolerate it. The responses were ten, ten and eleven respectively.

The responses to the liking/disliking of Mathematics question on the modified Clarke (1987) questionnaire showed a similar pattern in the results. In each of the three administrations of the questionnaire more children stated that they liked Mathematics than disliked it (See Table 9).

Since they were a long term view, the terms 'always' and 'most of the time' on the modified (1987) Clarke self-assessment questionnaire were considered to be indications of positive attitudes (liking) towards Mathematics and 'sometimes' and 'never' were considered to be expressions of negative attitudes (not liking) to the subject. Therefore the division that was found between the number of children in the sample who did like Mathematics and the number that did not like it, is roughly equal for each of the three administrations of the questionnaire. This finding is similar to that of the FitzSimons'

Table 9: Responses that show liking/disliking of Mathematics across the three administrations of the modified Clarke (1987) self-assessment questionnaire.

	JULY	SEPTEMBER	NOVEMBER
ALWAYS	10	9	3
MOST OF THE TIME	9 Total=19	9 Total=18	17 Total=20
SOMETIMES	9	5	11
NEVER	2 Total=11	7 Total=12	0 Total=11

(1994) study in which more students were found to have positive rather than negative attitudes towards Mathematics.

Similarly, if the responses to the short-answer questions can be considered to be attitudes, then it would appear that only ten responses could definitely be classed as negative attitudes to Mathematics while nineteen responses could be considered to be positive attitudes to the subject (See Table 7).

The analysis of the data from the individual interviews and the first administration of the modified Clarke (1987) self-assessment response sheet in which tests were the main issue discussed, indicated that the children should have given an overwhelming number of negative responses to the concept 'Mathematics tests' in the short-answer response activity. That the number of positive and negative responses to the concept were found to only show a difference of six indicates that the researcher had been drawing false conclusions from her analysis of the early data (See Table 7).

Spurious Conclusions

The initial journal entries, the individual interviews and the data from the first administration of the questionnaire suggested that the children did not enjoy Mathematics. However, videotapes of the children performing a range of tasks that were not tests saw them exhibiting positive affect displays and alter-adaptor behaviours (touching other children) and having friendly verbal interactions with their peers. The negative affect displays (frowning and grimacing) and self- and object-adaptor actions were only dominant during videotapes of test sessions. The observations carried out over the six month period seemed to indicate that the children enjoyed the Mathematics activities in which they participated but not the Mathematics tests. This idea was reinforced by statements made during the group interviews. The apparent contradiction in the data can be explained.

The individual interviews investigated the tasks that caused the children to circle specific words on the modified Clarke (1987) self-assessment sheet. The researcher found that for most children, negatively valenced words had been circled because of the negative emotions they experienced during tests. Memories of negative emotions dominated the children's thoughts. The emphasis on negative emotions made the researcher conclude that the children did not enjoy Mathematics. Similarly, the discussion about the physical

reactions that the children experienced and the Mathematics tasks in which the reactions occurred, focused the researcher's attention on the negative aspect of Mathematics.

In the initial weeks of the research, the children's journals contained many statements about negative emotions. The prolific number of sentences about negative emotions resulted from the children mainly being asked to write about the feelings they experienced before tests, rather than before all the tasks they did in Mathematics. It was only in the closing weeks of the research that the children in the sample, other than the case study children, began to record their thoughts and feelings about the activities and the tests in which they participated As soon as that occurred, the journal entries saw a corresponding change in the types of words that were recorded. Verification of the positive emotions that were written about in the children's journals came from the videotapes of the children participating in Mathematics activities.

The contradiction in the data highlights the importance of the researcher using more than one data collection method. In order to have obtained the most comprehensive understanding of the emotional states that the children experienced when they did Mathematics, more than one source of data had to have been used. If only one or two of the early data collection methods had been used in the study, then the conclusions drawn by the researcher would have been inaccurate. This finding appears to lend weight to the discussion in the literature about the value of using multiple research methods in qualitative research, and it supports McLeod's (1992) suggestion that qualitative research methods should be used in studies of the emotions.

Testing

The individual interviews showed that the children considered testing to be a significant issue. However, very few voluntary statements about tests were made during the research. Below are some statements that were provided by the children.

S.B.: I don't like them.

J.C.: One every term or like two every term instead of one every two weeks. One every four weeks would be a bit better.

J.B.: I don't like them but they're important. You have to learn Maths because Maths comes into almost anything you do.

J.B's statement can be seen to contain both an attitude and a belief. Her thoughts indicate the closely related nature of the two constructs - a topic that has been discussed in the literature by Leder (1993).

Additionally, J.B.'s statement suggests that she has come to realise the relevance and importance of Mathematics to her everyday life. This realisation is an objective of the Mathematics K-6 (NSW Department of Education, 1989) syllabus. It would appear that for J.B. the syllabus has achieved one of its main aims.

Data from the research also revealed *positive* attitudes towards tests.
[Journal entries]

J.S.
Week 2 Term 3 22/7/94
I am thinking about the maths test and what it is about
I feel good better then I shoulc

C.D.
Week 2 Term 3 22/ 7/ 94
I am thinking about maths and lunch
I feeling very very very happy
After Test
I realy realy realy very very realy happy.
I am thinking about my mark.

S.H.
Week 10
I think I will go good I fill [fee] happy
After Test
I feel good

N.A.
Week 10
I am about to do a Maths test. I feel happy.
I have done the test. I feel good.

Several statements made by the children during their group interviews were seen to contain a behavioural component of attitudes. This component has been included in many definitions of the term (See Hart, 1989; Rajecki, 1982; and Leder 1993).

Example One

K.B.: When I was at Nan's and had a week off this class, like I thought *please go slow, go slow* Mrs Reddy, like, cause M.,

> she always told me that you done big tests and she said watch out and all this. And, and I just wanted the days to go slower and slower, because I didn't want to come back to school and start big tests (written tests) there.

Example Two

T.C.: Well, sometimes if it is a big test I get really nervous and it turns me off wanting to do it [Mathematics]. It turns me off heaps!

Example Three

S.B.: Awh, sometimes when I woke up in the morning I didn't feel like going to school, cause I knew there was going to be a Maths test waiting. [talking about Mathematics at her previous school]

The reluctance of K.B. and S.B. to come to school was caused by the knowledge that they would have to do Mathematics tests. Both children's comments support Hart's (1989) claim that the development of negative attitudes to Mathematics can result in children wanting to avoid the subject. Statements made by the children in the sample also support research into Mathematics anxiety (Morris 1981; Clute 1984) in which the same finding has been made. In the case of K.B. and S.B., that avoidance extended to school in general. T.C.'s statement lends further weight to Mandler's (1989) argument about early unhappy experiences leading to the development of poor attitudes to Mathematics.

Activities

Attitudes towards Mathematics activities were mainly found in the journal data. Most of the children made positive statements about the activities. However, a few did not. The following extracts are typical examples of statements about the activities.

[Journal entry: group two]

I did sums.
Borring yuk.

[Journal entries: group three]

Child One
I am happy we didn't do much Maths because I don't really like Maths. I wish we could do more Maths in groups like we did on Wednesday when the mums came in.

Child Two
I thought the puzzle activity was fun.
I thought the multiplication sums were interesting.

Child Three
I thought the activity is very dumb

[Journal entries: group five]

Child One
I think the activity is hard but fun

Child Two
I did a Maths card. It was fun.

Child Three
It was a fun activity.

FitzSimons (1994) found that negative attitudes to Mathematics were related to the complexity of a task and to test anxiety. The journal entry of child one from group five indicates that positive attitudes to Mathematics activities can be developed even when tasks are found difficult. The findings from the study of emotional states suggest that the degree of difficulty of a task and its enjoyment level may be factors that influence attitude development in children.

Riedesel and Burns (1977) have noted that children develop attitudes to Mathematics by the time they have reached eight or nine years of age. The nine and ten year old children that constituted the sample already appeared to have developed definite attitudes towards Mathematics activities.

Peers

Data from the group interviews showed that the children had developed specific attitudes towards their classmates. Most of the attitudinal statements about peers related to preferences for a partner with whom to work. A few responses were of a general nature.

M.F.: I don't care. (who he worked with)

J.M: She's too good. (talking about another child at her table)

S.H.: I only like working with boys.

