EFFECTIVENESS OF RECORDING
IN PRIMARY SCIENCE

A study of the ability of junior primary school pupils to use
drawing as an effective method of communication
in science lessons.

DOROTHY MAY HAYES

BEd (Primary)

Deakin University
Toorak

Submitted in fulfilment of the requirements for the
Degree of Master of Education in the Faculty of Teacher Education
Deakin University - Toorak.

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DECLARATION

I declare that this thesis contains no material which has been accepted for the award of any other degree or diploma in any University and that it contains no material written by another author, except where due reference is made in the text of the thesis.

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January 1992

Dorothy May Hayes
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ABSTRACT

Drawing as a means of recording is a very common practice in junior primary science lessons. This is largely due to the availability of necessary materials. Also, most young children have some degree of drawing skill and enjoy drawing activities.

Since 1956 the science curriculum to be implemented in primary classrooms in Victoria has changed from one that was based largely on nature study (biological) to one that includes physical and technological aspects. Further, there have been changes in the teaching methodologies advocated for use in science lessons.

Throughout the period, however, there has been very little guidance to teachers concerning the value of drawing to either the teacher's program or to the development of the child. Accordingly, this study was designed to gather data about the potential of drawing in science activities with a view to providing guidance for teachers.

A modified Interactive Teaching Approach was used for the studies. Drawing was the main means by which the children recorded information. The topic of 'shells' was used to enable collection of data about the children's enjoyment of the activity and satisfaction with their achievement. This study was replicated using the topic 'rocks'; again data were collected concerning satisfaction and enjoyment.

During a series of lessons on 'snails' data were collected concerning the achievement of 'process' and 'objective' purposes that teachers might have in mind when setting a drawing activity. In addition to providing data about
purposes the study stimulated some questions regarding the techniques the children had used in their drawings. Accordingly, data concerning the use of graphic techniques by the children were collected during a series of lessons on 'oils'.

The data collected and analysed in the various studies highlighted the value of drawing in junior primary school science lessons. It also validated strategies developed by the author and designed to help teachers and children use drawing effectively in science activities.
Chapter 1

OVERVIEW OF THESIS

1.1 Introduction

This study was developed to investigate and gather data related to the value of drawing as an activity for use in junior primary science classes. It was designed to be of use to teachers by providing information and strategies that could easily be implemented in classrooms and teachers' programs.

The researcher is a classroom teacher who wanted to complete a research project that would systematically test the ideas developed from her experience of the uses and benefits of including drawing in class programs in science.

The major research question being addressed is whether drawing activity can be used to achieve specific purposes in science activities in the first years of primary schooling.

To gather data a number of studies were planned to be implemented in junior primary classrooms as part of the usual science program.

In the thesis it will be necessary to describe and analyse the context (the development of primary science and the place of drawing), review the relevant literature, indicate the orientation of the studies, report the studies themselves, and offer conclusions.
The remainder of this chapter provides an overview of the thesis.

1.2 The development of primary science in Victoria

A number of changes have taken place in the science curriculum in Victoria during the last thirty years. Some of these have a direct effect on the studies reported in this thesis, the most noteworthy being the move from a course based only on biology to one including physical science and technology.

The definition of content of the course has also been modified. Originally, the curriculum developers specified the content of the courses in some detail. Later, broad areas of study were suggested. The most recent course has provided teachers with a framework that enables them to develop suitable content based on the children's interests.

Methods of teaching have undergone significant change. The classroom setting has developed from a teacher centred model to a more interactive one. However one feature important to this thesis, that is the ways that children record, has changed very little. Written descriptions and drawings have always been, and continue to be, accepted methods of recording.

Some of the developments in the science curriculum at the primary school level in Victoria have also occurred at both a national and international level.

In Chapter 2 there will be a more detailed discussion of the development of primary science in Victoria and reference to overseas developments.
1.3 The place of drawing in primary science

Drawing is the central focus of the studies reported in this thesis. It has always been popular with teachers as a method of recording during primary school science lessons.

The inclusion of drawing activities can contribute to the teaching and learning processes in a number of ways:

- the children can experience enjoyment through drawing;
- drawing may contribute to the development of the children's skills, knowledge and understandings;
- drawing activities can also contribute to the teaching processes in a number of ways;
- completing a drawing activity may assist the children to formulate their own questions.

Although there are many reasons to include drawing activities there has been very little guidance to teachers related to the value of drawing activities or implementation strategies.

In Chapter 3 there will be a more detailed consideration of the place of drawing activities in primary science.

1.4 Research in the area of children's drawing

For more than a century researchers have been studying the area of children's drawing. Some researchers focussed on the product, others focussed on the processes involved in producing a drawing.
Researchers in the area of art education generally focussed on the product, identifying similarities in drawings and using these similarities as the basis for theories of 'stages of development'. This developmental orientation has been challenged recently by some researchers and educators.

Psychologists also have paid attention to children's drawings and used them as indicators of the child's mental maturity and emotional status.

Other researchers have focused on the way in which children approach the drawing process. Some of these have observed the children as they completed their drawings to gather data related to the drawing process. Others have looked at children's drawings and inferred processes that the children used to produce them. A few researchers have interviewed the children after the drawing activity in an attempt to find out why they have included certain features in their drawings.

In some recent studies children have assisted researchers to analyse drawings. For example children have evaluated other children's drawings.

In Chapter 4 there is a review of research from a number of different perspectives.

1.5 The orientation of the studies

A number of clusters of key issues needed to be considered when planning the studies.

The first cluster included the context of the studies, the topics that were used and the teaching/learning strategies.
The topics chosen for the studies included both biological and physical science. The selection of topics was also influenced by their interest for young children, their relevance to the children's own environment and whether they were suggested in curriculum materials for teachers.

The teaching model to be implemented in the studies needed to include teaching strategies that are generally considered important for the development of skills, attitudes and understandings related to science learning.

The second cluster concerned the methods used for data collection and analysis. It was decided that the focus of the studies would be whether or not the drawings achieved the purpose for which they were produced.

The final cluster concerned issues of reliability and validity. Features of internal and external reliability and validity were taken into account when planning the studies that are reported in Chapters 6, 7, and 8.

In Chapter 5 there will be an overview of the orientation of the studies.

1.6 Pupil satisfaction with drawings

As was suggested in 1.3 one of the important reasons for having children draw is that they usually experience enjoyment in this type of recording.

The studies reported in Chapter 6 were designed to collect data related to both the children's enjoyment and their satisfaction with the representational
drawings of shells and rocks they produced as part of the classroom activities.

1.7 Drawing for a range of purposes

Another reason suggested in 1.3 for the inclusion of drawing in the class science program is the contribution that may be made to the development of the children.

The investigation reported in Chapter 7, was designed to gather data related to the purposes for using drawing in science activities. In this thesis purposes have been divided into two types, 'process' and 'objective'. Process purposes are those that contribute to the flow of the lesson. Objective purposes are those linked to the learning objectives that the teacher has in mind.

1.8 Techniques children use to produce drawings

It was decided to conduct another study to collect more data regarding purposes and to also collect data concerning the techniques that children use to produce their drawings.

In collecting data about techniques it was hoped that the information collected would be of use to teachers in determining the most effective ways of using drawings in science activities.

1.9 Conclusion

The final chapter of the thesis deals with a number of issues.
The first issue is the research questions explored during this thesis. The research questions and a summary of the results is presented.

Another issue that is addressed is that of the reliability and validity of the data and findings of the studies reported in the thesis.

A third issue is the directions proposed for further research.

The final issue is the implications for teaching, curriculum and teacher education.
Chapter 2

THE DEVELOPMENT OF PRIMARY SCIENCE IN VICTORIA

2.1 Introduction

As the studies reported in this thesis were conducted in a science setting it is important to look closely at the development and changes in primary science in Victoria as they provide the context for the research. The researcher was determined to gather data in a classroom setting. But what setting would be the most appropriate? There were a number of choices which had to be made. First, which topics would be chosen as the setting for the studies? How would they be chosen? What teaching methods would be used? What guidance would the teacher give to pupils with respect to the drawings they would complete?

To answer these questions it was necessary to reflect on developments in primary science in Victoria but also, to some extent, internationally.

Science as a subject in the curriculum of primary schools in Victoria had its origins over 30 years ago in the nature study courses.

There are many aspects of these courses which could be reviewed. Space does not permit them all to be considered so the focus will be on three of particular relevance to the thesis. These are the selection of content, the method of teaching and the ways that children record in science lessons.
Selection of content in the science courses covers two aspects; what was to be included and who was to choose it. In early courses the main focus was on biological content. This gradually changed to include physical sciences and technology. This can be illustrated by reference to two topics taught as part of the research reported here, namely "snails" and "oils". The topic "snails" is listed in the content area in all the nature study/science courses since 1956. The topic "oils" is only mentioned as a suggested topic in the most recent official science document in Victoria, Frameworks [Ministry of Education (Schools Division), Victoria, 1987]. Initially, the curriculum developers specified the content of the courses. Later, broad areas were suggested. Recent courses provide a framework that enables the teacher and children to develop suitable content based on the children's interests.

The suggested method of teaching science has changed from a classroom setting which was teacher centred to one which is more interactive. In comparison, little has changed in the ways that children are expected to record in science lessons. Written descriptions and drawings have always been accepted methods.

More information related to drawing as a method of recording in science lessons will be found in Chapter 3. The value of tables, graphs and models as methods of recording are suggested in courses dating from 1968.
2.2 Description and analysis of the development of primary science in Victoria

2.2.1 The Nature Study Course (1956)

The basic aim of this course was "to provide for continuous observational contact with the local environment so that nature study will be a practical living experience for every pupil" (Education Department, Victoria, 1956, page 3).

Four specific aims were also listed. These were:

- to foster and develop the children's natural attitude of curiosity in the objects and phenomena of their immediate environment.
- to help them to satisfy their curiosity by using the problem solving way of thinking.
- to develop a clearer understanding of the relationship of plants, animals and the physical environment.
- to foster in the children an appreciation of life about them, and to interest them in the conservation and re-establishment of flora, fauna and country-side.

