CHAPTER 4 - THE SYLLABUS AND THE SURVEY

4.1 THE NSW MATHEMATICS SYLLABUS

To date there has been minimal specific research into the mathematical area under investigation here, although it is of significant interest to teachers of children with learning difficulties and of real-life relevance to those children in their daily functioning now and in later life. For this reason it is necessary to find other sources of information regarding current teaching practice in this area. One obvious source of such information is current syllabus publications, in this case Mathematics K-6 (NSW Dept of School Education, 1989). This should provide some insight into why many normal learners, let alone those with learning problems, lack skills and understanding in these areas (Engelmann, Carnine, & Steely, 1991).

Being competent with all applications of time telling, time reading and computations relating to time is a high priority life skill for independent living. Time is one of the few areas which impacts upon our daily lives in which a non-decimal number system is used. A thorough understanding of this is necessary for competence to develop in this area. Mastery of basic clockface recognition tasks both analog and digital, and the reading and writing of pictorial representations of Time is frequently accepted by teachers as acceptable and adequate educational achievement in this area for primary school students, particularly those experiencing learning difficulties. These objectives are in line with Time Objectives 8,9,10 and 11 from the Mathematics K-6 (1989) N.S.W. Syllabus (1989, 175) reprinted below.

TIME 8

* tell time on the hour on both digital and analog clocks

TIME 9

* tell the time on the half hour using digital and analog clocks

TIME 10

* read and write digital time in hours and minutes

TIME 11

* tell the time in one minute intervals using both analog and digital clocks

These objectives fall within the scope and sequence of the upper end of Level 1 (Infants) and the lower end of Level 2 (Junior or Middle Primary) as set out in the NSW Mathematics K-6 Syllabus (1989, 51).

Since the main indicators, as well as results, of learning difficulties are slower progression through the curriculum and lower levels of success or mastery, attainment of objectives such as these may seem reasonable. However, it must be realised that students with learning difficulties need to develop the skills and strategies that will enable them to deal with the curriculum. In the long term they are hurt by a lowering of expectations or a watering down of standards.

The real-life application of mathematical understandings of Time to situations such as what time to start cooking various parts of a meal which take different amounts of time to cook so that the meal is completely ready to serve at a particular time; or what time to set the alarm to ensure adequate time to eat, dress, and walk to the bus-stop; or what time to go and wait on the verandah if you are being collected one quarter of an hour from 7:20 requires mastery of much more sophisticated and less tangible and assessable objectives such as Time 12,13 and 14 presented below (Mathematics K-6, 1989, 175).

TIME 12

* compare seconds, minutes, hours, days, weeks and months
* select an appropriate unit for measuring time

TIME 13

* recognise and read time using a.m. and p.m.

notation

* read and interpret timetables

TIME 14

* recall time facts and the relationship between time units

Thus it can be seen that being able to fill in pages of clockfaces and call out times read are by no means adequate or even useful Time skills in real-life.

With regard to the teaching of Fractions children need to "develop concepts of fractions, gain a sense of fractional number, use models to find equivalent fractions,and apply fractions to problem situations" (Steffe & Olive,1991). Real-life applications of fractional knowledge such as sharing 3 apples between 5 people; mixing cordial and water to the recommended ratio; and measuring a quarter of a cup of caster sugar require more than a shaky grasp of the lower level objectives in Fractions and Decimals 1 to 5 from Mathematics K-6 (1989, 262) reproduced below.

FRACTIONS AND DECIMALS 1

* discuss and describe equal parts
* divide an object or group of objects into equal parts

FRACTIONS AND DECIMALS 2

* relate one part or parts of a group to the whole

FRACTIONS AND DECIMALS 3

* manipulate concrete materials to show a part of a whole
* name a part of a group and the parts remaining

FRACTIONS AND DECIMALS 4

* name parts of a group using 100 objects
* name part of a whole using the term hundredths

FRACTIONS AND DECIMALS 5

* model hundredths using concrete materials
* name part of a group using the term hundredths

The prescribed objectives in Fractions for Level 2 are from 4 to 10, with mastery of 1 to 3 assumed. Objectives 6 to 10 are reproduced below:

FRACTIONS AND DECIMALS 6

* compare and order hundredths
* count in hundredths, forwards and backwards

FRACTIONS AND DECIMALS 7

* record hundredths using the decimal form
* record decimal fractions as hundredths

FRACTIONS AND DECIMALS 8

* use the term tenths during modelling activities
* express fractions in tenths as hundredths
* express fractions in hundredths in tenths where possible

FRACTIONS AND DECIMALS 9

* demonstrate equivalence using hundredths and tenths
* compare and order tenths with concrete materials

FRACTIONS AND DECIMALS 10

* record tenths using the decimal form
* model whole numbers, tenths and hundredths

Steffe & Olive (1991) reported research in Finland, England and the United States which revealed that the majority of students, slow learners included, "learn rules and tricks for fractions and rely on rote memory of these rules and tricks". They did not reveal use of mathematical thinking, meaningful learning or the forming of links between fractions and real-life or between fractions and other areas of mathematical study. Furthermore the reductionism of the curriculum to an almost exclusive emphasis on decimals, tenths and hundredths, as can be seen in the Fractions and Decimals Objectives (Mathematics, K-6) set out above, detracts from a flexible working knowledge of fractions as they truly arise. Such a modified view loses sight of the fact that "mathematics was not handed down by some mathematical 'Moses' in bygone times. Mathematics is something that man himself creates' (Wilder, in Steffe & Olive, 1991) largely for real purposes.