J.B.: Cause she's a girl. I would like to sit next to a boy. (in Mathematics)

The findings from the research indicate that the main aim of the Mathematics K-6 (NSW Department of Education, 1989) syllabus, to develop in children positive attitudes towards Mathematics, is able to be achieved when children are given tasks that they enjoy. Negative attitudes to Mathematics are likely to develop when children are given an excessive number of written tests and easy or repetitive tasks that they find boring or unchallenging. Data from the research also shows that Hart's (1989) statement about the multi-dimensionality of attitudes is accurate.

BELIEFS

From the analysis of the data it was found that the children expressed beliefs about the subject of Mathematics, teachers, peers, their parents, themselves and tests.

The Subject of Mathematics

The researcher concluded that the children in the sample did not really perceive themselves to be doing Mathematics when they participated in activities other than ones involving numbers. This point was raised during the whole class discussion. After nearly an hour of completing the planned questions for the discussion, a child's response to the question, "Why don't you like Maths?" was, "I don't like doing sums". The researcher pointed out that the class had done a lot of Mathematics that morning but that none of it had involved numbers. The child's reply prompted the researcher to ask the children an unscheduled question, "What is Maths?".

The responses to the question were as follows: "a boring subject", "numbers, sums and times", "my worst subject", "things you can use when you're older", "times tables", "a whole lot of tables and adding up and just numbers and oh, working on the calculator", "times tables and multiplication", 'hard stuff", "times, plus, take away divided by and numbers", "problems", "trying to work out addition sums and subtraction sums, tables and lots of numbers", "division and angles and times, plus, problems and heaps of

numbers". Some of the children replied "Same as ....." when another child had given a response they were going to give.

The data shows that most of the children considered numberwork to be the main component of Mathematics. The type of activities in which the children regularly participated, and which did not involve numberwork, were not included in any of the responses. This finding reflects that of the FitzSimons (1994) study in which TAFE students viewed Mathematics to be primarily about numbers, rules and formulae. The above finding also support Borasi's (1990) claim that children's beliefs about Mathematics were usually stereotyped, deep-seated and unconscious.

An explanation for the children's belief that 'real Mathematics' involved numbers may be found in the teacher's use of testing. Testing was mainly used to evaluate the numberwork aspects of the syllabus. The public nature of recording the marks and the children's taking home of test papers for their parents to sign, would have made the testing process a salient feature of the class's Mathematics program. The procedures employed by the teacher would therefore have given the children the wrong information about the importance of the topics covered in the tests.

Using the argument put forward by Rajecki (1982), that attitudes have an affective or emotional component, a behavioural component and a component containing beliefs about the object, it could be assumed that the emotional and belief components might exert the greatest influence in determining a nine or ten year old child's attitude towards Mathematics. Since the most salient emotions that the children reported were the negative ones, and they were experienced during tests or when completing bookwork or stencils which involved a high proportion of numberwork questions, then the children's attitudes to Mathematics may have been based on their belief that Mathematics was really only about numbers. The children's memories of the unpleasant feelings and physical reactions that tests evoked could also have played a contributing part in the formation of their attitudes to, and beliefs about, Mathematics.

The above explanation could partly explain a contradiction found in the data. Some children stated that Mathematics was a boring subject or their worst subject yet wrote positive statements about Mathematics activities.

The findings from the research suggest that, in addition to discussing the development of positive attitudes in students, the Mathematics K-6 (NSW Department of Education, 1989) syllabus should contain a section on student beliefs.

The analysis of the data revealed that the children in the sample held beliefs about the following topics in Mathematics: the difficulty level of Mathematics tasks, a preference for the type of work done in the child's class, the amount and type of Mathematics done in other classrooms and past classes and the reason for one child not expressing the 'YES action'. The following statements are some examples of children's beliefs.

M.F.: Because it, Maths, Maths is really um, really hard and um, it and you get really, really nervous and it turns out to be your worst nightmare.

T.H.: Miss X's class isn't learning their tables.

K.U.: The work last year was too easy.

K.B.: Maths is good. Most people in this class try.

G.G.: Last year we only did pluses.

M.K.: Not many people like Mathematics.

K.U.: You get into trouble saying it.
[the 'YES action']

Teachers

Beliefs about teachers related to them being considered good or bad at their job.

K.U.: ... you *make* us learn more. You *make* us practise them [multiplication tables].

Peers

Statements concerning peers resulted from the researcher inquiring into the gender of the child with whom each child preferred to work or sit beside when doing Mathematics. Most children replied that gender was not important. However, a few children (both boys and girls) stated a preference for working with children of the same gender. Data from the videotapes also found this to be true. The following excerpts from the group interviews are examples of children's beliefs about their peers.

[A girl]
J.M.: Some girls are hopeless. Some girls are good. Some guys like S. reckon they're a professional at things. They think

they're the best and they, just because they can make things real good.

[A boy]
S.H: Girls get too fussy about things.

[A girl]
J.S.: Boys are better to work with because cause I mainly work with girls and that. I reckon it doesn't really matter.

[A boy]
S.M.: I prefer to work with a girl cause girls are probably a bit smarter than boys.

Parents

Beliefs about parents related to how the children in the sample thought their parents felt about their progress in Mathematics and their test results.

J.S.: As long as I work hard she'll be happy. If I work hard she's proud of me.

T.H.: It doesn't matter what I get she'll be happy.

S.M.: She'll know I need more working at it. She'll know I've been doing well and don't have to practise it. Like when I got 90%.

J.B.: It's very important.

The Self

Only a few children expressed beliefs about their Mathematical competence.

[Group three's interview]

K.B.: I'm not good at hardly anything. (The same child later in the interview)
K.B.: When I do like the times tables and that and everyone goes "Oh, that's easy", like, sort of like, I feel like, oh God I'm dumb, I don't know this.

[Class Discussion]

T.C.: Well, I hate doin' th ngs that I know I won't get right, that I know, like somethings I feel like I don't have a clue about what I'm doing and (pupils giggle) I just hate doin' that sort of like. Yeah, cause I'm going to get way out answers.

[Journal entry]

L.G.: I think I'm hopeless except at useing the straws and tangrams.

Tests

The children expressed diverse beliefs about tests. Some children believed tests were a necessary part of the class's Mathematics program.

M.S.: Maths tests make you try harder.

S.B.: Cause we wouldn't be learning things we are supposed to be learning in the year. [If no tests were given]

One child expressed her belief that the negative emotion of frustration occurred during a test.

J.M.: Some people get frustrated when they do tests.

Another set of beliefs relating to tests involved the expression of ideas about the significance of the two types of tests in which the children participated.

J.B.: We have different tastes. We're all different. Some people are good at some things, others are good at other things.

The data on beliefs, or as Schoenfeld (1985) stated, the children's 'world view', indicated that the children in the sample thought tests had a legitimate place in the teaching of Mathematics - even though they were not always liked. The various sub-categories into which the data could be placed, strengthens McLeod's (1992) conception of the multi-dimensionality of beliefs.

LANGUAGE AND THE EMOTIONS

A discussion about the negative emotion of anger during a group interview, suggested that some of the children may have been having difficulty giving the researcher an accurate description of their emotions. The following statement illustrates the point.

> **K.U.:** When, or, in this Maths test we've just had and I hadn't finished writing down the fraction for the last two and then you [the teacher] just told us to stop and I felt really angry cause I didn't get to finish.

In the above statement the child claimed that she experienced anger. If that had been an correct description of her emotions then the statement made by the child would have been accurate. However, it is possible that the girl could have been using the term 'angry' to signify frustration or to stand for a combination of anger and frustration. The statement made by K.U. illustrates Ortony et al.'s (1988) point, that when it comes to describing the emotions, we only have evidence of emotional experiences from the language used by the informants, and that even though we tend to trust that people's reports of their emotional experiences are accurate and valid, it must be remembered that the reports are not scientific observations. As Lang (1994) has stated, emotions are private and unconfirmable.

On three other occasions during the group interviews there were indications that the children were having difficulty using language to describe their emotions. One child had trouble describing the way she felt when she did Mathematics.

> **S.B.:** Yeah, it's not scared it's not nervous either. It's different to both of them.
> **Pupil:** worried (coughs).
> **S.B.:** No.

On the second occasion a child attempted to explain the way she felt before she did a written Mathematics test.

> **J.S.:** I get this real funny feeling in my stomach. I goes real funny. I go all shaky. I don't know if I'm nervous or something or if I'm happy.

The above examples suggest that the children's vocabulary did not contain the words they needed to accurately explain their feelings. The children's statements also hint at the

inadequacy of the spoken word to describe a concept as complex as an emotion. The inability of the children to describe their feelings or the physical reactions associated with them, became obvious in a statement made by a third grade boy during his group interview.