This course specified the content at each grade level. The content of the course was based on the children's natural environment and their understanding of it. The children's observations, not formal lessons, were to be used as the basis of the nature study program. An informal approach was to be adopted with observation as its focal point.
Observation incorporated five main skills. These were looking, seeing, inquiring, interpreting and appreciating. "What the child finds out for himself is the vital feature of any observation and care should be taken to avoid telling him something that he has a right to discover for himself." (Education Department Victoria, 1956, page 3).

An important aspect of the nature study program in the classroom was the daily discussion. This was a brief discussion based on either the children's nature study observations or on any natural objects that they had brought to school. In grades 3 and 4 following this discussion, the children were encouraged to have a short nature study period of free and directed observation work. In grades 5 and 6 a longer nature study period was to be implemented involving maximum activity work arising from the children's observations and experiments.

Teachers were encouraged to use the outdoors whenever possible. An observation bench, arranged and maintained by the children was a useful display area for specimens that were collected.

The Nature-Study Information Bureau was a service offered to teachers by the Nature-Study Department at Melbourne Teachers' College (Education Department Victoria, 1956). This was a last resort for children's questions that couldn't be answered by first hand observations or text or reference materials. The service ensured that questions need not be shelved or forgotten.

An appendix to this nature study course was the Circular of Information O (Education Department Victoria, 1963). This circular stressed the importance of nature study as a subject to be studied in primary school. "Nature study
has been defined as a process whereby common things and events acquire a meaning. It is of all subjects the one that offers the widest scope for truly educative work, because it comprehends the whole environment of man and may be used to stimulate close observation, clear reasoning, and a profound emotional response." (Education Department Victoria, 1963, page 6)

The circular covered the main features outlined in the nature study course (Education Department of Victoria, 1956) and reinforced the importance of observations, the place of morning talk, the nature study bench and excursions.

The circular also outlined in more detail the teacher's role. The teacher needed to be interested and be able to motivate the children. It stated that although the teacher may see their own lack of background knowledge as a problem, as long as they were willing to investigate with the children they would be successful. "He must look, see, inquire, and interpret with them." (Education Department Victoria, 1963, page 10).

Comments on the place of recorded work were made in the circular. It was stated that "pupils should be trained to develop skill in making neatly labelled drawings to illustrate details of the natural objects that have been studied". (Education Department Victoria, 1963, page 8). This was argued to be a useful method of helping children to understand their observations.

2.2.2 Victorian Primary School Science (1968)

This program was the first to incorporate the word science in the title. The program was an extension and broadening of the nature study course and
intended to show that "Science has an important place in the primary school" (Education Department of Victoria, 1968, page 9)

The content was expanded to include areas of physical science. The main aim of the program was to assist in the development of a style of thinking which has a wide application. It also aimed at laying a basis for later work in science, mainly by providing a variety of experiences and developing the pupils' ability to think.

This science program was set out in 3 guides -

A  Beginning Science
B  Following On
C  Branching Out.

It was suggested in the guides that the ideas and topics included there were not mandatory. Teachers should build the curriculum around the children's interests but at times they would need to be the initiators.

The guides were based on the premise that the "teacher should not hand out facts that go beyond evidence that the children have been able to collect" (Education Department Victoria, 1968, page 9). The emphasis was on sensory experience, close observation, planning and, carrying out activities, organising information and developing methods of communication.

Science was to be thought of as a social activity where the children work and interact together in an environment where they had direct experience of handling materials. A major consideration was that science activities should be enjoyable.
The children were to use painting, modelling and writing to communicate any information gathered during science lessons. It was suggested that by doing these activities the children were not only expressing or communicating ideas but helping to assimilate new information and form concepts, "such activities represent ways in which the child forms ideas and then makes them part of his range of concepts (Education Department Victoria, 1968, page 9)."

2.2.3 Science in the Primary School (1981)

The basis of this program was that "science is a part of the primary school curriculum because it allows the child to investigate the world in an ordered way" (Education Department of Victoria, 1981, page 1).

The content area of this course was more structured than the previous science course. The science curriculum was organised into planners. Each planner had approximately ten work areas listed that would be suitable to use for investigations related to the major theme of the planner. The teacher was able to choose the investigations that were considered most appropriate to the grade. The planners were sequentially grouped to form a year's program. Thirty two planners were developed to allow children in grades Prep to 6 to progress through the curriculum in an ordered way. There were two guides, 'Implementing Science : Preparatory Year to Year Three' and 'Implementing Science : Year Four to Year Six'.

This program was based on six major concepts that individual children could explore. These were Matter, Energy, Life, Time, Change and Relationships. Through investigation of these concept areas the children would be able to develop skills in the areas of observing, measuring, classifying, questioning, experimenting, planning, recording, concluding and communicating.
The attitudes to be engendered were originality, persistence, open-mindedness, objectivity, independence, interest, co-operation and responsibility. The development of the children's skills and attitudes was to be a gradual process. The program commenced with investigations that were designed to enable the development of discrimination and classification skills. After these skills had developed adequately the children progressed to more difficult ones.

These guides for classroom teachers detailed both the planners and important aspects of classroom management. The aspects discussed included the types of lessons, grouping of children, teaching techniques and common problems that may occur in the classroom. The planners were set out with suggested activities, materials and questions. Supplementary guides cross-referenced topics and detailed where equipment could be found.

This course refers to drawing as a method of recording but provides no comment on the purposes for using drawing or on methods of helping pupils develop in their ability to use drawing to communicate observations. Other suggested ways of recording were tables, models, paintings and concise, accurate written reports.

2.2.4 The Science Framework : P - 10 (1987)

In the Frameworks documents (Ministry of Education [Schools Division], Victoria, 1987) there has been an increased emphasis on technology and the social aspects of science. "Science for every student" is the central concern underlying the science Frameworks documents. The document is designed to provide school and curriculum developers with -
"...an educational position; a definition of science education that looks forward;
guidelines for the development of curriculum and curriculum materials; and
a stimulus to curriculum debate and action." (page 1)

The science framework outlined the importance of science education for children. "Science education offers students a valuable way of exploring and understanding their world. It helps them to operate effectively in their environment, and prepares them to take an informed role in Australia's national development." (Ministry of Education (Schools Division), Victoria, 1987, page 10)

Four aspects of science were outlined. These were:

- scientific knowledge
- solution of practical problems - technology
- the cultural and human context of science - society
- opportunities for personal development

and were represented diagrammatically as follows

(Ministry of Education (Schools Division), Victoria, 1987, page 29)
These four aspects were equally important and needed to be emphasised at all grade levels. It was also suggested that these aspects should be treated in an integrated way. Science teaching should start from, and build on, the children's level of development in the areas of interests, strategies, beliefs and understandings.

These documents are directed towards assisting teachers to develop both their own teaching skills and a suitable curriculum for the development of their students' skills, attitudes and scientific knowledge. It was suggested that a school-based curriculum developed by teachers, parents and students would be the most appropriate for each individual school.

It is also suggested that the children could record information in the form of reports, assignments, models, drawings, films and stories. Again, however, the documents do not provide teachers with advice on the purposes of drawing in science activities or how teachers can help children to improve the ability to use drawing effectively.

2.3 Reflections on changes evidenced in the curriculum documents

As can be noted in the above guides, primary science has changed in content from purely nature study based programs to those including science and technology. The content has also changed from one that was centrally determined to one that allows for individual schools to determine what is important for them. Children's interests are also regarded as important when determining current curriculum content.
The suggested method of taking science lessons has not changed radically. Recently however there has been a greater emphasis placed on starting where the children are and basing much of the work covered on their questions. The teacher's role has developed into a more interactive one where they need to be willing to learn along side their pupils when necessary.

There has been little guidance in the area of recorded work. This area will be discussed more fully in Chapter 3.

The issues which have been discussed above in relation to the Victorian curriculum can also be considered in the national and international setting.

2.4 Some developments in science education at the primary school level in relevant overseas countries

There are a number of developments in science education in the national and international setting at the primary school level which could be discussed. Two with particular relevance to the development of the research reported here will be discussed.

2.4.1. A change in focus to include technology and social implications of science in the curriculum

Technology has recently become a highly important area of educational study. The Australian National Science Statement discussion paper (Curriculum Development Centre, 1988) outlines changes that would need to be made in the area of curriculum content. It is suggested that an important addition to the science curriculum would be a study of technology, specifically in the area of the applications of technology.
In the United States of America, the new project developed by the "Biological Sciences Curriculum Study" has as one of its initial statements -

"Science for life and living:
Integrating Science, Technology and Health". (Bybee and Landes, 1988, page 36)

This new program attempts to integrate science, technology and health while developing concepts and skills. Millar and Driver (1987) described an approach known as 'active learning' designed to enable learners to become involved in natural and technological aspects of science. This involvement in turn would enable the learner to cope with, and understand, the ever increasing level of technological advancement in their own life style.

2.4.2 Methods of teaching

The interaction of learners and ideas

Many of the developments in methodology reflect a belief in the importance of the ideas the children bring to any lesson. Beginning any science topic from the ideas the children bring to the classroom is an important aspect of the Learning and Teaching section of the Victorian Science Frameworks document. "Children bring their perceptions and beliefs to the learning situation." [Ministry of Education (Schools Division), Victoria (1987), page 30]. These beliefs are often not the same as accepted scientific concepts. Science instruction often has little or no affect on the children's beliefs.
"Osborne and Freyberg (1985), Mitchell and Baird (1986), and Driver (1986) found that children respond to traditional science instruction in the following ways:

- Some become confused; recognising shortcomings in their own views, but unable to make sense of the teacher's explanations.
- Some completely ignore the teaching.
- Some carry two perspectives - the teacher's and their own. They apply the first "in school", and the second "for living".
- Some "misinterpret" the teaching, adapting it or using parts of it to reinforce their own view.
- Some, indeed, modify their earlier views and explore enthusiastically the ones presented in instruction." (Ministry of Education (Schools Division), Victoria, 1987, page 31)

It is necessary for teachers to identify the children's beliefs and concepts to use as a starting point in the new approach to teaching and learning in science. This emphasis reflects both national and international thinking in science education. For example, in the discussion paper - Science for Everybody? Towards a National Science Statement (Curriculum Development Centre, 1988), it is noted that in science teachers are able to use the ideas that children have and through experiences integrate and modify them. From these experiences the children will have the opportunity to develop an understanding of scientific knowledge, skill and practice and the confidence and skills to enable them to apply their scientific skills and knowledge to participate in decision making.