For instance, if you have a 375ml can of drink to share with two friends you really need to understand the relationships between multiplication, division and fractions and to have a real concept of equal thirds. It would also be an advantage to know that a cup holds 250mls which would make a half a cup very useful in this situation. In real life the parts of mathematics we so often teach in isolation (Schmaltz,1990) are connected and interrelated. More able learners are able to make these connections spontaneously and gather and retain related learnings for application in novel or real situations. It is in this area particularly that children with learning problems often flounder. Relationships and connections between concepts, skills and knowledge need to be made explicit, to be taught and practiced (Robicheaux,1993; Bennett & Nelson, 1994,24).

4.2 THE SURVEY

Having critically examined the N.S.W. Mathematics K-6 Syllabus (1989) with regard to likely achievement objectives in Time and Fractions for children with learning problems in regular junior primary classrooms, by what other means can we gain an insight into actual teaching practice and content with regard to its adequacy and effectiveness?

Two recent American articles "The Mathematics Textbook: How can it serve the Standards?" by Schmaltz (1990) and "Making Connections in Mathematics" by Engelmann, Carnine, and Steely (1991) make the point strongly that textbooks provide a reliable and objective insight into what goes on in classrooms in mathematics. Engelmann, Carnine and Steely (1991) state that "maths textbooks usually represent the maths curriculum" and go further to suggest that they "seem to be linked to the poor math performance of U.S. students". According to Schmaltz (1990):

> No matter what the organizational style of the elementary school classroom, the mathematics textbook almost totally determines the day-to-day mathematics instruction...One reason for this approach, of course,is the inherent logical order of mathematics. Another may be the teachers' perception that since the course guide or curriculum embodied in the textbook was prepared by 'experts' then following it guarantees the best possible coverage of topics.

In an effort to discover if Australian teachers of primary mathematics, specifically teachers working within the Upper Hunter region of N.S.W., displayed a similar adherence to or dependence on textbooks a survey was planned and undertaken.

The specific purposes of the survey were as follows:

* to discover which mathematics textbooks currently available to Year 3 teachers in

N.S.W. were being used.

* to attempt to quantify the amount of classwork that was based on these textbooks.
* to establish whether children were allocated individual texts to work from or whether the influence of texts was teacher mediated.
* to gauge teachers' opinions as to how well or adequately preferred texts fulfilled the objectives of their school's mathematics curriculum.
* to get an indication of the size of the schools (number of Year 3 classes) and whether this related in any way to special education placement and textbook usage.
* to gain an indication of the integration or withdrawal of children with learning problems in N.S.W. schools.

It was hypothesised that the results of this survey would confirm a similarly strong dependence on textbooks in the teaching of mathematics in our junior primary schools. It was also hypothesised that the majority of children experiencing learning difficulties would be found to remain within their regular classrooms with the regular class teacher.

If these hypotheses were confirmed by the survey it would be justifiable to use the data gathered from a review of preferred mathematics textbooks to provide insight into content and current teaching practice relating to the teaching of Time and Fractions to children with learning problems in the regular classroom. This in turn would provide data on which to examine the adequacy of current practice in the light of research and to attempt to design more appropriate or effective teaching methods and materials.

The word survey is derived from the Latin words 'super' and 'videre' and means to look or see beyond the surface or the superficial (Leedy,1993,186). A descriptive survey, such as the one undertaken here, consists of detailed and precise observations being made by some means of the population falling within the parameters of the study. This is followed by careful recording and analysis of the data thus gained.

The underlying assumption of such a descriptive survey is that whatever we observe and record at the time of the survey is normal and would be found to recur under the same circumstances at another time. For this reason such a survey is also often referred to as a normative survey (Leedy,1993,185).

The main characteristics of a well designed descriptive survey are:

* a standardised method of observation across all cases.
* a carefully selected, well defined population of study, with precise and well considered sampling techniques.
* avoidance of introducing bias to the sample, and acknowledgment and recognition of possible sources of bias.
* systematic collection, organisation and presentation of data leading to accurate and valid conclusions being drawn (Leedy,1993,187).

Common means of collecting data for descriptive surveys consist of actual observations of subjects, interviews and the use of questionnaires. In this case the use of a postal questionnaire was deemed to be the most cost and time efficient method of data collection in view of the relative geographical isolation of the researcher, currently located in a small town in the Upper Hunter region of N.S.W.

Accordingly,the Questionnaire which can be found in Appendix I was constructed. In designing the questionnaire great attention was given to the use of clear, simple language as ambiguity or underlying assumptions can be the cause of poor response rates and erroneous results (Leedy,1993, 187-92). These factors can interfere at any of the cognitive response stages identified by Jobe and Mingay (1988): comprehension, retrieval, estimation/judgement and response.

To ensure that the meaning of the questions and the desired form of response was clear and unambiguous the questionnaire was pretested on family and friends who were not associated with teaching and on non Year 3 teaching colleagues. Minor adjustments were then made and retested.

Care was taken in the size and format of the questionnaire so that rather than appearing long or threateningly technical it would be accepted as professional yet approachable, that is, as an inquiry from one teacher to another. The entire survey consisted of only one page typewritten on both sides.

Each response method was clearly indicated within the question (eg. tick, list, circle) as well as by the layout of the response section. Different response methods were used for each question for several reasons. Variety and change make the questionnaire more interesting for the respondents and requires them to read more carefully and stay more focussed than would a series of yes/no questions or rating scales. The type of response was also determined by the sort of data which was being examined in each question. For example, 1.(d) "Is each student in Year 3 allocated a Mathematics Textbook at your school?" is quite adequately answered by a Yes/No response for the purposes of this survey. Whereas,for an estimate of quantity a choice of percentages was more appropriate in 1.(c) and to tap opinions a rating scale was more useful in 1.(e).