[Describing how he felt before a written Mathematics test]

S.M.: Um, I get shaky and sometimes I feel um, like um, (pause of 2 seconds) err, this yukky stuff, like when I have this eye drops and it tastes like it's going down my throat.

Difficulty in using language to describe the emotions was not restricted to the students. In many instances the researcher experienced difficulty in describing particular emotions, and in wording questions simply enough for the children to understand. This was evident in her description of the 'YES action'. For example:

Teacher: Well, something like putting your hand up in the air and going, "YES, this is terrific!".

Difficulties associated with the language of emotion and the language used to describe the emotions have been written about since the time of James (1884) and Lang (1922). The deficiencies of language that become obvious when theorising about the emotions, have been discussed in some depth by Ortony et al. (1988). Data from this research adds substance to those findings.

A MODEL OF EMOTIONAL STATES

The analysis of the data from the nine data collection methods used in the research enabled the researcher to construct a basic model of the emotional states that children experienced when they participated in Mathematics lessons.

Fundamental to the model were the positively and negatively valenced emotions described in the theory by Ortony et al. (1988). The four levels of emotion that the researcher originally devised from the analysis of the data were able to be reduced to three main levels.

The researcher called the extreme positive level of emotion the State of Elation. The mild positive and mild negative levels were combined and named the State of Equilibrium. This state corresponded to the neutral state that was first found in the data from the individual interviews. Data from the group interviews yielded a range of

emotions that could also be classified as being mild, and therefore belonging in the neutral state. By placing the mild negative and mild positive emotional states together and considering them to be equivalent to the neutral state, the difficulty of classifying some emotional expressions, such as "I am excited" or "I feel hungry", was able to be overcome. The extreme negative level of emotion became the State of Apprehension. Indicators and descriptors of each state were devised (See Table 10).

The State of Elation

The State of Elation was thought to signify the extreme positive emotional state that children could experience during Mathematics lessons. It was the ideal state that children might attain. However, children rarely experienced the State of Elation.

In the research, the State of Elation was described by the words "fantastic", "excellent", "I feel like chucking a party", "I get a big lift", "great", "terrific", "wonderful", "cool" and "awesome". Non-verbal indicators of the State of Elation were the positive affect displays of smiling and laughing, the 'YES action' and alter-adaptor actions (See Table 10).

The State of Equilibrium

It was considered that the State of Equilibrium contained both positive and negative emotions that were continually interacting with each other and therefore cancelling each other out. The result of the action meant that the children achieved a balanced and neutral emotional state. "I feel normal" were the words used to express the way the children felt when they experienced the State of Equilibrium. In the neutral state there were extended periods of time in which no overt signs of emotion were witnessed.

The direction or pole towards which children's emotions gravitated within the State of Equilibrium changed when there was a change in the conditions within Mathematics lessons. Conditions were defined by the researcher as being the type of Mathematics task in which the children participated and the difficulty level and enjoyment level of the task. Physical states such as being hot or cold were not considered in the definition of the term 'conditions' in the research. However, it is feasible that in a different environment the physical attributes of being hot or cold could become a factor effecting children's emotional states.

Table 10: Model of the Three Emotional States showing their Descriptors and Indicators.

Descriptor	Children's Verbal and Written Indicators of Emotion	Children's Non-verbal Indicators of Emotion
State of Elation This state is thought to signify the extreme positive state that children could experience. It is the ideal state that children might attain.	terrific, cool, awesome, fantastic, excellent, wonderful, I feel like chucking a party. I get a 'big lift'. great,	the 'YES action'; the positive affect displays of smiling and laughing; alter- and self-adaptor actions;
State of Equilibrium This state is thought to contain both mild positive and mild negative emotions which are continuously interacting with each other and therefore cancelling each other out. As a result of this action the children achieve a balanced and neutral emotional state.	excited, can't wait, yippee, clever, successful, interested, proud, pleased, relaxed, glad, happy,much better, good, fine, OK, alright, confident, easy, I feel normal. I get this funny feeling. I don't know what it means. boring, not very good, YUK, silly, impatient, confused, tired, disappointed, upset, don't tell me, let down, embarrassed, frustrated, ashamed, dislike, cranky, hungry, bad, mad, I wish it wasn't invented.	positive and negative affect displays (smiling and frowning); self -, object - and alter-adaptor actions such as nibbling the nails;
State of Apprehension This state signifies the extreme negative emotional state that children can experience and is therefore the state the children most want to avoid.	sick, craving food, scared, horrible, hopeless and miserable, dreadful, frightened, hate, angry, It's your worst nightmare.	prolonged self- and object-adaptor actions and a large variety of actions for example, biting the fingers or a pen; Frequent hand-to -face, hand-to-head actions. Negative affect displays such as grimacing and pulling faces.

Within the State of Equilibrium there were thought to be some emotions which directed children's feelings towards the extreme emotional states. When particular conditions prevailed it was envisaged that the director emotions bridged the gap between the State of Equilibrium and the extreme positive and the extreme negative states. For example, data from the research indicated that worry was a director emotion for the State of Equilibrium and the State of Apprehension while excitement was the director emotion for the State of Equlibrium and the State of Elation.

When changes in emotions and emotional states occurred in Mathematics lessons it was assumed that children employed strategies that would help them re-establish a balanced emotional state. Strategies that might be used by the children for this purpose included concentrating on finishing a task, completing a task to the best of one's ability or giving up. These strategies were sometimes employed by the children during written tests.

J.M.: No, I don't feel anything [before doing a paper and pencil test], as long as I get it finished.
Teacher: Is that what you're thinking about when you're doing it [the test]?
J.M.: Yeah.
Teacher: So you're thinking about getting it finished and that's your main concern? It's not the Maths? It's just whether you're going to get it finished. Is that right?
J.M.: Yep.

It was hypothesised that a test situation or an unexpected success or failure at a task were likely to produce the greatest changes in the children's emotions.

From the research the words "excited", "successful", "can't wait", "clever", "yippee", "relaxed" "interested", "confident", "proud", "fine", "pleased", "glad", "much better", "happy", "good", "OK", "alright", 'easy", "don't tell me", "boring", "confused", "silly", "tired", "yuk", "not very good", "dislike", "upset", "embarrassed", "bad", "ashamed", "disappointed", "frustrated", "impatient, "let down", "cranky", "mad", and hungry" were used to describe the State of Equilibrium. Nibbling the nails, touching others and the self, frowning, smiling, grinning and laughing were found to be the non-verbal indicators of the state (See Table 10).

The State of Apprehension

The State of Apprehension signified the extreme negative emotional state that children could experience during Mathematics lessons. The State of Apprehension was the emotional state that children most wanted to avoid. The State of Apprehension corresponded to anxiety in the Byrd (1982) model and to panic in the theory proposed by Buxton (1981). Children were thought to sometimes experience the State of Apprehension during written Mathematics tests and Mathematics tasks that they found difficult to complete.

Negative emotions and emotional memories, such as those experienced in the State of Apprehension, were found to exert a strong influence over children's attitudes to Mathematics and their beliefs about themselves as learners of Mathematics.

Indicators of the State of Apprehension were the words "hate", "scared", "craving food", "angry", "worst nightmare", "horrible", "hopeless and miserable", "dreadful", "frightened" and "sick". Non-verbal indicators of this state were prolonged physical actions involving a high frequency and great variety of touches to the head and face, prolonged biting of the fingers or an object (self- and object-adaptor actions) and the negative affect displays of grimacing and pulling faces (See Table 10).

The Relationship of the Model to the Themes: an Extended Model

The themes that emerged from the research were able to be related to the model of emotional states.

The positive emotions that accompanied an unexpected success, such as that of obtaining high marks in a written Mathematics test or the correct solution to a difficult Mathematics task, were seen to cause the children to experience the State of Elation. The extreme intensity of the emotional reaction separated it from the State of Equilibrium and was determined by the degree of unexpectedness of the success.

The State of Elation was witnessed in the children's performance of the 'YES action' and in alter-adaptor non-verbal actions. The positive affect displays of smiling and laughing were also evident when the children were in the State of Equilibrium. The experiencing of the State of Elation was verified by the children's written and verbal statements.

For the majority of the Mathematics lessons in which the children participated, a range of emotions occurred that were not extreme in nature. When children experienced those emotions they were said to be in the neutral state, or State of Equilibrium. The State of Equilibrium was thought to encompass most of the emotions that the children experienced when they participated in Mathematics.