In the United States of America the new programs that were developed as part of the Biological Sciences Curriculum Study are designed to provide
experiences that will challenge the existing ideas of the children and help them to make sense of their world. It was envisaged that the children would be active in their science studies. They would be encouraged to explore their world, ask questions and solve problems. The programs are designed so that the topics and activities are meaningful and relevant for the children.

The British "Active learning" approach, discussed in the previous section, suggests that to achieve its aims it would be essential that the science contexts are relevant to the children's interests and concerns. The contexts also need to offer strategies and frameworks for deepening understanding of scientific concepts, and make the children aware of the cultural contribution of science. Finally, the science context needs to be stimulating. The children bring to the learning situation a wide range of existing ideas which interact with the new situation. This interaction may lead to modification, extension or change of existing ideas in the process. The curriculum needs to be based on a set of learning experiences which allow for this to happen. If children are to gain from the learning experiences then the basis for the selection of experiences must be the children's existing conceptions which are set in contexts of current or future interest and use. It is desirable that the children be able to develop the skills to query, question and seek alternative views on scientific and technological decisions which will affect their future lives.

**Teacher's role**

The teacher's role in the new programs has many facets. These range from curriculum developer to that of an active fellow investigator, a definite change in the teaching role from many traditional models. In the Victorian Frameworks [Ministry of Education (Schools Division), Victoria, 1987] document the teacher's role is defined as a developer of both curriculum and
materials, an implementer of the new program and an evaluator too. These extensions to the teacher's role would be necessary to attain the goals set by the new program.

The discussion paper for the National Science (Curriculum Development Centre, 1988) statement maintains that there would need to be support for teachers to bring about change in both policy development and teaching style.

In the project, Biological Sciences Curriculum Study (Bybee and Landes, 1988) in the United States of America it is stated that the teachers need to be prepared to take on the role of active learner. To achieve this goal strategies are included for ongoing teacher development and materials management. These were considered as essential elements in the adoption and implementation of the new programs. Assessment strategies are also incorporated in the program to provide information for teachers on the effectiveness of the learning experiences and to make teachers aware of the effectiveness of the instruction and general class progress. Curriculum materials have been written to help a wide range of teaching abilities, from the 'first year out of college' teacher to the very experienced teacher who is only looking for a new approach, activity or teaching strategy.

2.5 Interactive Teaching

Many of these developments appear together in an approach in New Zealand and known as Interactive Teaching. During the Learning in Science Project (Primary), Biddulph and Osborne (1984) developed an alternative approach to teaching science based on children's questions. They and other
researchers realised the importance of children's questions (Osborne and Wittrock 1985).

Children's questions are important in a number of ways -
- they help them to make sense of their world;
- they provide teachers with an indication of ideas;
- they can generate interest.

The approach had as its key aim the development of "an inquiring mind and the skills for exploring and interpreting the environment" (New Zealand Department of Education, 1978 page 4). Adopting this aim required that other important factors be taken into account.

According to the New Zealand Department of Education (1978), these included -
- the need for the children to develop skills to gain understanding;
- the fact that the desire to learn something can be a powerful motivating influence on the children to improve their processing skills;
- that children construct their own meanings;
- that the meanings constructed by children result from an interaction of their original ideas with the learning experience and the skills they employ to make this happen;
- the need for the opportunity for children to make mistakes, accept these and learn from the experience.

Bearing these factors in mind a model was constructed that related to content, knowledge and the development of skills and attitudes.

The Interactive Teaching model consists of 5 stages.
Stage 1. **Preparation:** During this initial stage the teacher collects the necessary background information and resources.

Stage 2. **Exploration:** This stage is divided into 2 parts -

(i) Initiating activities to encourage the children to want to find out more about the topic of study.

(ii) Clarification of terms and ideas. A time for finding out the children's ideas about the topic. This is done by asking them.

Stage 3. **Children's Questions:** At this stage of the model the children's questions are recorded, discussed and decisions made about the ones to be investigated.

Stage 4. **Specific Investigations:** During this stage the children record their before views prior to commencing an investigation. These are kept for later comparisons. They then gather information on the topic by the means they consider most appropriate.

Stage 5. **Reflection:** During this final stage the children report back on their findings. Comparisons of before and after views will enable the children and the teacher to assess the learning which results from the investigations.

The Interactive Teaching approach is child centred where the children are investigating what they want to find out and devising their own ways of tackling a problem or question. Through their own investigations they are able to understand what they're doing and why. By completing their investigations they are developing skills that will help them to make better sense of their rapidly changing world. In this approach the content is based on the children's interests and the children are encouraged to plan their own investigations.
The role of the teacher is a very important one. No longer seen as a fountain of knowledge or dispenser of facts, during the course of interactive teaching there are several important roles that the teacher can adopt. These include a naive fellow investigator, a resource person, a facilitator of learning and a challenger of the children's ideas.

Drawing has been used in a number of ways in the Interactive Teaching approach -

- as a method of finding out the children's ideas and concept level;
- as a method of recording predictions;
- as a method of recording investigations; and
- as a method of communicating between members of the class.

2.6 Conclusion

As was indicated earlier in the chapter, the researcher set out to gather data about children's drawing in a classroom setting. The validity of the data would be influenced, therefore, by decisions made about the lessons to be concluded. The review of developments in primary science suggested a number of directions. First, it would be important to investigate the pupils' drawing not just in relation to biological topics. Current programs for primary schools include physical science topics alongside the more traditional biological areas. Further, the teaching methodology used should be one which reflected current thinking.

Although there were a number of teaching models that could have been used to study the drawing activity it was decided to use an Interactive Teaching approach in the lessons reported in this thesis. This approach brings together many key elements in recent research and development in primary
science: the approach takes account of the ideas the children bring to the classroom, encourages the children to ask questions and to plan how to obtain answers to the questions, and applies to both physical and biological topics.

More information related to the Interactive Teaching Approach and its significance to this study can be found in Chapter 5.

Drawing was a very important component of the study as it was the major means of communication. The issue of recording by drawing will be discussed in detail in the next chapter. What this brief overview has suggested, however, is that very little direction or advice has been available to teachers in deciding when, how, and for what purpose to use drawing. It appeared that there was scope for the researcher to devise and test ways of using drawing in primary science activities.
Chapter 3

THE PLACE OF DRAWING IN PRIMARY SCIENCE

3.1 Introduction

Recording what the children have observed or discovered by means of a drawing has always been a very common practice in primary schools. It is an activity popular with both teachers and children. It does not require much in the way of preparation or materials and most children have some skill, as well as interest and enjoyment, in participating in drawing activities.

In this chapter there will be two focal points related to the place of drawing in primary science. The first is the contribution of drawing to classroom activities and the development of the children. The second is the guidance or lack of guidance given to teachers regarding the value and methods of using drawing effectively in class science lessons. Particular emphasis will be placed on the documents produced as guides to, or supplementary materials for, the various nature study, and later, science courses. This will then be contrasted with the level of detail available to teachers on the use of language in science.

3.2 Purposes for using drawing

Reasons for using drawing in primary school activities can be classified under three main headings, as outlined in Figure 3.1 on page 30. It is suggested that drawing in primary school activities can be justified because it contributes to:

• the enjoyment of the pupils;
Figure 3.1: The contribution of drawing in primary school science activities
the development of individual skills, knowledge and understandings;
the teaching/learning processes.

Each of these aspects will now be discussed in more detail.

3.2.1 The enjoyment of the pupils

Children often gain a great deal of pleasure from drawing. If they receive positive feedback they are likely to develop a feeling of satisfaction with their drawing ability. The feedback may be extrinsic as their work is praised by teachers or their peers. Or it may be intrinsic. Such is the case when the pupils are able to see the drawings achieve the purpose for which they were produced. Chapter 6 contains the report of a study which suggested that the majority of children enjoyed the drawing activity in which they were involved, and were satisfied with their drawings as they achieved the purpose for which they had been drawn.

3.2.2 The development of individual skills, knowledge and understandings

When teachers plan a drawing activity they may have some specific learning objectives in mind. In this thesis the purposes related to learning objectives will be described as "objective purposes". The objective purposes outlined in Figure 1 are:

- improved ability to observe;
- improved ability to communicate graphically;
- improved knowledge of phenomena;
- improved understanding of phenomena.
Improved ability to observe

For the children to improve their observational ability they need to have both the opportunity to observe and the motivation to ensure that they look closely at an object. The requirement to record what they have observed by using a drawing may provide the children with a reason for close, careful observation which may in turn help to develop their observational ability. For example, if the children are studying leaves and the teacher asks them to draw their leaf so that their friend could find one exactly the same, it is likely that the children will look closely and make a more accurate representation of their leaf, than if the teacher just asked them to draw a leaf.

Improved ability to communicate graphically

All children have some ability to communicate by drawing. In some science guides (for example, Science 5/13 1972; Education Department of Victoria 1981) it is suggested that by the end of year 2 (approximate age of 7) the children should be able to record using a drawing. The more opportunities that the children have to communicate by using a drawing, the more proficient they may become. However, this could depend upon many factors. For example, for improvement to occur the children may need to feel satisfaction and a sense of achievement related to their drawings. Or they may need to be exposed to examples of successful drawings so that they can see and develop techniques and skills which improve their ability to communicate.

Improved knowledge of the phenomena

If the children are asked to complete a drawing of an object that they are studying, then one of the outcomes may be an improved knowledge of that object. The children may have had little knowledge or incorrect knowledge of the object prior to their observations and drawing. This knowledge may be
modified or extended due to the drawing activity. For example, if the children are asked to draw their leaf so that later they could identify their leaf from a collection of leaves, they may through careful observation and recording by drawing improve their knowledge of the venation of a leaf.