In recent years the deficits, oversights and oversimplifications which can result from a dependence on quantitative research have been highlighted by researchers and statisticians. Accordingly, an interest in collecting and analysing qualitative data has gained momentum (Taylor & Bogdan,1984,1-4).

In an effort to provide a balanced approach to collecting and interpreting data this survey incorporated several opportunities for respondents to clarify their answers or make comments (1.(b), (e) and 3). Of course, such data is much harder to analyse and compare than quantitative data where the range of responses is controlled by the researcher. It may, however, provide a greater depth of understanding of responses and may indicate possible areas of difficulty or bias in the survey previously overlooked.

Approval was sought through the regional Department of School Education to survey the targeted government schools. Likewise the Association of Hunter Region Independent Schools was approached with regard to access to non-government schools in the region.

An introductory letter (see Appendix II) to the principal of each school was included with each survey and the surveys were addressed to the principals. This was for two reasons. Firstly, responsibility for a great many policy decisions has now devolved to individual school principals so that out of courtesy and respect the principal should be the first line of approach and approval. Secondly, by going through the principals the targeted teachers are being approached by a known authority figure to read and complete the survey, rather than an unknown and irrelevant stranger. While this is likely to ensure a better survey return rate it has the disadvantage of introducing a level of bias in that the teacher may consciously or unconsciously respond in ways perceived as being approved of by the principal or may reflect the school's policy rather than actual practice. In either case the responses still provide valuable insight into how closely this group of N.S.W. schools resemble their American counterparts as reported by Smaltz (1990) and Engelmann, Carnine, & Steely (1991).

A covering note to the individual teachers was included at the top of the survey form as a matter of courtesy and in an attempt to encourage interest and co-operation. By including it on the actual survey form, so that the respondent did not have to turn a page or locate another sheet to co-operate, it was hoped that the reader would be lead to directly read and complete the questionnaire.

A closing statement of thanks acknowledging the time and co-operation of the respondents was included immediately after the questionnaire along with a reminder that the completed questionnaire should be returned. Prepaid and addressed envelopes were included with the surveys but the researcher's address was also included in the principals' letters in case these were separated or mislaid.

The sampling method chosen by the researcher was less than ideal statistically and was influenced by such factors as time, money, proximity and the relatively small and specific scope of the survey. Ideally, in order to be able to generalise the results of this study to Australian schools or even N.S.W. schools a multi-stage randomised sampling technique should have been employed (Leedy, 1993,206-213). In such a case, either subsamples of schools randomly selected from all over Australia would have been surveyed or a proportional stratified sampling technique would have been employed ensuring adequate representation of city and country schools, government and non-government schools,as well as various socio-economic, religious and ethnic groups.

The sampling area selected as most relevant and accessible for the purposes of this research was the sections of the Upper and Lower Hunter clusters of the N.S.W. Department of School Education which fell within the 065 N.S.W. telephone area code as well as the Catholic and private primary schools within that region. The small sample size of the survey and its restriction to schools within the Upper Hunter region of N.S.W. severely restricts its ability to be generalised beyond the region surveyed. Yet the fact that all schools within that region were surveyed means that both town and country schools were represented, both government and non- government schools were represented and all socio-economic and cultural factors should be reflected. Possible areas of bias include the preponderance of small and rural schools and the unusual economics of the region with large numbers of high wage earners with relatively little educational background, as well as high levels of emergency and government housing. On the other hand, all government schools in N.S.W. are required to comply with the requirements of the Board of Studies and with the

Department of School Education Syllabus. The majority of mainstream independent schools operate along similar lines and must comply with the Board of Studies also.

Thus, inasmuch as the Upper Hunter region is representative of N.S.W., the results are applicable generally. If it was of interest or relevance to continue further along this line of investigation it would be best to regard the survey here reported as a pilot survey and to widen and stratify the sample. Nevertheless, the results of the survey are of interest as an indication of the relevance of U.S. findings to our own local situation.

4.3 QUANTITATIVE DATA

Thirty schools in the Upper Hunter region were sent postal questionnaires. Initially nineteen of these questionnaires were returned. A follow up letter was sent to those schools which had not responded. This resulted in seven more returns and one letter from Australia Post to indicate that one of the small schools had been closed due to decreased numbers. This was an 86.7% response (89.7% if the closed school is removed from the sample) to the postal questionnaire. This is considered to be a high response rate and was quite acceptable to the researcher. Furthermore it indicated that the format and wording of the survey was successful in that a high level of response was obtained. The inclusion of a stamped, addressed return envelope was another factor contributing to the success of the survey. It was clearly a worthwhile exercise to send out a follow-up letter to initial non-respondents since this netted a substantial number of replies. Both quantitative and qualitative results of the survey follow.

TABLE 4.1

RESPONSE RATE:
Total schools surveyed = 30 26 responses received; 3 non-respondents; 1 school closed. Response rate = 26/30 x 100 = 86.7% Response rate (with closed school removed) = 89.7%

TABLE 4.2

RESPONDENTS BY SCHOOL TYPE:
GOVERNMENT SCHOOLS: 25 (21 respondents; 3 non-respondents; 1 closed) NON-GOVERNMENT SCHOOLS: 5 (Catholic: 2 ; Christian: 3)

Answers to questions 1 (a) and (b) of the survey were tabulated to obtain the data for Table 4.3 displayed over the page.