Within Mathematics lessons children's emotions appeared to fluctuate. The variations in emotion were found to depend upon the conditions that were prevalent at the time. The main condition that influenced the children's emotions was the amount of enjoyment that they experienced as they performed a task. This in turn was influenced by the type of task on which the children were working and its difficulty level (See Table 11).

While the data from the research suggested the existence of a relationship between the enjoyment level of a task and the emotions that children experienced, it was not able to be quantified. Therefore the relationship between the conditions and the three levels of emotion were not statistically tested.

Hands-on activities were found to produce the most enjoyment in children while written tests were found to produce the least. Drill and practice work, blackboard work or work that was considered to be boring, easy or not sufficiently challenging fell between the two extremes of emotion. The amount of enjoyment experienced during a Mathematics task was indicated by the words the children used to describe their feelings and by their non-verbal actions. In lessons in which a great deal of concentration was required there were few visible indications of emotion.

Mild physical reactions were found to occur in children when they were rushed or were prevented from completing a Mathematics task on which they were working. Children experienced few physical reactions during Mathematics tasks that were not tests.

When children were experiencing the State of Equilibrium a range of non-verbal behaviours were witnessed. These included self-, object-, and alter-adaptor actions. Positive and negative affect displays such as smiling and frowning were also observed.

The data on tests revealed that children sometimes experienced intense negative emotions. When they did, they were considered to be in the State of Apprehension (See Table 11). Thoughts about marks were found to be prevalent in, and a dominant feature of, the experiencing of intense negative emotions (See Table 12). The experiencing of intense negative emotions was marked by an increased number and variety of hand-to-

Table 11: Four different journal entries that show the words the children used to describe their feelings before they completed each Mathematics task. The tasks are two written tests and two types of activities.

	TEST:22/7/94 28 children present	Test: 3/11/94 26 children present	Activity: bookwork or stencil (September) 30 children present	Hands-on Activity: dice game or measurement activity (November) 30 children present
State of Elation	very, very, very, happy(1), Total=1	great(1) Total=1	cool(1) great(2) Total=3	great(7) terrific(1) Total=8
(Mild Positive)	happy(5), OK(1), confident(2), good(1), Subtotal=9	happy(3), good(3), OK(2), Subtotal=8	funny and can't wait to start(1), happy(7), good(10),OK(3), all right(2), Subtotal=23	very good(1),good(11), happy(3), happy and relaxed(1),happy and confident(1), OK(2), interested(1), Subtotal=20
State of Equilibrium	normal(1),	normal(1),	normal(1),	normal(1),
(Mild Negative)	nervous(6), worried(4), Subtotal=10 Total=20	YUKKY(1), bit nervous(1), nervous(4), worried(4). confused(1), worried and disappointed(1), Subtotal=12 Total=21	a bit nervous(1), a bit worried(1), Subtotal=2 Total=26	boring(1), Subtotal=1 Total=22
State of Apprehension	sick(1), scared(3), bad and cold(1), Total=5	scared(1),sick(1), sick and worried(1), Total=3	really bad(1), Total=1	 Total = 0
Undecided about how she/he felt	don't know(2)	don't know(1)		

Table 12: The number of children who recorded in their journals that they were thinking about the grades they were going to get for their written tests; and the number of children who commented on a physical reaction that they were experiencing before the test.

Test: 22/7/94	Test: 22/7/94	Test: 3/11/94	Test: 3/11/94
Noted thoughts about grades	Noted a physical reaction	Noted thoughts about grades	Noted a physical reaction
16 out of 28 children	1 out of 28 children	12 out of 26 children	2 out of 26 children

head and hand-to-mouth actions for prolonged periods of time. Those actions were accompanied by frowning, grimacing and the pulling of faces. Closely associated with the experiencing of intense negative emotions was the experiencing of unpleasant physical reactions.

Children's attitudes and beliefs were found to be greatly influenced by the emotions they experienced during written Mathematics tests. Similarly, children's beliefs about the subject of Mathematics were found to be based on the content of the written tests they completed.

For each level of the researcher's model of emotional states, statements could be found that illustrated the problem children had in describing their emotions. Comments such as "I get this funny feeling. I don't know what it means", "I get a big lift" and "It's your worst nightmare" typified the children's difficulty in using language to describe their emotions.

Conclusions

The research found that it was possible to describe the emotional states that children experienced in a Mathematics environment, and that descriptors and indicators of those states could be developed. The study also produced an unexpected finding: the ability to associate specific non-verbal actions or 'body language' with each of the emotional states.

SUMMARY

The first part of Chapter Five discussed the five main themes that emerged from the analysis of the research data. The themes were: tests, the subject of Mathematics, attitudes, beliefs and language. Many of the themes were interrelated and four of the themes were found to contain sub-themes.

Chapter Five continued with a discussion of the difficulties associated with the use of language to describe the emotions and with the presentation of a model of emotional states. The model was found to be comprised of three main levels or states: the extreme positive state (the State of Elation), the extreme negative state (the State of Apprehension) and the neutral state (the State of Equilibrium). The researcher

hypothesised that there was a direct relationship between the emotional states that children experienced during Mathematics lessons and the conditions in which they found themselves. The main condition that appeared to influence children's emotions was the level of enjoyment of the task on which they were working and this in turn was found to be determined by the nature of the task and its level of difficulty.

The following chapter discusses the conclusions the researcher has drawn from the study of emotional states. Chapter Six also discusses the implications the research has for policy makers in Education and for practising teachers.

CHAPTER SIX

CONCLUSIONS AND IMPLICATIONS

Introduction

The previous chapter investigated the five themes that emerged from the research: testing, the subject of Mathematics, attitudes, beliefs and language. Each of the themes appeared to be interrelated and four were found to contain sub-themes. Chapter Five also discussed a model of emotional states that the researcher constructed from the analysed data.

Chapter Six discusses the conclusions the researcher has drawn from her investigation into children's emotions. Also described in this chapter are the limitations of the research and the implications of the study for future research.

Chapter Six has been divided into two sections. Section one discusses the conclusions drawn about the emotions, the researcher's model of emotional states, 'body language', additional issues raised by the research and the subject of Mathematics. Section one also describes the limitations of the research, and relates the findings of the study to the literature.

Section two of Chapter Six discusses the implications the study has for teachers and policy makers in Education, and for future research.

CONCLUSIONS REACHED FROM THE STUDY OF EMOTIONAL STATES

The Emotions

The study of children's emotions addressed the question:

> **Can the emotional states of children in a Mathematics environment be described?**

To facilitate the inquiry into emotional states two subsidiary questions were devised:

Can descriptors of emotional states be developed?
Can indicators of emotional states be developed?

The research found that it was possible to describe the emotional states that children experienced during Mathematics lessons, and that descriptors and indicators of those states could be developed.

The analysis of the data from eight data collection sources revealed a range of emotions that children experienced as they participated in Mathematics tasks. The emotions extended from the extremely negative and unpleasant feeling of fear, which was signified by "It's your worst nightmare", through to the extremely positive and pleasurable feeling of elation, which was described as 'I feel like chucking a party". However, for most of the time that the children participated in Mathematics tasks, their emotions fell between the two extremes. Within that band of emotion lay both positive and negative emotions whose continual interaction had a neutralising effect. When the children described the emotional state between the two extremes, they frequently used the word 'normal'.

In the research setting it was found that the emotions created during written Mathematics tests dominated children's thoughts and influenced both their attitudes to, and beliefs about, the subject of Mathematics and their beliefs about their Mathematical competence. Thoughts about marks and the ability/inability to achieve success in written tests, often caused children to experience the negative emotions of worry and fear. This finding supports cognitive theorists' arguments about the role of cognition in the experiencing of emotion.

The emotions experienced during tests were mainly found to be negative. They included feelings such as worry, being rushed, disappointment, fear and hate. Physical reactions, such as shaking or feeling sick, were also sustained when the children experienced negative emotions.

The children's pre-occupation with written tests occurred even though the tests were only one of many Mathematics tasks in which the children participated and took up a small amount of the total time spent on Mathematics.

The findings about the use of tests, especially the regular use of written tests, have important implications for educators. First, teachers must be made aware of the effects

that testing can have on children. Second, teachers need to realise that there may be a relationship between testing and children's attitudes and beliefs to Mathematics. Third, a variety of assessment methods should be used to evaluate student progress so that students come to realise that alternate forms of assessment are just as valid as tests in determining Mathematical ability and progress.