**Improved understanding of phenomena**

Another outcome of the children's involvement in observing and recording their observations in a drawing may be an improved understanding of the phenomena. Based on their observations recorded in a drawing format the children may improve their understanding of the phenomena. For example, if when the children draw some objects that are floating they record that some float lower in the water than others, this may in turn lead to an increase in their overall understanding of floating and sinking.

Sue Foster, a tutor in 'Early Literacy in Classrooms', suggests that for young children drawing is a very important way of clarifying ideas and should always be used prior to writing (personal communication).

**3.2.3 The teaching/learning process**

As was outlined in the previous section, drawing activities may lead to the achievement of pupil development that the teacher has in mind. Drawing can also be included for reasons more related to teaching strategies. For example, drawing activities may assist with the flow of the lesson. The drawing activities related to the teaching and learning process will be described in this thesis as "process purposes".
The process purposes shown in Figure 1 are:

- to provide a non-verbal activity;
- to facilitate communication between the children;
- to focus the children's attention on the phenomena;
- to provide a record of something done or observed;
- to assist the teacher to understand the children's ideas;
- to assist the children in formulating their own questions.

**To provide a non-verbal activity**

The children may be asked to complete a drawing to provide a quiet, individual activity to help the children settle down after an active, noisy group activity. It is not suggested that such a process purpose is in conflict with the achievement of objective purposes. For instance, the teacher may think that it would be appropriate, after a discussion to ask the children to do a drawing as a change of activity. However, the drawing activity whilst meeting this requirement can also contribute to the children's understanding of the topic discussed.

**To facilitate communication between the children**

Communication through drawing within the classroom environment operates on two levels -

- small group interaction, and
- the grade as a whole.

When the children are involved in a drawing activity they share ideas with those around them both verbally and through their drawings.

As the children complete their drawing, their discussion is likely to relate both to their observations and to the information they are showing in the drawings.
If the children's drawings are displayed in the classroom then it is highly likely that the children will discuss them, thus facilitating communication between the children.

Children may be given the opportunity to use their drawing at the end of a science lesson as the major part of a report, using their drawing to communicate to the other children in the class what they observed or found out. The drawing then becomes a very important means of communication. The children will often put more effort into their drawing if they know that this type of reporting is to be implemented.

To focus the children's attention
The purpose that the teacher gives to the children for doing the drawing is relevant when focussing the children's attention. If the children are asked to complete a drawing to show a specific part of an object e.g. a bird's beak, then they are more likely to concentrate their attention on that part rather than the object as a whole.

Another strategy that appears successful in focussing the children's attention, is to use their drawings in later classroom activities. This may include using the drawing as a focal point in a report, or as a method of identifying an object at a later date. For example, when the children are told that their drawings of a stone will be used by other children in the class for matching, they include extra detail of shape, colour and markings that are relevant to their individual stone.

Provide a record of something done or observed
Drawing is a simple method of demonstrating what the children have seen or observed during a lesson. For young children with limited abilities in any
other form of recording it is very practical, and provides the children with a useful tool for expressing themselves. As outlined in Chapter 2 drawing in science has been for many years considered a useful method of helping children to record their observations.

**Assist the teacher to understand the children's ideas**

Drawings completed by the children at different stages of a study can provide the teacher with a large amount of information on what the children are thinking. By asking the children to complete a drawing at the commencement of a topic, teachers may be able to gain insight into the understanding the children bring to the topic, and therefore enable them to provide a relevant starting point to the proposed study.

Drawings during a study can provide the teacher with an understanding of the children's ideas and observations. Often it is difficult for a teacher to speak to every child during a science lesson, but the teacher is able to gain valuable insights from drawings done by the children.

To complete a drawing as part of the evaluation of a topic may provide the teacher with information on the development or modification of existing ideas. This may become apparent when comparing initial and final drawings.

**Assist the children in formulating their own questions**

Children have always asked questions. These questions have enabled them to make sense of their world. Science educators have looked at different aspects of children asking questions. The function of questions for children was investigated by Isaacs (1930). Others, including Wastnedge (1967), suggested their value as the basis for classroom activities. Some
investigators stated the value of children's questions in providing insights of the child's world. More recently it was suggested by White (1977) that the development of an ability to ask questions should be an important objective in science education.

While completing a drawing during a science lesson the child may become aware of a question that they would like answered. The results of an investigation of children's questions asked after completing drawings will be discussed in chapter 7.

3.3 Assisting teachers to use drawing effectively

In the field of language education teachers have available to them a great deal of material which both identifies the purposes for which children will write and how teachers can promote the children's development in this area.

For example, Derewianca (1990), discusses many different writing genres including recounts, narratives, information reports, explanations and arguments. For each of these she identifies the purpose and suggests ways that the teacher can encourage the children to achieve the purpose.

With respect to drawing the situation is very different. Little attention has been given either to identifying purposes for drawing or for assisting teachers with appropriate strategies to ensure that the purposes are achieved. The remainder of this chapter reviews the very limited guidance provided for teachers in this area. The survey begins with the official course materials.
3.3.1 Nature Study and Science Guides

*Nature Study Course (Education Department, Victoria, 1956)*
The nature study course of 1956 outlined no detailed guide to strategies for recording work covered in primary school classes. It proposed considerable value in recorded work. In the program teachers were to encourage the development of the children’s ability to build up their own individual records. It indicated that the copying of set sketches and diagrams was to be avoided.

"The Nature-Study period should not be regarded as an art or composition period. The best 'show' books do not necessarily indicate the best nature-study". (Education Department, Victoria, 1956, page 4)

As reported in Chapter 2 the Circular of information O (Education Department, Victoria, 1963) outlined the place of drawing in more detail and stated that the children should develop the skill of making neatly labelled drawings to record their observations as this would help them to clarify and extend their understandings. Again however there was no survey of purposes or strategies.

*Victorian Primary School Science (Education Department, Victoria, 1968)*
This course did not specifically mention the use of drawing as a method of recording.

*Beginning Science*, which was the infant level manual advocated the use of science to provide material for experience books. It also suggested the use of themes and topics to create classroom displays. Displays would motivate children to create models, paint or write more willingly.
Following On, the middle school manual, suggested the presentation of data in a paragraph and the use of graphs and tables. These methods of recording were to be continued into the senior grades in the primary school.

*Science in the Primary School (Education Department, Victoria, 1981)*

In the materials published by the Victorian Education Department, "Science in the Primary School", it is stated that by the end of year two the children should be able to "record information using tables, models, paintings and drawing" (Education Department of Victoria, 1981, page 22).

In England the Schools Council had already endorsed the publication of the Macdonald Educational series entitled "Science 5-13". In the teachers' handbook (With Objectives in Mind, 1972), it is stated that in the concrete operations stage the child should be able to communicate by using the "ability to record impressions by making models, painting or drawing" (page 64).

Although proposing what children should be able to do there was no guidance given to teachers regarding their role in assisting the children to achieve these goals.

*The Science Framework P -10 (Ministry of Education (Schools Division), Victoria, 1987)*

The only mention of drawing in the Science Framework document is in the assessment section. Drawing in the form of diagrams is part of a sample grid for progressive assessment of practical work. Drawing is also mentioned on page 81 in 3.2 Assessment of Products, "In assessing such things as reports,
assignments, models, drawings, films, stories etc., a clear statement of goals, understood by both students as well as teachers, should be used". Again there is no advice to teachers on strategies for using drawings.

3.3.2 Supplementary materials

As well as official course guides, over the years teachers have had access to a range of supplementary materials. No attempt has been made to conduct a comprehensive survey of these materials, but comment will be made briefly on two of these.

Gould League Books

In the 1930's the Gould League of Bird Lovers produced two sketchbooks entitled "Sketches of Australian Birds" (May undated) to assist bird lovers to improve their skills at drawing Australian birds. In the introduction it states - "Teachers, members of the Gould League of Bird Lovers, and all others interested in bird life and sketching will welcome this guide to the drawing of birds".

The purpose of these books was to help a wide range of people, including children, to study the native birds. The books proposed the learning of formalised drawing techniques through instruction. Measurements, colours and construction lines were shown in great detail. In the general preface it states - "The construction lines will prove a simple foundation upon which to build the drawings, and will also assist greatly in obtaining correct proportions, but they must be sketched in very lightly." Refer to figure 3.2.
Figure 3.2: A sample page from one of the original Gould League sketch books. a. Outline to be used as a guide and b. the final drawing (from May undated).
Young children were included in the group who were encouraged to use these sketchbooks. The expectations for this group was not as high as for adults. It was suggested that they should not attempt to sketch in the detail shown. A simple outline would be enough to begin with, this could then be completed using coloured chalk.

These books were designed to not only improve drawing skills but hence to extend the children's understandings and knowledge of these birds. "Do not attempt to do too much at once; make a careful study of the relative proportions of the bird, so that when the drawing is completed something has been learned from the Nature Study point of view." (General Preface)

These books were reprinted many times as both teachers and children found them a valuable resource for both reference material and drawing strategies.

*Science and Nature Study Activities in the Classroom (Matchett, 1967)*

The emphasis in this book was for children to spend most of their science lesson involved in experimentation, observation, activities and class discussion. It was suggested that a time be allotted for recorded work and the book outlined the benefits of recorded work. These were seen to be:

- a record of work done;
- a means of learning;
- a means of testing;
- a means of expression;
- a means of securing interest.
Recorded work was to be on both an individual and a group basis. Individual recorded work included sketches and written notes. "Sketch making is the earliest and simplest form of recorded work in nature study." (Matchett 1967, page 13)

The book suggested that children from Grade 3 would be able to make an attempt at drawing from an object that they were observing. It was suggested that this activity may improve their observational powers and make the lesson more meaningful. It was felt that the children in grade 1 were capable of labelling a sketch.

3.4 In Conclusion

It is apparent that although there are a range of reasons why drawing could be included in primary science activities little attention has been given to making these explicit or to exploring strategies which would enable teachers to make use of this simple but valuable method of communication.
Chapter 4

LITERATURE REVIEW - ANALYSIS OF CHILDREN'S DRAWINGS

4.1 Introduction
For more than a century researchers have been studying the area of children's drawing and a large amount of data has been collected. The researchers however have differed widely in their purposes and hence in the way they have gathered and analysed data. Some researchers have concentrated on the product, while others have focussed on the processes involved in producing the drawing.