TABLE 4.3

TEXTBOOKS CURRENTLY USED BY YEAR 3 CLASSES IN UPPER HUNTER SCHOOLS: * = 1 school (some schools use several)		
TEXTS		TOTALS
HBJ	* * * * * * *	7
RIGBY MATHS	* * * * * *	6
RIGBY MATHS 2000	* * *	3
LET'S EXPLORE MATHS 2000	* * * *	4
SIGNPOST MATHS 3	* * * * * * * *	8
KOOKABURRA MATHS	* * * * * * * * * * * *	12
MAKE IT MATHS	* *	2
JACARANDA	*	1

From the graph it can be seen that Kookaburra Maths is the most widely used text among this group of schools. The next most popular choices were Signpost, HBJ, and the old and new Rigby Maths texts. Next in order of popularity were Let's Explore Maths 2000, Make It Maths, and lastly Jacaranda Maths. A review of these texts and their relationship to the N.S.W. Mathematics Syllabus will be undertaken later to attempt to investigate how teachers are currently teaching Time and Fractions in Year 3 Mathematics.

Survey answers to Question 1 (c) were analysed to discover the following data relating to teachers' estimated percentages of classwork that is based on textbooks in Mathematics lessons in schools in the Upper Hunter.

TABLE 4.4

PERCENTAGE OF CLASSWORK BASED ON TEXTS

T	10					
E	9					
A	8				*	
C	7			*	*	
H	6		*	*	*	
E	5		*	*	*	
R	4		*	*	*	
S	3	*	*	*	*	
	2	*	*	*	*	*
	1	*	*	*	*	*
		0%	25%	50%	75%	100%

CLASSWORK BASED ON TEXTS

It can be seen from the graph above that in this sample few teachers do not use textbooks at all (11.5%). Even fewer use textbooks alone as the basis for classwork in mathematics (7.7%). The majority of teachers in this sample estimated that they used textbooks for between 25% and 75% of their classwork (80.7%).

Of the teachers surveyed 34.6% estimated that they based less than half of their classwork in mathematics on texts, whereas 65.4% estimated that they used textbooks as the basis for more than half of their mathematics classwork. Even taking into account the imprecise nature of self-estimation and the variety of connotations and psychological second-guessing associated with the use of textbooks, it is clear that this Australian data lends support to the American data discussed earlier. A relatively small number of textbooks are being used regularly by teachers in the Upper Hunter region to form a substantive amount of their classroom mathematics content.

If it can further be shown that these texts are allocated to the students rather than used as teacher reference material then it would not be unfair to suggest that mathematics students are likely to perceive these texts as the way they learn mathematics in school. The following table sets out the data obtained from question 1 (d) in the survey.

TABLE 4.5

ALLOCATION OF TEXTBOOKS TO EACH STUDENT IN YEAR THREE.

YES	NO
13	13

Interestingly, although more than half of the schools surveyed used textbooks for at least 50% of the basis of their Mathematics classwork, only half of the schools surveyed actually allocated texts to students in Year 3. This is an indication that teachers are using texts substantially as teacher references in teacher-made programs of instruction.

This level of text allocation is also a reflection of the cost of student and teacher resources and the difficulty associated with providing consumable and/or reference texts in sufficient numbers in classrooms in the current economic climate. It is interesting to note that all of the five non-government schools surveyed allocated texts to students. The parents of these students would have been charged for these texts. 46% of the government schools which did not allocate individual texts to their Year 3 students still estimated that more than 50% of their classwork was based on texts.

A look at the data obtained from question 1 (e) throws further light on textbook usage. Teachers were asked to rate how well their preferred text/s fulfil the objectives of their school's Year 3 mathematics curriculum and were allowed space for further comments. The results of their ratings follow:

TABLE 4.6

RATING OF HOW WELL PREFERRED TEXTS FULFIL YEAR 3 MATHEMATICS CURRICULUM:

NOT AT ALL	*
QUITE WELL	* * *
WELL	* * * * * * * * *
VERY WELL	* * * * * * * * * *
COMPLETELY	*

Two respondents did not answer this section as they had previously expressed an absence of textbook use.

4.4 QUALITATIVE SURVEY DATA

The comments made by teachers in the optional comments section, while hard to quantify or generalise from, complement the quantitative data. They provide information relating to the reasons choices have been made in the selection of textbooks; insights into schools' philosophies and curriculum development; and an indication of teacher preferences and practices.

Each of the comments made will be related below with any relevant quantitative data provided as well.
"Our Math program is based on the K-6 Curriculum. Concrete materials are the basis for Teaching and Learning in Mathematics". No textbooks were being used in teaching Mathematics or Mathematics classwork in this school.

"Not used - make own stencils" was another comment. Likewise textbooks were not being used by teachers or by children in these classes. Possibly the stencils being made were based on Resource Materials supplied to schools along with the Mathematics K-6 Syllabus.

"The principal of our school is critical of the N.S.W. Curriculum document and has a school-based policy. Some ideas can be gleaned from some texts." The texts used by this school (three Year 3 classes) were Let's Explore Maths 2000, Signpost Maths 3 and Kookaburra Maths. Children were not allocated textbooks at this school and only about 25% of classwork was estimated to be based on texts. A strong philosophical emphasis on school-based curriculum development was revealed in this comment and was supported by the other data supplied.

The teacher who made the following comments used Kookaburra Maths as a basic text and estimated that 75% of classwork was based on it. "I have Year 2 also - I find it excellent (being a first year out teacher) as it (Kookaburra) fulfils many of the requirements in syllabus and school policy and provides ideas for much 'hands on' work." It is interesting that a newly graduated teacher whom one would presume to be very familiar with the N.S.W. Syllabus documents has selected to use this as a basic text rather than rely solely on the Syllabus and Support documents. This may be a reflection on the insecurities of a new teacher, or more likely on the cumbersome, user-unfriendly layout of the Syllabus and Resource Materials. The lack of sufficient copies of the Syllabus documents within both government and non-government schools is also an issue of relevance.