The research found that children experienced many positive emotions during Mathematics lessons. Positive emotions appeared to be closely related to the enjoyment level of the task on which the children were working. The implication of this finding is that practising teachers need to carefully plan the teaching and learning strategies that are used in lessons. Attention to those strategies should help overcome issues such as excessive competition between children, worry about doing certain tasks or the frustration experienced from not being able to complete work. Findings from the study suggest that the teaching and learning strategies must also take into consideration the different learning styles of children.

The investigation into emotional states revealed that during Mathematics lessons memories of tasks in which positive emotions were experienced were overshadowed by memories of tasks in which negative emotions were experienced. This may have resulted from the physiological reactions that often accompanied the negative emotions. It may therefore be assumed that memories of negative emotions and physiological reactions together have a greater impact on children than memories of positive emotions alone. If this assumption is correct then it again implies that practising teachers need to plan their lessons so that a minimal number of negative emotions are experienced.

The research found that in Mathematics lessons there was a direct relationship between the emotions that children experienced and the conditions in which the children found themselves. Conditions were defined by the researcher as the enjoyment level of the tasks on which the children were working as well as the type of task and its difficulty level.

The Model of Emotional States

A model of emotional states was able to be constructed from the analysis of the data. The model was hierarchical in nature. Extreme positive emotions occupied the top level of the hierarchy while extreme negative emotions occupied the bottom level. The two levels appeared to be separated by a state that encompassed milder or weaker forms of both positive and negative emotions.

Each of the three levels in the model was found to have non-verbal indicators of emotion that were associated with it, and which made it distinguishable from the other levels.

The emotional states that the children experienced were found to be related to the conditions to which they were exposed during Mathematics lessons. The main conditions that influenced the children's emotions appeared to be the enjoyment of the task on which the children were working, the type of task and its difficulty level. Children experienced positive emotions when a task was enjoyable and not too difficult or too easy to perform. Negative emotions were experienced when a task was difficult to complete and/or lacked enjoyment.

The intensity of the emotions that the children experienced were also found to be related to the conditions that prevailed within a lesson and to the thoughts that occupied children's minds. Thoughts, especially those about marks, appeared to be highly significant to the children during written tests. These findings have important implications for practising teachers. They highlight the need to give children work that is appropriate for their level of development, and to minimise the number of written tests that children complete.

The construction of the model of emotional states created a number of questions that future research needs to address. For example:

Can the hierarchical arrangement of emotions that were evident in the researcher's model be found in other Educational settings?

Are the relationships between the levels in the model able to be quantified?

Is there a relationship between emotions and attitudes, and emotions and beliefs?

What are the relative weightings of the conditions that have been found to influence the emotional states that children experience? Can they be quantified?

If children's conception of Mathematics is broadened is it possible to change their attitudes to the subject?

The investigation into the emotions also suggests that additional research needs to be carried out into the non-verbal indicators of emotion that were noted in the study. The

researcher's hypothesis about the changes in the types of adaptors actions that children display when they are stressed, and the three frames of reference for distinguishing stress, need to be investigated in larger samples in both Mathematics and other curricular subjects.

'Body Language' or Non-Verbal Behaviour

The data on 'body language' that was obtained from the research was an unpredicted outcome of the study. It was found that each level of the researcher's model of emotional states was able to be identified by the 'body language' or non-verbal actions associated with it. It was also found that a child's non-verbal actions were, as Fast (1970) emphasised, closely related to the social context in which the child found herself/himself. In relation to Mathematics, social context signified the conditions that prevailed during a lesson.

The extreme positive state, or State of Elation, could be identified by the positive affect displays of laughing and smiling, together with a physical action that appeared to be under the control of the child. In this action the fists were clenched and shaken slightly, the arms were either extended or drawn close to the body and the word 'yes' was spoken. The expression appeared to be culturally derived.

The extreme negative state or State of Apprehension was distinguished by the children exhibiting a large number and high frequency of self- and object-adaptor actions and negative affect displays such as grimacing and pulling faces. These actions occurred for a prolonged period of time. While experiencing the State of Apprehension most of the children's adaptor actions involved the face or head. For some children, however, excessive jigging of the feet and/or wriggling of the body was indicative of the State of Apprehension.

In the neutral state, or State of Equilibrium, a large number of self-, object- and alter-adaptor actions were witnessed for short periods of time. Both positive and negative affect displays were observed. When children's feelings advanced towards the more positive end of this state, the number of alter-adaptor actions and positive affect displays increased while the number of self- and object-adaptor actions and negative affect displays decreased. When children's feelings moved towards the more negative end of the State of Equilibrium, the number of alter-adaptor actions decreased and the number of self- and object-adaptor actions increased. These actions were accompanied by an increase in the number and length of negative affect displays.

Additional Issues Raised in the Research

In addition to the five themes that emerged from the research, the study of emotional states yielded data on a number of related issues. While some of the issues were discussed in the findings from the research (See Chapters Four and Five), many were not. This was due to the limited amount of support for them in the data. However, it was felt that an awareness of the issues was warranted and that further research into them would be worthwhile.

The following topics were those found to be related to the study of emotions:

* co-operation between students during Mathematics tasks
* motivation to achieve high marks
* gender differences in such things as disruptive behaviour and the amount of time spent on tasks
* the satisfaction of parents with their children's achievement in Mathematics
* the use of Mathematics as a discipline strategy at home
* the content of Mathematics programs, and in particular, the content of the Mathematics K-6 (Department of Education, 1989) syllabus
* external constraints imposed upon students, such as limitations in the amount of time spent on Mathematics tasks
* careless errors and the production of emotions
* children's conception of their own Mathematical ability and that of other students
* the preference for grades over letters in assessment tasks
* the language used to describe the emotions.

Evaluation of the Research

When the study of emotional states had been concluded it became obvious that there were some areas of weakness in the research design and some areas of strength. These will now be discussed.

In a qualitative study validity and reliability are two facets of research that are difficult to qualify and make explicit. In the study of children's emotions, the use of triangulation, multiple data collection sources and references to the literature served to strengthen the validity and reliability of the investigation. This may otherwise have been considered

questionable because of the limitations of sample size, scope and cause and effect. In addition to this, there were many findings in the research that were similar to findings from the research of others. This fact enhances the external validity of the study.

The validity of the research may still be questioned because of the role that language played in the reporting of children's emotions. It is possible that in describing their emotions, the meanings the children gave to words were not the same as the meaning given to them by the researcher. Therefore language needs to be considered as a limitation of the study.

Resource limitation was another difficulty encountered in the research design. This was evident in the researcher's inability to obtain more than one videocamera for the collection of data. Resource limitation also became evident in the type of video data that was collected. In retrospect, it would have been beneficial to both the study of emotional states and 'body language', if the videotapes had concentrated on individual children as well as on groups. This would have provided more data that could have been used for direct comparisons.

A third limitation of the design of the study was the researcher's failure to follow-up some of the responses that were given to her in the interviews and the journals. If this had been done it might have provided data on new themes, or given more in-depth data on the themes that had emerged from the research. However, the interaction of the data collection methods provided the research with depth, and the use of triangulation strengthened its validity.

The Subject of Mathematics

Testing

Many of the findings from the study of children's emotions related to the test situation, and in particular, to the children's participation in written tests. The majority of negative emotions that were discussed during the research were done so in relation to written tests. Most of the children in the sample were found to dislike pencil and paper tests because of the negative emotions and adverse physical reactions that they created. The public manner in which the teacher recorded the children's grades was also found to contribute to the children's dislike of tests. However, some children stated that they enjoyed doing written tests, and several children viewed testing as an important part of the learning process - a necessary evil.

The investigation into emotional states found that Mathematics tasks in which negative emotions were experienced were the ones most firmly fixed in the children's minds and were the ones most easily recalled by children. This finding supports claims made in the literature about the significance of emotional memory. It also reinforces the researcher's argument that in order to develop positive attitudes to Mathematics, children need to experience frequent enjoyment in the Mathematics tasks they perform. The fact that the children in the sample were able to recall tasks in which they experienced negative emotions more easily than ones in which they recalled positive emotions, may be credited to the impact of the physiological reactions that were usually experienced with the negative emotions. As the written tests had a dominant position in the teacher's assessment program and it was during the tests that children most frequently experienced negative emotions, it is not surprising that several children in the class disliked Mathematics. Fewer written tests, the recording grades of privately and an increase in the number of enjoyable tasks, may have resulted in more children in the class developing positive attitudes to both tests and the subject of Mathematics.

The research found that the teacher used many teaching strategies which were stress inducing (Tobias, 1980; Morris, 1981). These included timed tests, making the children work on the blackboard in front of their peers and drawing attention to test marks.