Amongst those who focussed on the product are some involved in art education who identified similarities in the drawings produced by children of similar age. Based on these findings theories of 'stages of development' have been proposed by a number of researchers (Lucquet 1927, Arnhem 1954, Kellogg 1970, Lowenfeld and Brittan 1975, and Barrett and Light 1976).

Psychologists are another group (for example, Goodenough 1926, Harris 1963, and Koppitz 1962 and 1968) who have paid attention to the drawings produced by children. Their purposes, and hence methodologies, however have been quite different to those of the art educators.

More recently, researchers from a variety of backgrounds, for example, Goodnow (1977) from Child Development and Symington et al (1981a and 1981b) from Science Education have observed the children while they produced their drawings. From these studies, data have been collected related to the drawing process.
Others such as Freeman and Janikoun (1972), have interviewed the children after the drawing activity in order to ascertain why the children have included certain features in their drawings.

Researchers Ives and Houseworth (1980), and Van Sommers (1984), have looked at the children's drawings and have inferred processes that the children have utilised to produce them.

In some recent studies including those by Hart and Goldin-Meadow (1984), and Brooks, Glen and Crozier (1988), the researchers have used children to assist in analysing the drawings. Children have evaluated other children's drawings.

The results of these research studies will be discussed in this chapter from 4.2 to 4.4.

In section 4.5 the relevance of these studies to the present research will be discussed.

4.2 Product Based Analysis

There are various professional groups who have drawn inferences and developed theories based on analyses of children's drawings.

4.2.1 Stages of Development in Drawing

There has been a number of researchers, particularly amongst those interested in art education who, having noted similarities in children's drawings, have inferred stages of development in the ability to draw. The
ideas of these people have had a profound effect in art education, particularly at the pre-school and primary school levels. A sample of these researchers and their conclusions will be described here.

Lucquet (1927), after extensive research and analysing children's drawings wrote of four stages that the child progresses through as they develop. These were labelled as:

- scribbling
- preschematic
- schematic
- visual realism.

The scribbling stage
This stage encompassed the ages of two to four approximately. In this stage the children drew aimless pencil strokes that showed little or no control. As children proceeded through this stage they became aware of the meaning of their scribble. Lucquet named this 'fortuitous realism'. The children began to identify and name the scribbles. At the end of this stage the children started producing their first representational drawings.

The preschematic stage
This stage was from approximately four to seven years. The initial drawings at this stage displayed features of 'failed realism'. Later the drawings showed signs of 'intellectual realism'. Intellectual realism was when it appeared that the children drew what they knew about the subject, not a direct visual representation.
The schematic stage
This stage appeared approximately between the ages of seven and nine years. At this stage the children attempted to produce a descriptive drawing. However, they usually included a number of visually unrealistic features.

Visual realism
The visual realism stage, which is the final stage, appeared in children at approximately nine to ten years. In this stage the children produced visually descriptive drawings of the subject from any angle and could also produce drawings which indicated three dimensional relationships.

Kellogg (1970), worked with nursery school children for over 40 years. She gathered an extensive collection of children's drawings on which to base her theories. Kellogg looked for shapes and designs that occurred regularly and were clearly identifiable in the children's drawings. Kellogg described four stages that covered children from the first scribbles until approximately five years of age. These stages were:

- pattern stage
- shape stage
- design stage
- pictorial stage.

These stages formed the sequence of development that Kellogg called "self-taught art".

Pattern stage
During this stage the child drew Basic Scribbles and put some of them in Placement Patterns. This stage began at age two or earlier. There were 20 kinds of Basic Scribbles made by children of two or under. The Scribbles
were very simple line formations. Kellogg considered that these were the "building blocks of art".

The Placement Patterns needed a well defined perimeter or outline. These Patterns required a degree of hand-eye control. Kellogg identified 17 Placement Patterns in her book. These Patterns were early signs of controlled shaping in children's drawings. These Patterns usually occurred in children's drawings by the age of two.

**Shape stage**

This stage usually started between two and three years of age. It included 'Emergent Diagram Shapes' and 'Diagrams'. There were 17 Emergent Diagram Shapes listed by Kellogg. These preceded the Diagrams. Kellogg suggested that Diagrams provide evidence of careful thought and planning. She listed six types of Diagrams, five were geometrical and the sixth a "catchall" category for any deliberate external line formation that fenced an irregular area.

**Design stage**

The child was usually three or four years old at this stage. The Design Stage was characterised by the children combining units of two Diagrams, "Combines", and units of three or more Diagrams, "Aggregates".

**Pictorial stage**

This was the final stage described by Kellogg. The child usually entered this stage at approximately four years of age. In this stage the children often drew people, animals and buildings among other subjects.
Kellogg's pictorial stage is aligned with Lowenfeld's preschematic stage and both mentioned that the children made their first representational attempts including drawing people. Lucquet also confirmed that at this stage the children commenced drawing realistic representations.

The work of Kellogg (1970) contrasts with that of Lowenfeld and Brittan (1975), who based the information presented in their book, on several research projects and other work that spanned a number of years. They identified five stages. The stages followed each other but not all children moved from stage to stage at the same time and rate. The five stages were:

- scribbling stage
- preschematic stage
- schematic stage
- dawning realism
- pseudo-naturalistic.

Scribbling stage
This usually occurred between the ages of two to four. The stage was made up of three types of scribbles, 'disordered', 'controlled' and 'named'. Disordered scribbles were usually random lines varying in both length and direction. Controlled scribbling normally occurred about six months after the children commenced scribbling. The child exerted a visual control over his hands. Naming scribbles was an important stage of the child's development as the child started forming connections between the scribbles and the world around him. This stage happened at approximately three-and-a-half. The meaning of colour played a minor role at this stage.
Preschematic stage

This stage occurred between four and seven years. This was the stage when the children made their first representational attempts. The marks on the paper now became recognisable forms. The first recognisable form was usually a man, made up of a circle for the head and two lines for the legs. These drawings were common in five year olds. In their drawings the children showed little relationship between the colour and the object they had drawn. The children's concept of space was based on the relativity of an object to the individual child.

Schematic stage

This stage encompassed seven to nine year olds. Prior to this stage the children had experimented widely with different aspects of their drawings and had developed their own symbols or schemas. The children no longer used a random system of selecting colours. The children had reached the stage where the choice of colour was done objectively. Although drawings and paintings produced in this period appeared rigid, this was due to the children organising their thinking processes in such a way as to deal with relationships in the environment. At this stage the children took their first steps towards abstract thinking.

Dawning realism

This stage occurred from nine to twelve years of age. At this stage the children realised that they were members of society. The children started to develop the ability to work in groups. This period is also called the "Gang Age". At this stage a greater awareness developed and the children expressed this in their drawings. Individual expression and creative thinking were important aspects of this stage.
**Pseudo-naturalistic stage**

This was the final stage and was known as the "Age of Reasoning". The stage fell between the ages of twelve to fourteen years. It was a stage characterised by rapid changes. The children became critical of their work. They were concerned with naturalism and this was reflected in their drawings. There was pressure to conform to adult standards and the children were disturbed by a discrepancy between their adult feelings and childish art products.

Kellogg (1970), suggested that Lowenfeld (1968) interpreted children's drawings from a psychological point of view rather than from an art view point. She disagreed with his categories as she felt that you cannot separate the haptic and visual aspects of art in a meaningful way.

**Barrett and Light (1976)**, published the results of a research study which led them to propose three distinct stages in children's drawing. These stages were:

- symbolism
- intellectual realism
- visual realism.

**The symbolic stage**

This stage was when the children drew an object generically rather than as an individual object.

**Intellectual realism**

This stage was when the children drew what they knew about the individual object.
The visual realism stage

This stage was when the children drew the subject as they saw it.

The study supported these stages of development of children's drawing, especially the symbolic form, and questioned Piaget and Inhelder (1969) who had adopted Lucquet's four stages. Barrett and Light's (1976) study suggested that the use by Lucquet (1927) of the term 'intellectual realism' was misleading as it described a stage where the child appeared to be assimilating reality to his own concepts rather than accommodating directly to reality.

Barrett and Light (1927) suggest that symbolism was a more appropriate name to describe this earliest stage of development. Intellectual realism was the stage between symbolism and visual realism.

Some art educators, for example Lowenfeld and Brittan (1975), suggested that there were similarities between their art based stages of development and those that Piaget (1959) had proposed when studying children's thinking. "Although Piaget's stages are for intellectual development it isn't surprising to find the same stages in art. The first stage which lasts until about the age of two he calls the Sensory-motor Period, and this is followed by a Preoperational Period which lasts until about the age of seven, followed by a stage of Concrete Operations which lasts from about seven to age eleven. Another stage begins at age eleven or twelve and is usually called Formal Operations. Piaget, with his collaborators, has produced a tremendous amount of material which supports the proposition that the child thinks in quite different ways from an adult." (page 52)
The developmental orientation has been challenged by some art educators. Eisner (1972) stated that, "the characteristics that children produce in their drawings and sculptures are products of both purpose and skill. When coping with a problem, the child, like the rest of us, brings to bear upon it those technologies of mind that seem to be relevant to its solution." (page 116)

Eisner has argued that as the children work out the solution to a problem, the best way they can at their age without instruction, similar solutions occur, and this has been interpreted as evidence of developmental stages.

Symington et al (1981a) found that the data they collected in their study did not support a stages of development theory. "The overall conclusion which can be drawn from the analyses reported in this chapter is that, although the drawings do show a gradual increase in accuracy across the grades, the improvement is not dramatic. It appears that almost all of the pupils approached the task as requiring realism and the differences we note are improvements within this approach. There are no changes within the data which would support the notion of children moving from one developmental stage to another." (page 37)

4.2.2 Psychological Analysis of children's drawings

Psychologists form another identifiable group who have studied the products of children's drawing activity. One of the strategies widely used by psychologists working with children involves asking them to produce a Human Figure drawing. Goodenough (1926) developed a "Draw-A-Man Test" which remains in use today. Harris (1963), attempted to revise and extend Goodenough's test but concluded that there was very little that could
be added to improve on the initial test. The Goodenough-Harris scoring method is accepted as a reliable guide to scoring Human Figure Drawings.