"The Mathematics curriculum is excellent - a heavy reliance on text books is not necessary. Kookaburra Maths has been written following the curriculum." This teacher used Kookaburra Maths for about 25% of classwork but her pupils were not issued with individual copies. It is interesting that once again the easier access to teaching material based on the syllabus is being cited as a significant factor in textbook selection and use.

"We believe that no text is complete but a combination of resources is necessary." This comment comes from a teacher who used HBJ and Kookaburra Maths for 75% of classwork and whose children were allocated texts. So even a heavy reliance on texts which fulfil the objectives of the N.S.W. Mathematics Syllabus "well" does not preclude the use of a variety of other concrete and practical resources.

Most teacher comments have implied that texts are not used solely because of the emphasis on concrete and real-life Mathematics contained within the N.S.W. Syllabus. The following comments relate to deficiencies in the texts or the Syllabus which mean that children's needs are not being adequately addressed by texts alone. For instance, a teacher who used Kookaburra Maths for 50% of classwork and whose children were allocated individual texts commented "Sometimes tasks are too difficult eg. fractions and decimals".

One teacher who used Signpost Maths for 50% of classwork and as an allocated pupil text explained "Signpost relates directly to the N.S.W. Syllabus." However, another teacher commented about Signpost Maths, "Children generally find work repetitive and simple. Poor arrangement of book makes working/ marking difficult. No syllabus reference. Answers not appropriate in student's books." This teacher was using Kookaburra Maths as an additional text although the school's set text was Signpost. Yet another teacher preferred Jacaranda Maths and commented "Jacaranda is written for the N.S.W. Curriculum - Teachers' Handbook is excellent for programming." This is an indication of the need for a variety of sources of information since some layouts and examples appeal to or assist some teachers and students but are unappealing or confusing to others.

Another reason for the use of multiple texts is expressed in the following teacher's comment. "Extra practice is needed in most areas to develop accuracy and fluency in skills". This teacher used HBJ and Rigby Maths 2000 as well as the Syllabus support documents. Very often teachers place great emphasis on understanding and concept development in Mathematics. However, accuracy and fluency in applying mathematical concepts is necessary if mathematics is to become a real-life skill rather than just a classroom phenomenon and this is made clear in the

N.S.W. Syllabus. It is in this area particularly that individualisation and catering for the needs of talented and gifted children, as well as those in need of remediation can be planned and accomplished. Those children in need of extra experiences and more practice time can be catered to and monitored whilst their peers who have mastered the basic principles and can apply them with accuracy and fluency can be using them to solve higher order, more complex and interconnected problems. These are some of the issues which will be considered later in this paper with regard to the development of new materials.

Question 2 in the survey was included to gain information regarding the number of Year 3 classes included by surveying these 29 schools. Answers ranged from three full classes of approximately 30 pupils to one year 3 pupil at a small school. This was an indicator of the widely different teaching/learning conditions to be found in N.S.W. schools. In all 36.5 classes and two individual Year 3 pupils were represented in this sample. Of these, 13 classes were composites, with children from at least two year levels being taught by one teacher. Whilst more demanding in many ways for the teacher, composite classes can work to pupils' advantage by providing opportunities for revision, remediation and extension without damaging self-esteem.

Question 3 was included in the survey to test the hypothesis that most children with learning difficulties in N.S.W. currently remain within their regular class and that the responsibility for their remediation lies usually with the regular classroom teacher. The survey results showed that 69% of the schools surveyed retained children with learning difficulties in the regular class. This finding supported the hypothesis discussed above. It was found by reviewing the qualitative comment data specifying other means of assisting children with learning difficulties that in six of the schools with more than one Year 3 class or composite classes children had been streamed into ability groupings presumably to assist the teachers in providing adequately for learning differences. This practice occurred in 20% of the schools surveyed. It is also noteworthy that in several of the schools where remediation was provided outside the classroom this was of very short duration (eg. half an hour per week) or provided only to those children who were tested by the school counsellor and had been classified as falling into a recognisable category of retardation (eg.IM). It would therefore be true to conclude that the majority of children in Year 3 in the schools surveyed who experience learning difficulties are dependent upon their regular classroom teacher for assistance and remediation.

CHAPTER 5 - REVIEW OF MATHEMATICS TEXT BOOKS AND MANIPULATIVES

5.1 REVIEW OF PREFERRED TEXTS

In an effort to gain greater insight into the teaching/ learning strategies currently in use in the areas of Time and Fractions an extensive review of the mathematics textbooks which had been found to be currently preferred by teachers of Year 3 in the Upper Hunter was undertaken.

Several of the teachers surveyed commented that their school's textbook choice was largely based on its compliance with and adequacy in fulfilling the recommendations and objectives of the N.S.W. Mathematics K-6 Syllabus. It is of great significance that the survey indicated 25% to 75% of classwork in mathematics was based on these texts in 80.7% of schools. It is important therefore to examine these texts in some detail to determine just how adequately they do fulfil the objectives of the Syllabus and how closely they reflect aims and underlying principles of the document.

The Aims of the N.S.W. Mathematics K-6 (1989,8) are as follows:

* To create in students favourable attitudes towards

and stimulate interest in mathematics.

* To develop in students a sound understanding of mathematical concepts, processes and strategies and the capacity to use these in solving problems.
* To develop in students the ability to recognise the mathematics in everyday situations.
* To develop in students the ability to apply their mathematics to analyse situations and solve real-life problems.
* To develop in students appropriate language for the effective communication of mathematical ideas and experiences.
* To develop in students an appreciation of the applications to mathematics of technology including calculators and computers.
* To encourage students to use mathematics creatively in expressing new ideas and discoveries and to recognise the mathematical elements in other creative pursuits.
* To challenge students to achieve at a level of accuracy and excellence appropriate to their particular stage of development.