Data from the research supports the statements made in the Mathematics K-6 (NSW Department of Education, 1989) syllabus about the need for teachers to use a variety of assessment methods in the evaluation of student progress. While the teacher of the class *did* use several assessment methods, her regular use of the written test appears to have made it the most significant to the children.

Difficulty Level of Work

The study of emotions found that the children in the sample experienced negative emotions when the difficulty level of a task was high. This was true for both Mathematics activities and for written tests.

During written tests the degree of difficulty of questions was often high. Therefore, it is understandable that many children experienced negative emotions. The relationship between negative emotions and difficulty level is another area that needs to be investigated in future research.

Grades

Children's emotions were found to be influenced by the marks they obtained or thought they would obtain in written tests Moreover, the saliency of marks in the teacher's assessment program was found to induce the negative emotions of worry, embarrassment and disappointment If test marks had not been made public then there probably would have been a reduction in the number of negative emotions that the children experienced.

Activities

In general, the study found that the children in the sample approved of the Mathematics program that was taught to them from the Mathematics K-6 (NSW Department of Education, 1989) syllabus. However, the research also showed that unless the children were working on tasks that involved numbers, very few of them considered themselves to be doing Mathematics.

The children's enjoyment of Mathematics was evident in their verbal and written statements. It was also obvious in the non-verbal actions they displayed during Mathematics activities.

The majority of positive emotions that were discussed in the research were done so in relation to Mathematics tasks that were not written tests. However, two negative emotions, frustration and anger, were occasionally experienced during Mathematics activities. These emotions occurred when the children were prevented from finishing the task on which they were working. This finding again emphasises the need for teachers to plan lessons carefully in order to reduce or alleviate negative emotions.

Mathematics activities provided the children with the opportunity for using concrete materials and calculators and for discussion. Each of these issues, along with many others, had been raised in the literature upon which the Mathematics K-6 (NSW Department of Education, 1989) syllabus was based. Thus it can be seen that the NSW Board of Studies has successfully incorporated findings from research into the Mathematics K-6 (NSW Department of Education, 1989) syllabus.

The research into children's emotions indicates that the types of activities encapsulated within the Mathematics K-6 (NSW Department of Education, 1989) syllabus are suitable for classroom use because of their enjoyment value. The findings from the research also

indicate that there is a need for teachers to capitalise on the enjoyment factor in Mathematics. This could be done by structuring lessons in which enjoyment is often experienced. Similarly, the research indicates that success, through the achievement of challenging but not over-challenging tasks, is vital to the development of positive attitudes towards Mathematics and towards children's beliefs in themselves as learners of Mathematics.

Attitudes and Beliefs

Overall the research found that the children in the sample had positive attitudes to Mathematics. The strongest attitudes related to the activities in which the children participated. Attitudes to Mathematics were found to be related to the amount of enjoyment and success children experienced during an activity. The findings from the study were found to support Rajecki's (1982) claim that there is a relationship between beliefs and attitudes.

The study of emotional states revealed that the children in the sample had strong beliefs about Mathematics, and that many of their beliefs were stereotyped and old fashioned. This was most obvious in the high proportion of number-related responses given by the children in their description of the subject of Mathematics, and in their statements about the significance of written tests as an assessment method. The beliefs the children held could have resulted from the regular use of written tests as an assessment method, and could therefore be considered idiosyncratic to the population that being studied. Beliefs about testing and beliefs about Mathematics need to be investigated in more depth in future research.

The study of emotions suggests that positive attitudes to Mathematics can be developed by using the Mathematics K-6 (NSW Department of Education, 1989) syllabus. While the syllabus has discussed attitude development in children, it has not discussed the development of children's beliefs. The research draws attention to the need for children to develop accurate beliefs about themselves as learners of Mathematics, and for them to hold realistic beliefs about the subject of Mathematics. Therefore the Mathematics K-6 (NSW Department of Education, 1989) syllabus should contain a section on beliefs.

Language

James (1894), Lange (1922), Mandler (1989) and Lang (1994) have all discussed the problems associated with using language to describe the emotions. The study of

children's emotional states found that both the researcher and the children sometimes experienced difficulty in using language to precisely describe emotions.

The age of the children in the sample may have been a factor that contributed to their difficulty in using language, or the difficulty may been a consequence of the complexity of the concepts the children were trying to explain. The language problem encountered by the researcher arose from her need to adjust her vocabulary to a level appropriate to that of the children.

Findings from the Literature

Findings from the research support the theories of emotion put forward by Mandler (1984; 1989) and Ortony et al. (1988). Mandler's discrepancy theory can be seen to provide a feasible explanation for the production of emotions in a Mathematics classroom. Mandler's (1989) argument that children's unhappy early experiences in Mathematics causes them to form negative attitudes to the subject, and McLeod's (1992) suggestion that it is the emotions that children sustain during those experiences which form the basis for attitude development, were also found to be supported by the data. The relationship between the emotions and attitudes is an area that future research needs to investigate further. Ortony et al's (1988) theory about the valency of emotions, the graduations found in the emotions and the causes of an emotion's intensity were found to be applicable to a Mathematics environment.

Findings from FitzSimons (1994) study found support in the study of children's emotional states. This was evident in the data on student's beliefs about Mathematics, their attitudes to Mathematics and the significance of challenge in Mathematics tasks.

The Thompson and Thompson (1989) argument that the elimination of negative emotions in students does not mean a desirable affective state has been achieved, found support in the study of children's emotions. It was witnessed in a child's statement about the nervousness he experienced before written tests being an incentive for him to try harder. The boy's comment also reinforced the claim made by Mandler (1989) and Byrd (1982) that stress could sometimes be beneficial. However, the data on negative emotions that was obtained from the study indicated that overall a high degree of worry was detrimental to students' well-being and contributed to their dislike of Mathematics.

An overwhelming amount of data in the study related to Mathematics anxiety and Mathematics test anxiety. For example, many of the words used by the children to

describe their emotions were those found in the Buxton (1981) investigation of panic. Student's physiological reactions during tests and their desire not to participate in Mathematics were also issues that evolved from the research. Both of these topics have been discussed in the literature on Mathematics anxiety.

In addition to Mathematics anxiety and Mathematics test anxiety, the study of children's emotions disclosed data on children's attitudes to Mathematics, testing, peers and Mathematics tasks. The research also provided data on children's beliefs. These related to beliefs about Mathematics, beliefs about the children as learners of Mathematics and beliefs about teachers, parents and peers. Some support was found for the interrelation of beliefs and attitudes. All of these topics have been discussed in the Mathematics literature on affect.

Masters and Doig's (1992) statement that curriculum reforms should be accompanied by changes in assessment procedures and Clarke's (1992) argument that assessment in Mathematics is a high profile activity, found support in the data on testing.

The research also supports the following findings from the literature: Sowder's (1989) statement that emotional responses are not always visible, Banbury and Hebert's (1992) argument that 'body language' should be accepted over verbal responses when there is a contradiction between the two, and Ortony et al.'s (1988) conception of behaviour as being indicative of, but separate from, an emotion.

IMPLICATIONS FOR PRACTISING TEACHERS AND POLICY MAKERS

The issues that emerged from the research have important implications for practising teachers and policy makers in Mathematics Education. Each of the main issues will be discussed in the following section.

Emotions

The investigation into emotional states has shown that children experience a range of emotions as they participate in Mathematics lessons. The study has provided insight into the reasons for children experiencing specific emotions. However, more research needs to be done in this area.

The study of children's emotions has indicated that many of the feelings children experience during Mathematics are able to be identified by knowing the specific non-verbal behaviours that are associated with them. Teachers need to be made aware of the non-verbal indicators of emotion, particularly those relating to worry. An awareness of these indicators will enable teachers to have at their fingertips a quick and easy method of determining children's emotional states. Continuing teacher education programs, and the introduction of courses at the pre-service level are strategies that could be used to instruct teachers about non-verbal behaviour.

The research has shown that the following factors determine the children's attitudes to Mathematics: the enjoyment experienced during a task, the nature of the task on which the children are working, and the difficulty level of the task. Therefore, policy makers need to ensure that the Mathematics syllabuses they design stress the need for teachers to consider the above factors when planning their lessons.

The Mathematics K-6 (NSW Department of Education, 1989) Syllabus: Attitudes, Beliefs and Assessment

If Mandler's (1989) theory about the formation of attitudes is correct, then it can be assumed that positive attitudes to Mathematics should result from children frequently experiencing success in their early years of schooling. For practising teachers this implies that they need to program work that is not only educational but also enjoyable. Many of the activities that are contained within the stage two level of the Mathematics K-6 (NSW Department of Education, 1989) syllabus appear to satisfy both requirements.