Human Figure drawings have been used for many purposes. The two main purposes are:

- as a developmental test of maturity;
- as a means of uncovering unconscious needs, conflicts and personality traits.

**Drawings used as a developmental test of mental maturity**

As was stated above, the "Draw-A-Man" test has been promoted (Harris 1963) as a reliable way of assessing mental maturity. It was suggested by Koppitz (1962, 1968), that human figure drawings could be used in conjunction with other psychological tests, for example, the Bender Gestalt Test, to assess children's maturity at Grade one and two levels.

**Drawings used as a means of uncovering unconscious needs, conflicts and personality traits**

By analysing the children's human figure drawings it has been argued that psychologists can find signs of children's attitudes to many significant events. Koppitz (1968) found for example, that the attitude of children to the birth of a new family member can be ascertained, from their human figure drawings. The attitude may be shown in a drawing by the size and the position of the family members in relation to the child who drew it. If the new baby was drawn right in the centre of the picture with the drawer next to it this indicated, it has been argued, that the drawer was happy about the baby. Anxiety and fear at the arrival of a new baby, it has been claimed, was shown in a drawing by the child omitting the arms and feet of the mother figure.
4.2.3 Peer Judgement

Several recent studies have used children to judge other children's drawings. One study by Hart and Goldin-Meadow (1984), was concerned with children evaluating a number of drawings on the basis of their own personal likes and dislikes. The conclusion of the study was that children between the ages of three and seven were able to be nonegocentric art critics, that is to say that they appear capable of judging other children's drawings differently from the way that they judge their own.

In another study, Brooks, Glen and Crozier (1988) asked children to make decisions about drawings that they preferred. The children were asked to complete drawings and shown drawings of people and houses that were copied from children's drawings of the same age group. These drawings differed from one another in the number of features represented. The children were asked to indicate the drawing that they preferred. In conclusion, "It was found that children significantly prefer representations which have most in common with their own drawings, thus indicating that children draw as they do through choice, and not because they have difficulty in producing more advanced representation" (page 165). This conclusion may represent an egocentric response on the part of the children making decisions about the drawings.

The studies in this area to date suggest that children's drawings are not simply a reflection of their limited capabilities but that they can make judgements about the features that are necessary to include in their drawings for a specific purpose.
4.3 Process Based Analysis

Other researchers have focussed on the drawing processes of young children. Goodnow (1977) observed children while they were involved in the actual drawing process and interviewed children in regard to their drawings. From her extensive research she suggests three main features of the drawing process. These are:

- drawings as patterns;
- sequence in children's drawings; and
- developing conventional equivalents.

**Drawings as patterns**

Goodnow (1977) used the concepts of unit, line and boundary and space to discuss the drawing processes.

The units may be lines, circles or squares and may vary in number. Children often use a unit repeatedly in a drawing, for example a heart shape can be used in many different parts of a drawing to represent eyes, ears and mouth. This use of the same unit is seen as producing a sense of unity in the drawing.

Goodnow (1977) says that the use of a boundary line is very significant for three reasons.

- The possibility exists of the children being able to now include movement in their drawings.
- It may indicate the possibility of a breakthrough both intellectually and artistically. The use of an all embracing line showed that the child had
reached the stage of understanding the interacting relationship between parts.

- The use of an all embracing boundary line may be related to age.

**Sequence in children's drawings**

Goodnow (1977) suggests that children's drawings proceed according to a plan and follow an orderly sequence. This sequencing may cause problems for children in completing their drawings as they may have already used a space which is needed to complete the drawing. Her studies showed that children would not use a space that they felt belonged to a unit drawn earlier.

Some important aspects of sequence are whether the child:

*Works from top to bottom*

Usually the children will start their drawings at the top rather than the bottom. However, this starting point may vary according to the drawing.

*Works from left to right*

School age children will often employ a left to right sequence when drawing arms and legs. Pre-school children have a preference for right to left, but this may change with experience.

*Uses a pair as a single unit*

Young children usually use radial sequences when drawing arms or legs. These radial sequences are slowly replaced by the development of paired sequences for arms and legs.

*Works from core to accessories*
When children are faced with the problem of drawing a person wearing clothes, they often follow a sequence starting from the core, in this case the body and working to the accessories, the clothes. In this manner we often see the 'x-ray' drawings where the body is visible through the clothing.

**Developing conventional equivalents**

Goodnow (1977) conceptualises four important aspects of conventional equivalents. These are:

**Coming to know what should be included**

Learning what should be included in the drawing is difficult. This is shown by the illustration that Goodnow uses related to the maps that children draw. "To ask for a map introduces something more novel; and it also forces a child to search for some way of indicating not simply the presence of objects but the relationship between them, namely their relative positions." (page 28)

**Learning the orthodox equivalent**

The children learn that objects and events can be depicted in a number of recognisable ways. The ones that are used more than others become standard equivalents. Goodnow (1977) suggests that, "learning and using a standard visual form may not be so different from learning and using other appropriate forms of behaviour, from ways of talking to table manners". (page 127)

**Agreeing on a point of view**

Usually objects are drawn from a single point of view, as if we were looking directly at the picture.
Modifying old equivalents

New equivalents are usually just old ones that have been modified.
Children often change things by simply altering the size of an object or
by turning a human figure on to its side to make an animal.

4.4 Inferences Made About Processes

Some researchers have, on the basis of analysis of children's drawings,
suggested rules which may govern children's drawings.

Ives and Houseworth (1980) made predictions prior to commencing their
study and then confirmed these by using drawings from 90 children that were
analysed by two adult judges. The study found that: "children before third
grade have difficulty relinquishing general graphic principles such as the
arrangement of parts on a given axis when depicting people in motion or
bending. These results suggest that young children are constrained by their
reliance on specific graphic rules as a framework for organising drawings"
(page 593).

This study achieved similar results to Goodnow's (1978).
Van Sommers (1984) reported a large quantity of data about drawing
processes. He based his discussion of the data on the following concepts:

- stereotypes
- conservation
- innovations
- primitives
- contours
- space
- graphic individuality in children's drawings.
**Stereotype**

Van Sommers (1984) says that children often adopt public stereotypes to represent objects in their drawings. Even when these stereotypes are used they are adapted to suit the child's needs. These drawings may be changed if the child has a model present and has it's attention focussed on the model. The child may be "invited to look very carefully not so much at his own drawing, but at the detail of a model before him". (page 162)

The dramatic change that may take place in the child's style of drawing is obvious in the example from Van Sommers reproduced here in Figure 4.1.

![Figure 4.1: Two drawings of a man produced on the same day by a 7-year-old boy. Drawing (a) was his routine style of drawing. He could be induced to produce drawings like (b) when urged to pay close attention to the model.](image)

(Van Sommers 1984, page 164)
Conservation
Jones (1972) conducted a study, supervised by Van Sommers, to test predictions related to conservation. The prediction was that "If the second drawing does remain relatively naive with respect to structure, the first drawing may be said to be exerting a conservative influence, immunizing the child, so to speak, against making use of a new structural approach". (Van Sommers, 1984, page 166)

The data from the study support the view that the children tend to use a basic strategy of production and add extra features rather than change it. "The study points to forces within the drawing process itself that tend to restrict graphic development to a slowly incrementing evolutionary process." (Van Sommers, 1984, page 163)

Other researchers, for example McWhinnie (1971), found that this tendency could be changed if children are shown new drawing strategies.

Innovation
Van Sommers, (1984) suggested that innovations occured late in the drawing sequence. Innovations were noted as additional lines or parts added to a basic or original figure. Innovations often occured because of modifications. Innovations of substitution occured more at the beginning of a drawing series and usually whenever the appropriate part of the drawing was being completed.

Primitives
Van Sommers (1984) stated that primitives are basic geometric forms used in children's drawings. Motifs are more complex shapes that some children
use like primitives e.g. a shape like a crochet that a child uses to represent various objects like arms, oars, legs of a television set.

Contours
Contours are a boundary line or edge line defining a shape, that children draw as a continuous line. Contours begin as simple shapes and through experience become more complex. For example Van Sommers (1984) says, "they may begin with a very simple version of an envelope or contour and substantially upgrade it in subsequent drawings". (page 196)

Space
When dealing with spatial relationships in a drawing the children are presented with graphic problems that they need to solve. Physical arrangements, the problem of translating a three dimensional object on to paper and the problem of overlapping sections are all areas that need to be addressed. From this point of view any drawing activity is a definite problem solving activity for children.

Graphic individuality in children's drawings
Van Sommers suggested that children store information about the way they draw and this causes the consistency in drawing styles. "The similarities among the drawings of a single child could result from (1) a standard translation from object percept or memory to graphic scheme, or (2) remembering the form they previously produced, if not the construction routine". (page 227)

Both these suggestions involve the children using their memory. In one instance the memory is related to the object to be drawn and the other is
related to the drawing process. Graphic individuality may be caused by simple drawing accidents.

Although the various researchers who have observed the drawing processes use different sets of concepts to analyse the data the findings of the various studies are very similar.

4.5 Relevance to the Current Study

As was indicated in Chapter 1, it was decided to examine the issue of drawing in the context where both the teacher and the students have a clear purpose in mind for the drawing. After reviewing the literature it was decided not to limit expectations of children's drawing ability on the basis of any 'stages of development' theory. The studies on which the development stages models were built were characterised by adult analysis of the drawing. Rarely was there teaching of drawing strategies involved. Nor were drawings produced in a context where the children had a particular purpose in mind for the drawing.

In the psychological context adults again analysed the drawing. It is not clear whether children will express their feelings when asked to draw for a particular purpose under clinical conditions.

Peer judgement can be of significant value. This is especially so if the children are given criteria against which to judge the drawing, rather than judging against their own strategies or standards. In this study peer judgement was important as the children were able to feel satisfaction at having achieved the set purpose. Also through peer judgement the children were able to assist each other in developing their communication skills.
More information related to the current study will be outlined in chapter 5.