The underlying principles of the N.S.W. Mathematics K-6 Syllabus are revealed in the foreword statement entitled "the nature of mathematics learning" (1989,4-5). They can be summarised thus:

* Students learn best when motivated.
* Students learn mathematics through interacting.
* Students learn mathematics through investigating.
* Students learn mathematics through language.
* Students learn mathematics as individuals but in the context of intellectual, physical and social growth.

Further indications of the underlying principles of the NSW Mathematics K-6 Syllabus (1989) can also be discovered in the discussions on learning experiences, problem solving and applications, and language. For instance:

> Activities based on concrete materials should be used with all age groups because of
> * the learners' need to work from the concrete to the abstract with most new mathematical concepts
> * the need to provide a variety of experiences in a series of alternative settings
> * the confidence and enjoyment shown by students when given opportunities to use materials
> * the need to set the learning experiences in contexts that are relevant to the students' world
> * the need to cater for different learning styles
>
> (Mathematics K-6, 1989,17).

The Syllabus prescribes the Level 2 objectives in the Scope and Sequence Chart as "appropriate to the needs, strengths and abilities" of children in Years 2 to 4 (Mathematics K-6, 1989, 51). These have been reproduced in detail in Chapter 4. In summary, to achieve the prescribed Time objectives children should be able to tell time to one minute intervals using both digital and analog clocks; compare and select appropriate units of time; and read and interpret timetables using a.m. and p.m. notation (Mathematics K-6, 1989, 175).

To achieve the suggested Fractions and Decimals objectives children should be able to name parts of a group and parts of a whole; model hundredths; express fractions in tenths and hundredths; compare, order and demonstrate equivalence (Mathematics K-6, 1989, 262).

An examination of the expressed rationales of each of the mathematics textbooks reported in the survey findings was carried out to discover how closely their underlying principles mirrored those of the NSW Mathematic K-6 Syllabus (1989). Kookaburra Maths (1990, 3) professes to contain "a wide range of activities for each component of the new mathematics curriculum (and) should be used after hands-on material". It also contains "clearly stated objectives (to) ensure that the full scope of the curriculum is covered". The Year 3 Signpost (1990) mathematics text also expresses similar underlying principles to the N.S.W. Syllabus and links directly to the suggested scope and sequence of objectives, as do Rigby 2000 (1993), "Make It Maths" (1990,i) and Jacaranda Maths 3 (1990, 1 & 41). The HBJ (1989, vi & 2) text was developed concurrently with the N.S.W. Syllabus and reflects similar principles and objectives in problem solving, language, the use of concrete materials and real-life applications of mathematics.

The Rigby "Moving into Maths" text (1983,7) preceded the current N.S.W. Syllabus yet contains many similar elements including a strong emphasis on the role of language in mathematics learning. Likewise the "Let's Explore Maths 2000" (1990) text is an updated version which emphasises problem solving, language, technology and an "active experimental approach to learning" in line with the underlying principles of the N.S.W. Syllabus (1989).

The Fractions and Time teaching/learning activities within the preferred textbooks were examined to discover which of the Syllabus objectives they were designed to fulfil. This evaluation was based on the actual content covered and the teaching strategies recommended in the related teacher-reference manuals. The following table (over page) summarises the results of this examination.

TABLE 5.1

TEXTS	MATHEMATICS K-6 LEVEL 2 OBJECTIVES - TIME				
	T-10	T-11	T-12	T-13	T-14
KOOKABURRA	*	*			
SIGNPOST	*	*	*		
HBJ	*		*		
RIGBY	*		*	*	
RIGBY 2000	*	*	*		
LEM2000	*	*			
MAKEITMATHS	*	*			
JACARANDA	*	*	*		

TABLE 5.2

TEXTS	MATHEMATICS K-6 LEVEL2 OBJECTIVES-FRACTIONS						
	F-4	F-5	F-6	F-7	F-8	F-9	F-10
KOOKABURRA	*	*	*				
SIGNPOST	*	*	*	*			
HBJ	*						
RIGBY	*						
RIGBY 2000	*						
LEM 2000	*	*	*	*			
MAKEITMATH	*	*					
JACARANDA	*						

As can be seen from the tables above the texts do not cover the Syllabus objectives comprehensively and certainly do not provide for extension. The exceptions are the two Rigby texts which provide extension into the a/b notation described in Fraction Objective 11 which falls within Level 3. This is most probably an anomaly since the extreme emphasis on hundredths in the Level 2 Objectives leaves little room for the development of more general fraction concepts in these early years. This imbalance of emphasis on decimals and decimal notation could be seen as a weakness in the current N.S.W. Syllabus.

All of the texts reviewed did, however, cater to the need for revision, remediation and consolidation of lower order skills before and during the learning of more complex ones. In fact, much of the emphasis in the texts was on consolidation of Level 1 Objectives in symbolic and abstract forms.

Comparing textbooks is rather like comparing a selection of different fruits. Each is attractive, useful and has its own special characteristics. It is unfair to compare apples with oranges unless some objective measures can be established (eg. vitamin content; fibre content; kilojoule value). In an attempt to establish an objective means of comparison between the Year 3 Mathematics textbooks being reviewed a measure of the average amount of pupil effort in terms of responding to the text by thinking about and applying mathematical principles and skills was devised. This measure was defined as the number of pupil work pages allocated to a topic multiplied by the mean number of pupil responses (thoughts, actions, answers) required per page. The measure was named "pupil work units".