Not only should teachers be made aware of the educational and enjoyment value of using the Mathematics K-6 (NSW Department of Education, 1989) syllabus, but they should also be made aware of the reasons for using the various teaching strategies and assessment methods it recommends. Emphasis should be placed on the need to limit the use of written tests in the evaluation of students and on the benefit of using alternative methods of assessment. Teachers need to be encouraged to use the various methods of assessment advocated by the Mathematics K-6 (NSW Department of Education, 1989) syllabus. Attention also needs to be drawn to the detrimental effects of frequently using written tests in the evaluation of students, and of making grades a salient feature of student assessment. This again could be achieved through the inservicing of practising teachers and through courses presented to preservice teachers.

Findings from the research indicate that not enough emphasis is being placed on the importance of beliefs in Mathematics learning. The Mathematics K-6 (NSW Department of Education, 1989) syllabus does not contain any references to children's beliefs. However, statements that could be classified as beliefs about a number of issues, were found in the data from the research. This finding suggests that policy makers need to include references to beliefs in their documents.

Mathematics Anxiety and Test Anxiety

Many of the findings from the research were related to Mathematics anxiety and Mathematics test anxiety. Therefore educators need to be made aware of the significance of these issues in the learning of Mathematics. Strategies that would minimise the amount of anxiety that students experience, and strategies that would help students overcome Mathematics anxiety and test anxiety should be included in Mathematics syllabuses.

Programs such as the Family Mathematics Project of Australia (FAMPA, 1988) could be used by parents and/or teachers to help overcome Mathematics anxiety. FAMPA is a series of newsletters that contain unusual and interestingly presented Mathematics tasks on which the family, or a group of children can work.

Leder (1992) has stated that in Education documents little attention has been paid to affective factors other than curriculum statements. Greater emphasis must now be placed on the significance of affective factors in student learning; and it is imperative that teachers be given practical ways of catering for students' affective needs.

Concluding Thought

The research discussed in this study has described the emotional states that children experience in a Mathematics environment. It has also discussed indicators and descriptors of those states. The visible indicators of emotion were mainly found to be 'body language' actions that were peculiar to specific emotional states.

The study of the emotional states has drawn attention to the importance of the emotions in the formation of attitudes and beliefs. It is now time to more fully investigate the relationship between emotions and those constructs. If this is done then statements on affect in educational documents will be seen to do more than merely pay lip-service to the affective domain.

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APPENDICES

APPENDIX A

The Clarke (1987) Self-Assessment Sheet: Form B

Name: .....
Class: .....
Teacher: .....
Date: .....

* Write down the two most important things you have learnt in Maths during the last month.
.....

* Write down one particular problem which you still find difficult. .....

* How do you feel in maths classes at the moment?
(Circle the words that apply to you)

(a) interested (b) relaxed (c) worried
(d) successful (e) confused (f) clever
(g) happy (h) bored (i) rushed
(j) Write down a word of your own:

* How could we improve Maths classes?

.....
.

The Modified Clarke (1987) Self-Assessment Sheet

How do you feel about Maths?

Grade: .....
Female or male: .....
Date: .....

1a) Do you like Maths? Circle the answer that is the most correct for you:

ALWAYS MOST OF THE TIME SOMETIMES NEVER

1b) Why do you like Maths or why don't you like it?

.....
.

2a) Do you find Maths difficult? Circle the answer that is the most correct for you:

ALWAYS MOST OF THE TIME SOMETIMES NEVER

2b) If you find Maths difficult which area or areas do you find the hardest?

.....
.

2c) Can you give an example of something in Maths that you find difficult?

.....
.

3) When or where do you use your Maths skills?

.....
..

4) Do you think Maths is a useful subject? Circle the answer that is the most correct for you:

NOT AT ALL SOMETIMES MOST OF THE TIME ALWAYS

5) What sort of Maths activities do you find interesting?

.....
..

6) Can you think of a topic in Maths that you would like more help with? If you can, what is it? (You might think of more than one topic you would like help with. If you want to you can write the other ones down too.)

.....
....

7a) How do you mostly feel when you do Maths? Circle one or more of the following words:

(i) INTERESTED (ii) RELAXED (iii) WORRIED (iv) SUCCESSFUL
(v) CONFUSED (vi) CLEVER (vii) HAPPY (viii) BORED
(ix) RUSHED

7b) Can you think of any other words that best describes the way you feel when you do Maths?

.....
.

8) What is your biggest worry in Maths?

.....
..

9) Do you have any ideas about how Maths lessons could be improved?

.....
.

Thank you for your help.

APPENDIX B

INDIVIDUAL CHILDREN'S INTERVIEW QUESTIONS

1) Can you explain what you mean by the words you've used here? When do you feel that way? Do you know why?

2) When you do Maths do you ever get bodily feelings such as your heart beats quickly or you feel sick or you get a tight feeling in your stomach or you want to shout for joy?

a) Does this happen often?

b) What Maths activities make this happen to you?

c) Can you describe the way you usually feel when you are about to do a Maths test?
i)

ii) On a scale of 1-10 with 10 being the most worried, how worried or nervous or scared do you feel when you are about to do a Maths test?
** During the interviews the scale was changed to numbers from 1 to 5.

d) Is the way you feel when you are doing a Maths test or about to do a Maths test very different from the way you feel when you are doing activities in class and you know it's not a test or no marks will be given for the job?

APPENDIX C

SMALL GROUP INTERVIEW QUESTIONS

Today I'm going to talk to your whole group about Maths and the way you feel when you do it.

1. a) Many of you circled words like interested, successful, rushed, happy, worried, confused and bored when talking about Maths. Would any of you like to make any comments about those feelings or any others that you experience when you do Maths?

b) What about "frustrated"? Do any of you ever feel frustrated when you do Maths? (An explanation of the term may follow if it's felt necessary.)

c) What about "angry"? Do any of you feel angry when you are doing maths?

2. Most of the feelings people talked about or circled on the sheet for me were negative. That means they were unpleasant feelings. Do any of you experience good feelings when you do Maths, for example "joy", "happiness", or wanting to shout and say "yes"?

3. Another thing a few of you mentioned was that you get physical feelings just before tests. You might have shaking hands or feel sick or get sweaty.

Do you have any comments to make about Maths tests and how or why you feel the way you do before them?

4. Some people said they felt more nervous before little tests than before big tests and some of you said you felt more nervous before big tests than little tests.

Can you explain why different people feel different ways before the different types of tests that we do?

5. Would you feel better about Maths if you only did one or two tests a year?

6. Would it make things easier for you or make you like Maths more if you got a letter instead of a mark or percentage for a test, for example, "U" for "Unsatisfactory" or "S" for "Satisfactory".

7. a) How important do you think it is to your parents that you should do well in Maths?

b) Do they ever talk about Maths with you at home?

8. Do you know if either of your parents got nervous or worried before they did Maths tests when they were at school?

9. a) Does the person you're sitting next to or working with in Maths have any affect on how you feel when you do a test or your classwork?

b) A question for the girls: Would you prefer to work on things in Maths with other girls? (This question was repeated with the boys. The word "boys" was substituted for the word "girls".)

10. Do you have any final comments to make about Maths or how you feel when you do Maths?

Thank you for your help.

APPENDIX D

THE CLASS DISCUSSION AND FOLLOW-UP DISCUSSION

1. Quite a few of you said that often when you are asked a question to do on the blackboard, or in your books during mentals or in class, that your minds go blank. Can anyone give me a reason why their mind goes blank, or what happens?

2. Another question I asked you was "Why don't you show your good emotions like 'WOW' or 'I've got it', as much as you show your bad emotions like a frown or tears?

3. We talked about feeling nervous before Maths tests, big ones [written] and little ones [oral]. Do you feel more nervous, worried or scared before you do Maths tests than other types of tests such as Spelling tests?

4. Do you feel more nervous or worried in Maths lessons, not tests, than in other subjects like P.E. or Reading?

5. Most of you seemed to prefer getting a mark or percentage for tests instead of a letter. Think carefully before you answer this next question. Put your hand up if you prefer to get a mark or a percentage instead of a letter for tests. OK, now put your hand up if you prefer to get a letter for tests.

6. Think carefully before you answer this question. Which school subject do you think your parents consider to be the most important one?

7a. Some of you mentioned that your parents made you do Maths at home as a punishment for something you'd done wrong. Hand up if that's ever happened to you, either this year or last?