Observing the drawing process has provided a considerable amount of data on how children draw. However the drawing rules that children follow may not reduce the possibility of the drawings achieving the purpose. Where the children commence or finish their drawing, and in what sequence they complete it, may not have any bearing on whether their drawings achieve the purpose. This aspect will be discussed in more detail in chapter 5.

In all the literature reviewed the focus of the research studies has centred on the product or the process of completing a drawing. Both of these are very important aspects. The current study, however, is investigating another important aspect of any drawing activity, especially in the educational context. That is whether the drawing achieves the purpose for which it was produced. There will be more detail about purpose in chapter 5.
Chapter 5

THE ORIENTATION OF THE STUDIES

5.1 Introduction

In planning the studies it was necessary to consider several clusters of key issues. The first cluster included the context of the studies, the topics that were used, and the teaching/learning strategies that were implemented. The second cluster was concerned with the methods used for data collection and analysis and included issues related to the interviewing of young children, the videotaping of sessions, the use of a number of observers, and the judgements that were made of children's drawings. The final cluster concerned issues of reliability and validity.

5.2 The context in which the data were to be collected

Laboratory or classroom?

Much of the research into children's drawing has been conducted in a laboratory type of setting that was entirely foreign to the participants. The children were frequently given a task to complete which had little or no relevance to their usual home or school environment. They were given no indication as to the purpose for doing the activity and were supervised by a virtual stranger in an isolated, unfamiliar environment.

An example of the studies in which the task had little relationship to their normal activity is Clark (1897) in which he showed the children an apple with a hairpin stuck through it and asked them to draw it. In recent studies more realistic or familiar objects have been chosen as the subject for the children to draw. Ives and Rovet (1979) in their experiment on graphic orientations in
children's drawings of familiar and novel objects asked both adults and children to draw six objects: a man, house, owl, horse, boat and car. However, although the objects to be drawn were more familiar, no purpose was given for the drawing activity, and the drawings were taken out of context.

In a classroom situation drawing is part of the ongoing program. The children are usually given a purpose for completing the drawing, for example the drawing is going to be displayed on the classroom wall or become part of a class book. The children feel secure with the person who is asking them to complete the task, the teacher. The environment is one that ensures that the children feel comfortable and the materials that they use are familiar to them.

This situation reduces the likelihood of feelings of anxiety of the type that the children might have when operating in strange surroundings. The reduction in the level of anxiety, together with providing the children with the purpose for doing the activity, is likely to limit the number of unfamiliar, external variables that may be operating at the time of the drawing activity.

The purpose of this study was to provide, ultimately, insights which would assist primary school teachers to involve children in drawing activities in science in ways which would maximise the benefits derived from the activity. It seemed appropriate therefore that the data should be collected in a situation as near as possible to the normal classroom situation - the context to which the results of the study would finally be applied.

As has just been suggested data collection in the child's usual environment is likely to produce information of greater validity and reliability. This is likely
to be particularly true when the subjects are children in the early years of primary schooling.

5.3 Topics in which children are to be engaged

As was indicated in Chapter 2 there has been a shift in primary school science from an almost exclusive focus on biological science to the inclusion of physical science. It was important therefore for this study that the topics chosen reflect current curricula which promote exploration of both physical and biological phenomena.

'Shells' was chosen as the topic for the study reported in Chapter 6 because:

• The children had displayed a high level of interest in shells as part of their study of the beach.
• The children had brought into the classroom many examples of different shells.
• The topic 'shells' has been mentioned in the content area in nature study and science courses in Victoria since 1956. It is worth noting, however, that it was usually only suggested as an example of an object for sorting or classification activities.

'Rocks' was chosen as the topic for a further study reported in Chapter 6. This study was designed to gather more data to answer the questions that had been proposed for the 'shell study'.

The topic 'rocks' was chosen for a number of reasons. These included:

• 'Rocks' has been listed in the content area of all nature study and science courses in Victoria since 1956.
• One of the children in the class participating in the study had brought along a collection of rocks and the other children had demonstrated a high level of interest in the rocks.

'Snails' was chosen as the topic for the study to be reported in Chapter 7 for several reasons.

• As noted in Chapter 2 the topic 'snails' is listed in the content area in all nature study and science courses in Victoria since 1956. It is proposed as a topic for study in the Science Frameworks (Ministry of Education [Schools Division], Victoria, 1987), the most recent curriculum document in Victoria.
• Young children are interested in snails.
• Snails are harmless and slow moving, thus they are ideal for observation, investigation and drawing by young children.
• Snails are readily available and accessible from the children's own environment.

The implementation of the topic 'snails' initiated a close study of a biological phenomenon. The topic chosen may have had some influence on the way the children reacted to the study including:

• the number and content of the questions that the children asked;
• the children's interest level;
• what and how the children recorded;
• the investigations the children suggested;
• the out-of-school investigations that the children conducted.
As a point of comparison a further study, reported in Chapter 8, was based on a study in the physical sciences. The topic chosen was 'oils'. This topic was chosen for several reasons.

- It is suggested as a topic for study in the Science Frameworks (Ministry of Education [Schools Division], Victoria, 1987).
- Oils are something with which the children would have had experience in their everyday lives.
- Oils are readily available.

5.4 Theoretical orientation

As shown in Chapter 4, most of the research into children's drawing has occurred in the fields of art education and psychology. As the studies reported in this thesis fall within the field of science education it is within this field that a theoretical orientation for the study has been sought. Driver (1982), describes three orientations which she sees as having had a significant impact in science education. These are:

- the developmental orientation;
- the behaviourist orientation;
- the constructivist orientation.

The developmental orientation

As its name implies this orientation was based on the idea that as children develop, they pass through a series of stages. A 'normal' child is supposed to reach a certain stage of development at a certain age. As described in Chapter 4, this orientation has had considerable influence in the areas of art and related activities, such as drawing, in other curriculum areas. As noted in
Chapter 4, Lucquet (1927) stated that children progressed through developmental stages with their drawing. More recently Barrett and Light (1976), proposed that there were three distinct developmental stages in the child's use of symbolism in drawings. Some researchers, including Eisner (1972) and Symington et al (1981), have challenged the validity of the developmental orientation. Their reasons were detailed in Chapter 4.

**The behaviourist orientation**

This orientation is based on the structuring of learning in small amounts and the reinforcement of that learning prior to proceeding to the next, more advanced step. Sequential schemes have been developed in some curriculum areas based on this orientation. Schemes have been developed in the areas of reading, spelling and mathematics. This orientation has not made any long term, significant impact in the areas of science or children's drawing.

**The constructivist orientation**

This orientation emphasises the importance of the child's existing ideas in developing concepts, making sense of experience and responding to stimuli.

A well known researcher of this orientation was Piaget. His main consideration, when researching child development, was that all knowledge is constructed by the children interacting with, and trying to make sense of, their environment. Another important consideration is that the children use what they already know to acquire, represent and interpret any new knowledge.
West and Pines (1984) have suggested that Piaget's interviews and his ideas about assimilation and accommodation fit very comfortably within what has become known as the constructivist tradition. Osborne and Wittrock (1985), operating within the constructivist orientation, developed a Generative Learning Model. In this model it is proposed that the children "generate perceptions and meanings that are consistent with their prior learning" (page 64).

![Diagram](image)

**Figure 5.1:** Schematic representation of the generative learning model. (Osborne and Wittrock 1985, page 67)

The relevant postulates of the Generative Learning Model for the proposed studies are outlined here.

- The learner's existing ideas influence what is made of the senses and in this way the brain can be said to actively select sensory input. (Selection)
• The learner’s existing ideas will influence what sensory input is attended to and what is ignored. (Attention)

• The learner generates links between the input selected and attended to and those parts of memory store activated by the input. (Generating Links)

• The learner uses retrieved information and the sensory input to actively construct meaning. (Constructing Meaning)

• The learner may test the constructed meaning against other aspects of memory store and against meaning constructed as a result of other sensory input. (Evaluation)

Publications such as those by Leder and Gunstone (1990) and Northfield and Symington (1991) reflect the dominant role of constructivist views in thinking about science education in Australasia.

5.5 Teaching/learning strategies

As indicated in Chapter 2 there are some current teaching strategies that are generally considered important for the development of skills, attitudes and understandings related to science learning. These needed to be present in any teaching model that was to be implemented in the studies that form part of this thesis. These teaching strategies are:

• choosing curriculum content based on the children’s interests;
• beginning a topic from the ideas that the children bring to the classroom;
• involving the children in enquiry;
• the teacher adopting an interactive role in which he/she becomes a fellow investigator, a resource person, a facilitator of learning and a challenger of the children's ideas.

As stated in the Victorian Science Frameworks, "Science teaching should identify, begin from, and build on the strategies, interests, beliefs and explanations that children bring to the classroom" (Ministry of Education, [Schools Division] 1987, page 9).

Although the drawing activity could be studied within a range of teaching models it was decided that in the studies to be discussed in this thesis the Interactive Teaching Approach developed in New Zealand by Biddulph and Osborne (1984) would be used as the framework for the lessons in which the drawing would occur. This approach has been discussed in some detail in Chapter 4.

5.6 Assessment of children's drawings

It was decided that for the studies reported in this thesis, rather than judging the drawings themselves, the focus would be on whether the drawings achieved the purposes for which they were developed. For example, if a drawing was produced so that it could be used to select one particular shell from a group of shells, then the test of the success of the drawing would be whether it could be used for that purpose. This seemed a more appropriate way of assessing the drawings than to evaluate them out of context.

Further, it was decided that the children would be treated both as intelligent participants whose ideas about drawing for a specific purpose were
important, and as individuals capable of making judgements about whether the drawings did achieve the purpose for which they were produced.

As established in Chapter 4 most of the data related to the area of children's drawing have been gathered by research studies in which the researcher assesses the data collected without making any attempt to seek from the participant their ideas or reasons for completing the task in a certain way.