NUMBER OF PAGES X MEAN NUMBER OF PUPIL RESPONSES

= PUPIL WORK UNITS

The aim of applying this pupil work unit formula to the texts was to overcome differences such as page size, print size and density which were found to be vastly different across this sample. It was also an attempt at quantifying the amount of exposure and practice in Fractions and Time students would be receiving in Year 3 if any of these texts formed a substantial proportion of their year's classwork in mathematics.

Results of this examination of the texts follow in Table 5.3 on the next page:

TABLE 5.3

TEXT	NUMBER OF PAGES TIME	+ FRACTIONS	MEAN RESPONSES	PUPIL WORK UNITS
KOOKABURRA	8	6	32	448
SIGNPOST	9	21	25	750
HBJ	5	7	14	168
RIGBY	8	8	20	320
RIGBY 2000	14	14	17	476
LEM 2000	4	6	14	140
MAKEITMATHS	4	2	13	78
JACARANDA	8	4	14	168

It is clear from the table that these texts differ substantially in the number of pupil work units they present for classroom use. That is, in the actual amount of thinking and responding a pupil is required to do to complete the mathematical topics of Time and Fractions. It is of some consolation to the researcher that those texts with very few pupil work units were nominated as extension or additional texts rather than representing a substantial portion of pupils' classwork for a year.

However, it is of great concern that even the more demanding texts provide very little content relating to the higher Level 2 objectives and thus very little challenge or extension for more able students. It would seem that sideways extension or more quantity is being provided in these schools in general rather than more complex problem-solving, more abstract or formal experiences, or exploration of real-life and mathematical connections.

Revision of lower level objectives was found to be present in all the texts reviewed presumably for the benefit of all pupils as consolidation and of those with learning difficulties for remediation. However, the texts themselves would be woefully inadequate to provide sufficient concept development and practice opportunities for children with learning difficulties. The reading level required for independent work in these texts would present an insurmountable hurdle for pupils with reading difficulties as well as problems in mathematics. Text use would need to be supported by a great deal of one-to-one or small group instruction for language and concept development along with the use of well chosen concrete materials or manipulatives.

5.2 REVIEW OF AVAILABLE MANIPULATIVES

The teacher-reference materials accompanying each text strongly recommended, in all cases, the frequent use of manipulatives before formal bookwork activities were introduced. For pupils with language, memory, or perceptual difficulties constant reference to manipulatives with the provision of appropriate language may be necessary if the relationships between real life, manipulatives and symbolic representations are to be established and retained.

In using manipulatives it is necessary to make sure that students make the connection between the concepts developed using manipulatives and the mathematical knowledge that such work is supposed to enhance (NCTM,1989). That is, a pupil with learning difficulties who has mastered reading times from drawings of clockfaces to five minutes accuracy but cannot read the time from the classroom clock or estimate when five minutes has passed has mastered a skill of very little value in the real world.

As discussed in Chapter 3 the use of manipulatives *per se* does not ensure that improved or useful mathematical learning will take place (Raphael & Wahlstrom, 1989). To be of use in developing mathematical skills and processes, the learning taking place when using manipulatives must be transferred into other situations relating to real life, other manipulatives and symbolic representations. Research has shown that for effective transfer to occur there must be "common elements" in the manipulatives and the new situation, and the more "common elements" the better, and that the learner must be aware of the existence of these common elements (Bohan & Shawaker, 1994). For instance, a pupil can be helped to read a watch with Roman numerals or a dress watch with a purely decorative face if the common elements of all analog clockfaces are well understood and can be applied to the new situation. More able and average pupils will often make this sort of transfer readily, but children with learning difficulties usually need such connections to be made explicit and to be given appropriate language to express them.

Manipulatives used in classrooms should be selected carefully and used effectively if they are to assist in the mathematical learning process. Researchers have identified several stages that learners should progress through to maximise the effectiveness of manipulatives (Bohan & Shawaker,1994). These stages have been given various names depending upon the theoretical position of the researcher.

Bohan & Shawaker's (1994) descriptors "concrete", "bridging" and "symbolic" will be adopted for the purposes of this paper. At the concrete stage mathematical learning is taking place as the pupil is acting upon the manipulatives. It is important that a close match is made between the way the manipulatives are used and the desired outcomes for the symbolic stage if transfer is to be promoted.

At the bridging stage manipulatives, language and symbols are used simultaneously in order that the relationships between objects and symbols are well understood. If this stage is sufficiently well accommodated by the pupil the movement into the use of symbols alone will remain meaningful since the symbols will represent real experiences, cognitions and the language structures and concepts with which to act on them.

The symbolic stage is where the pupil is acting upon symbols alone. The trend in all mathematics teaching is to move learners towards this symbolic stage especially as they enter the middle primary grades. To attempt to do so with insufficient time spent on the concrete and bridging stages is, however, pointless since rote procedural learning is unlikely to transfer successfully to general problem solving situations.

For all learners movement backwards and forwards between these stages is most likely to produce the most meaningful learning in mathematics. These three stages are closely aligned with the recommendations of the N.S.W. Mathematics K-6 Syllabus (1989, 5) which states "as each new mathematical concept is encountered, learning should proceed, where possible, from the concrete to the abstract. Concepts should be continually developed and consolidated through a wide variety of learning experiences. The development of understanding should, as a general principle, precede a requirement for both automatic recall of factual information and speed and accuracy in performing mathematical computations. Skills should be maintained through meaningful practice and enjoyable drill."

We can assume from overseas research, Syllabus recommendations, teacher-reference texts and the present survey's results that most teachers are using manipulatives and associated language in a substantial amount of mathematics classwork in teaching Time and Fractions in Year 3. If this is the case what manipulatives are they likely to be using? How effective are they? Are there ways they could be improved or used more effectively?