7b. Why do you suppose they might choose Maths as a punishment and not, say, Spelling or Reading? Do they ever make you do those subjects as a punishment?

7c. Which of your parents seems to take the most interest in how you're doing in Maths, mum, dad or both the same?

8. I am going to ask you how you feel about doing Maths at school. First I'll read through three choices that you will have and then I will go through each on separately. You can only choose one answer. These are the choices: hand up if you really enjoy doing Maths; hand up if you can't stand doing Maths; hand up if you think Maths is O.K. but you have other subjects that you like doing better? Alright, now I'll ask you for your answer.

- Put up your hand if you really enjoy doing maths at school.

- Put up your hand if you can't stand doing Maths?

- Put up your hand if you think Maths is OK but you might have other subjects that you like doing more?

9. A lot of you mentioned that you feel rushed when you do Maths. Put your hand up if you do? How does being rushed make you feel, or what does it do to you?

10. Another thing some of you mentioned was that you find questions in Maths that are easy or too easy, boring. You said you liked harder questions or problems, or work that challenged you better than easy work. Does anyone have any comments to make?

11a. Who could tell me what annoys them most when they are working on Maths in class?

11b. What is the best thing about doing Maths in class.

12. Many of you mentioned that in last year's class you did very few tests or no tests. Hand up if you would prefer to be in that type of class again?

[Unscheduled question]

If someone asked you to explain to them what Maths was, what would you say? Alright I'll ask each of you the question "What is Maths?

Thank you.

FOLLOW-UP CLASS DISCUSSION

1. How would you feel about doing something on the blackboard in front of strangers?

2. If you think Maths is your worst subject, or one you're not very good at, does that make you think you'll do badly in it?

3. What sort of things are you thinking about when the teacher is talking in a Maths lesson?

4a. Why is it that when you come to the blackboard you forget what you were going to do or say?

4b. How or what does getting nervous have to do with what you're thinking about?

5a. J. in the interview you had with me you said that you sometimes craved for food. Why do you do that?

5b. M. said she nibbled her nails. Can you tell me why you do that M.? Can anyone think of a reason?

5c. S. and K, said they felt 'normal'. Could you two explain what you meant by that?

6. I want you to put your hands up and tell me the answer to this next question. How do you feel most of the time in Maths: happy, normal, sad, worried, terrified or nothing in particular?

7. For the people who get more nervous for paper and pencil tests than oral tests why do you feel that way?

8. I asked you whether it made any difference who you sat next to when you did Maths. Some of you said "yes" and some of you said" no". Could any of you explain what you meant by this?

S. and J. said it wasn't nervousness and it wasn't fear they felt when they did written tests, it was something else that they couldn't explain. Can either of you explain that feeling or tell us more about it?

Thank you.

APPENDIX E

PARENT SURVEY

** The questions being asked only relate to your child in 3/4. **

PLEASE CIRCLE THE ANSWER THAT IS THE MOST CORRECT FOR YOU. THERE IS AN OPPORTUNITY TO MAKE ADDITIONAL COMMENTS IF YOU WANT TO. HOWEVER, THIS IS NOT ESSENTIAL.

1) Who is mainly answering the questions on this survey? Please circle.
a) mother
b) father
c) both mother and father
d) other (please specify) .....

2a) Do you and your child talk about Mathematics at home?

NEVER SOMETIMES ALWAYS MOST OF THE TIME

Additional Comments
.....

2b) Do you talk about Maths with your child after she/he has received a major report?

NEVER SOMETIMES ALWAYS MOST OF THE TIME

Additional Comments
.....

2c) Do you talk about Maths with your child after she/he has brought home a Maths test for you to sign?

MOST OF THE TIME ALWAYS SOMETIMES NEVER

Additional Comments
....

3. My child enjoys Maths at school.

NEVER SOMETIMES MOST OF THE TIME ALWAYS I DON'T KNOW

4. My child enjoys doing Maths at home.

I DON'T KNOW ALWAYS MOST OF THE TIME SOMETIMES NEVER

5. Do you ever use extra Maths done at home as a punishment for something your child has done wrong at home?

YES NO

6. Do you ever use extra Maths done at home as a punishment for something your child has done wrong at school?

NO YES

7. Do you ever give your child extra Maths to do at home so that it will help her/him with the Maths done in class?

YES NO

Additional Comments
.....

8. Does your child get nervous before she/he does a Maths test or Maths task in class?

NEVER SOMETIMES MOST OF THE TIME ALWAYS I DON'T KNOW

Thank you for your time and assistance with this survey.

APPENDIX F

THE MATHEMATICS TASKS USED WITH THE CLASS

The following tasks are those completed by the children during the collection of data from the videotapes, the researcher's observations and the case studies.

Construction Activity

The children are to use plastic geometric shapes to construct three dimensional objects. This is an exploratory activity.

Multiplication Grid

A grid is numbered horizontally and vertically. The multiplication sign is written in the top left-hand corner of the grid. The child must multiply each number in the horizontal column with each number in the vertical column. The answer is written in the appropriate grid square. The activity practises multiplication tables. It can be used to practise addition and subtraction facts.

Below is an example of a multiplication grid.

X	6	2	3	4
2	12	4	6	8
1	6	2	3	4
6	36	12	18	24

Multiplication Board Game

Using a die and a counter two children play a game in which the multiplication tables must be recalled. For each square that the child lands on she/he must be able to give the number sentence that equals the answer on the board. If this can be done then she/he may move her/his counter the number of spaces indicated by a little number on the square. The first child to reach the end of the board is the winner.

Stencil work; Bookwork; Blackboard work

* Some of the stencil work and bookwork activities were performed to practise the four basic operations of addition, subtraction, multiplication and division. The child completed algorithms for each of the operations.
* Stencils that involved the child in writing the time and/or recording given times on clock faces.
* Colouring sections of a picture by number after having completed a number sentence within each section.

* Children go out to the blackboard in front of their peers and complete an algorithm or a part of an algorithm.

Working out the Number of Metres and Kilometres run in the Weekly Fun Run

Once a week the class would go for a ten minute run. During that time each child had a lap (225m) marked on her/his hand everytime she/he passed a given point. At the conclusion of the run each child worked out the number of metres she/he had run. Each of the five groups of children in the class would then add up the distance all its members had run altogether. The total number of metres that all the children in the class had run was then determined. The total in metres was then changed to kilometres. A weekly score was kept of the distance the class had travelled. The children used calculators and written algorithms to do their calculations.

Written and Oral Mathematics Tests

At the conclusion of a fortnight the children would participate in a pencil and paper Mathematics test. The test would cover the class work treated during the two weeks and usually consisted of quick recall questions and algorithms. Problems or measurement work were also put on the written tests. For example, one of the tasks required the children to make an angle finder. This necessitated them cutting two circles along their radii and slotting them together.

The oral tests required the children to write the answers to questions read out by the teacher. Oral tests involved the instant recall of Mathematical concepts and/or facts. They were randomly given during the school week.

Soma Cube Puzzle

Each child was given an assembled soma cube. He/she had to pull it apart then reassemble it. There was a time limit of twenty minutes.

Measurement Activity

Aim:
To design a garden bed.

Objectives:
- to measure and mark out a plot of land 30cm X 30cm
- to decide upon the plants to be grown in the plot of land
- to care for the plants for one month

The children used their measuring skills and creativity to choose and design a small garden bed. Once the area was chosen and marked out the children had to bring in plants or bulbs for their garden. These were tended daily until the end of term (approximately one month).

APPENDIX G

THE CHECKLIST USED IN THE CASE STUDIES

The following outline of a checklist was used in the case studies. Each child had one checklist for each of the activities in which she/he participated. Under the heading of 'Frequency' the observer placed a tick or check everytime an action was performed.

Name:
Date:
Condition: (title of activity)

	Frequency							
1. smile								
2. frown								
3. grimace								
4. yawn								
5. finger(s) in mouth (biting, sucking, tapping)								
6. knuckle in mouth (biting, sucking, tapping)								
7. object in mouth (biting, sucking, tapping								
8. hand-to-face / head (cheek, chin)								
9. scratching face (nose, cheek, etc)								
10. scratching other body part								
11. laugh								
12. cry (or pretend to cry)								
13. covering eyes with hand(s)								
14. banging head on desk								
15. banging hand on desk								
16. "YES" movement (hand and facial expression, and saying 'yes'.								
17. Other comments?								
Q = quick movement (0 to 5 secs) P = prolonged (greater than 5 secs)								