The manipulatives for mathematics lessons that are found in primary classrooms generally fall into three categories: everyday objects, teacher-made materials and commercially available equipment.

Everyday objects are widely used because of their low cost, ready availability and because of the ease of relating them to real-life mathematical situations. Creative teachers faced with pupils with learning difficulties frequently adapt or invent materials to assist them in developing understanding and skills.

In Australia there are a few major companies who specialise in supplying the needs of schools and,therefore, supply mathematical manipulatives. These companies frequently compete directly by stocking identical equipment or variations and adaptations of particular products. These companies are listed in Appendix III. A similar situation but on a larger scale exists in the United States.

The manipulatives relating to the teaching of Time and Fractions currently available to schools through the major school suppliers were examined in terms of whether they would be most useful at the concrete or bridging stages of mathematical development. They were also reviewed in terms of perceived common elements between the manipulatives and symbolic representations and between the manipulatives and real-life situations.

TABLE 5.4

MANIPULATIVES SUITABLE FOR USE AT THE CONCRETE STAGE
<u>TIME</u> The kinder clock Tocker timers Water timers Clock dials Transan (sand) timers 60 seconds to go Digital dilemma Standing clock Standing clock faces Stop clock All-purpose Digital stopwatch Sunbeam 60-minute ring timer Sand timer Jumbo sand timers Pupils' clock dials Replica clock face Plastic clock Quartz timer Teddy bear clock <u>FRACTIONS</u> Fraction birthday cakes Multi fraction kit Ariel fraction set Square decimal set Circle fraction set Square fraction set Fraction board Square fractions Circle fractions Triangle fractions Geo fractions Fraction circles Fraction squares Fraction bars Visual fraction discs Fit-a-fraction circles Fraction puzzle set Fraction pattern blocks Block fraction set

The manipulatives in the table above were classified as suitable for use with children at the concrete stage of mathematical learning because they consisted of materials which were designed as visual and kinaesthetic aids to the development of mathematical concepts. Those listed in the Tables 5.5 and 5.6 were classified as appropriate for use at the bridging stage because they combined both visual and kinaesthetic stimulation with symbolic and language input in their design.

TABLE 5.5

MANIPULATIVES SUITABLE FOR USE AT THE BRIDGING STAGE
<u>TIME</u> Wooden clockfaces Telling time jobcards Clockfaces for the overhead projector Telling time chart The teaching clock (quartz or manual) Digital learning clock Standing clock faces Analog clock Digital clock Logiclock Time teacher clock Time flies game Tick talk clock Scholar's clock face Geared clock Time flash cards One hand at a time program Time telling kit Tutor clock Digital learning clock What time is it? (game) Judy clock class pack Primary clock Clock-o-dial Polydron teaching clock Teaching time clock Big clock Invicta clock Laminated teaching cards Clock puzzles Universal clock

TABLE 5.6

MANIPULATIVES SUITABLE FOR USE AT THE BRIDGING STAGE
FRACTIONS Fraction bar The fraction factory pieces Fraction kits Fraction circles plus jobcards Fraction circles/ squares plus (transparencies) Fraction circles/ squares plus Activities for fraction pieces plus Fractions chart Fraction set and dice Fraction stax Pizza party fraction game Hundred board Fractions game Fraction tile package for the overhead projector Fraction bars transparencies New fractions kit Comprehensive fraction laboratory Fraction flip books and activity cards Comparative fraction strips Overhead fraction squares/ circles Frac Jack game New fraction cakes game Burned cookie card game Rainbow fraction tiles Overhead rainbow fraction tiles Fraction activity flash cards Lineal fractions set Square parts M3- Making sense of fractions MAB blocks Centicubes

The manipulatives classified in Table 5.7 over page as suitable for use as drill methods for learners operating at the symbolic stage have designs which are based on the premise that the pupils using them have already acquired symbolic knowledge and skills and require increased fluency and accuracy.

TABLE 5.7

MANIPULATIVES SUITABLE FOR USE AS DRILL AT SYMBOLIC STAGE
<u>TIME</u> Telling time bingo Clockface digital/ analog stamps Digital clock dominoes Time lotto Time telling puzzle cards Time clothespin books Clock dominoes Tell time quizmo Beginning telling time bingo Time to time Flip and learn Telling time cards Time matching puzzles Time dominoes 24 hour clock dominoes <u>FRACTIONS</u> Fraction dominoes Equivalence dominoes Metric dominoes Decimal fraction dominoes Decimal place value dominoes Decimal squares computer games Learning wrap-ups - Fractions Focus on fractions Fraction activity flashcards Fraction chart Basic fraction flashcards Advanced fraction flashcards Fraction 500 game Recognising fractional numbers and their relationships - thinkcards What decimal? (game) What fraction? (game) Fractions set Fraction percentage dominoes Equivalent fraction dominoes Fractions: mixed number dominoes Percentage fraction shapes

Initially it would seem to be a contradiction in terms to have manipulatives that are considered most suitable for use in the symbolic stage of mathematics learning. In fact many manipulatives, as can be seen from the tables above, are really enjoyable drill activities (Mathematics K-6,1989) and are inappropriate for use in establishing mathematical concepts. They are simply a glossier, more interesting mode of practicing skills and recognising symbols than paper-and-pencil exercises in a textbook.

Of all the manipulatives listed above very few attempted to relate their mathematical topic to the real world or to other areas of mathematics. The exceptions were the cake, cookie and pizza fraction materials; the hundreds board, MAB blocks and centicubes; and the actual timing devices. No attempt was made to link the two areas of Time and Fractions together in any of the manipulatives despite the fact that the average person's most frequent use of fraction language is in relation to the time.