In many other research studies predictions were made prior to the drawing activity. After the drawing activity was completed the researcher scored the drawings according to set criteria and drew conclusions based on these. For example, Ives and Houseworth (1980) used the feature - marking model proposed by Ives and Rovet (1979) to make predictions, then tested these predictions by involving 90 children in drawing, and scored the drawings that resulted. No interviews of the participants were conducted so that the researchers had to make inferences about the decisions made by the children in producing their drawings.

By contrast, Freeman and Janikou (1972), adopted an approach in which, after the drawing activity was completed, the researchers spent some time discussing the children's drawings with them. These discussions provided the researchers with information about how the children actually felt and what they thought about their drawings. The use of the participants' knowledge to explain their actions enabled the researchers to validate the inferences they were making. New information and questions emerged for future study.

Hayes and Symington (1984) found that even grade 1 children, (approximately six years old), could explain some of the thinking involved in creating their drawings.
As reported in Chapter 4, recent studies have shown that young children can make judgements about features that are necessary to include in their drawings for a specific purpose.

5.7 Relevant data sources

Data were collected during these studies using three methods. These were:

- Interviews
- Observation
- Videotaping of lessons

Each of these methods will be discussed in more detail here.

Interviews

Interviewing was a major method of data collection. The interviews were either recorded on audiotape or the interviewer made a written record. The interviewer (the researcher) was well known to the children. This was important so that the children felt secure and comfortable when answering questions. The questions needed to be expressed clearly and in simple form so that these young children understood what was expected of them (Appendix 4).

Interviews took place on the day following the actual lesson. In the majority of cases the interviews were conducted on an individual basis. Once, where the children had completed a drawing with a partner the two children were interviewed together.
Observation

Observation as a means of collecting data was approached in a different way in each study. In the studies of shells and rocks reported in Chapter 6, the observer was the class teacher/researcher. Observations were made during the matching activity. These observations were recorded using a written format (Appendix 5).

In the studies of snails and oils, conducted in two classes, the observers were the class teacher, a parent and two or three Victoria College teacher education students. Each observer chose one group of four children to observe during each of the lessons. Thus, in each lesson, 16 children were being closely observed. The observer was given a record sheet by the researcher outlining the format of the lesson and directing them to the observations that the researcher wanted them to record. Because the children spoke quickly, at times it was impossible for the observers to record everything that was said. However, the observers did record many relevant pieces of dialogue.

Videotaping of lessons

In one of the studies reported in Chapter 6, when the children were completing their shell drawing the drawing activity was videotaped without the children being aware that this was being done.

The cameras were set up prior to the lesson. Some interesting data were collected in this way. An attempt to videotape a lesson during the oils unit was not successful as there was too much noise and it was impossible to place the camera to get a clear picture of what was happening.
5.8 Issues of reliability and validity

Reliability

LeCompte and Goetz (1982), state that "Reliability refers to the extent to which studies can be replicated" (page 35). When discussing the issues of reliability it is necessary to address both the external and internal features.

"External reliability addresses the issue of whether independent researchers would discover the same phenomena or generate the same constructs in the same or similar settings". (page 32)

"Internal reliability refers to the degree to which other researchers, given a set of previously generated constructs, would match them with data in the same way as did the original researcher". (page 32)

The features of reliability, both internal and external which are related to the studies will be discussed here.

Researcher status position

The researcher was a teacher at the school where the studies took place. She was familiar to all the children who took part in the studies and had taught many of them. The children willingly and freely contributed data to the researcher during interviews. Independent observers also collected data on the children's discussions and activities.

Informant choices

The science lessons that provided the basis for the studies reported in Chapters 6, 7 and 8 involved all the children in the grade 2 classes. Every
child was interviewed and the data from all interviews formed the basis for analysis and conclusions.

Social situations and conditions
The studies reported in this thesis were part of the children's normal school program. The series of lessons was taught in two separate classes. All lessons were conducted in the children's normal classroom environment.

Analytic constructs and premises
Throughout the studies whenever a main focus had been identified a definition has been provided to enable other researchers to understand the underlying assumptions. For example, in Chapter 7 the definitions of process and objective purposes are clearly established.

Methods of data collection and analysis
These have been clearly outlined and detailed in each of the studies to enable other researchers to replicate the studies.

Low - inference descriptors
Throughout the studies observers and the researcher made full written accounts of what the children said, did and anything else they observed. Audio tapes were also made of some interviews.

Peer examination
Aspects of the studies described in Chapters 6, 7 and 8 have all been presented as research papers at the Australasian Science Education Research Association conference for discussion and comment and these papers have been accepted and published, following peer review, in the journal 'Research in Science Education'.
**Mechanically recorded data**

Where possible audio tape and video tape were used to record data. In some cases the researcher made written notes of interviews as the children talked more freely when a tape recorder was not present. Reliability as stated, is concerned with the ability of the research to be replicated. However," because human behaviour is never static, no study can be replicated exactly, regardless of the methods and designs employed." (LeCompte and Goetz 1982, page 35)

**Validity**

"Validity necessitates demonstration that the propositions generated, refined, or tested match the casual conditions which obtain in human life." (LeCompte and Goetz 1982, page 43) External validity determines to what extent the abstract constructs and postulates generated, refined or tested by scientific research are applicable across groups.

Internal validity refers to the extent to which " scientific researchers actually observe or measure what they think they are observing or measuring". (LeCompte and Goetz 1982, page 43)

Features of external and internal validity relevant to the studies included in this thesis will be discussed here.

**Selection effects**

In the studies reported in this thesis two separate grades of children were used as the sample. The children were at the same grade level. This "increase in sample size over single-site studies does strengthen the external validity of their findings" (Campbell 1979).
Setting effects

As this research was conducted in the normal classroom setting, following the normal program and the person conducting the research was familiar to the children there appeared to be no adverse setting effects.

History and maturation

The impact of history and maturation were limited through the use of studies that were conducted over brief periods.

Observer effects

As the children were used to having a number of adults in the classroom they paid very little attention to the observers. Observers were also provided with written directions as to the observations they were to record, therefore all observers recorded data related to the same observations.

Individual interviews verified observer's written comments.

5.8.1 Reliability and validity in these studies

"Attaining absolute validity and reliability is an impossible goal for any research model. Nevertheless, investigators may approach these objectives by conscientious balancing of the various factors enhancing credibility within the context of their particular research problems and goals." (LeCompte and Goetz 1982, page 55)

As has been indicated the design of the various studies to be reported in Chapters 6, 7, and 8 were planned with a view to taking account of the various factors which influence reliability and validity.
Chapter 6

PUPIL SATISFACTION WITH DRAWINGS

6.1 Introduction

It was suggested in Chapter 3 that one important reason for having pupils drawing in science is that generally they enjoy this form of recording. Although there would be widespread support from teachers for this view, there has been no research into the area. Accordingly it was decided that this research should include an appropriate investigation.

The research question chosen to study was: "Do grade 1 and 2 children enjoy creating representational drawings of shells for use in a matching activity?" (A matching activity is one in which the children are required to match drawings of objects with the actual objects.) The decision to focus on Grade 1 and 2 children was made because this was the grade level being taught by the researcher at the time.

Another important consideration is the children's personal satisfaction with their drawings. Therefore a second question chosen for investigation was: "Do grade 1 and 2 children experience satisfaction in creating representational drawings of shells for use in a matching activity?" One of the factors which could influence the children's satisfaction is their ability to represent in the drawing the properties they see as important to communicate. To gain insight into this issue it was decided to explore the question: "What properties do grade 1 and 2 children see as important to be communicated in representational drawings of shells to be used in a matching activity?"
A final question was related to the children's ability to communicate information about these properties through their drawings. This question was: "To what extent can grade 1 and 2 children produce drawings of shells which communicate the identifiable features of the shell?"

6.2 Context

This study was part of a unit of work for grade 1 and 2 children (approximately 6 and 7 years old) about the beach, planned and taught by the author. There were 25 children in the class. The children had already listed the things they could see or do at the beach. The class had discussed sea creatures such as fish and crabs. Shells was next on their list. Many of the children had brought shells that they had found and so the class had developed quite a large collection. A one hour session per week was devoted exclusively to science activities. The children investigated activities planned by the teacher (the researcher). Work in language, mathematics and art also was centered around the topic.

6.3 The Lessons

Lesson 1

This was an introductory lesson for the topic. It commenced with a full class discussion. This was stimulated by some large pictures of shells and one of a small child looking at a shell he had found. The discussion was followed by the children getting into groups of four and sharing and talking about the shells they had brought to school. The children asked each other questions about where the shells had been found.
Sorting and classification activities using the shells came next, the children being able to choose how the shells should be classified. Classification categories chosen by the children included size, shape, colour, pattern and whether broken or not. The children then recorded their classification scheme on a chart using the actual shells. The charts were displayed on the wall to encourage comment.

Lesson 2
This lesson started with the children reciting a poem they had learnt about shells. A brief discussion of the charts made in the previous lesson followed. The lesson was based on the univalve class of shells. The children suggested what the word univalve meant and then proceeded to use the reference material around the room to check if they were correct. The reference material included books, magazines and charts. The children came up with a simple definition; "Univalves are creatures that have one shell".

The children, working in small groups, then sorted their shells into univalves and others. This sorting process continued and the children discussed similarities and differences. Each group made a simple oral report back to the rest of the class.

Lesson 3
At the commencement of this lesson one of the children showed and discussed a chart that he had made at home. He had glued a number of different shells on to a piece of cardboard and had labelled them. Several children recognised which shells were univalves. There were other shells on the chart and the children wanted to know what they were called. The child who had made the chart said that they were called bivalves. Many children
suggested this was because two shells were stuck together. The children then worked in their groups to check if this definition was correct. Sorting and classifying activities followed with the children deciding the criteria.

The session ended with a whole class discussion which centred around the way that the children had classified their shells and the fact that most of the shellfish we eat are bivalves.

The final activity for this session was for the children to choose a shell that they really liked and to glue it to a piece of cardboard to be used in an activity in the next session.

Lesson 4

After a short introductory discussion the cards on which the shells were glued were distributed. The children were asked to draw their shell so that we could use the drawing and actual shell for part of a matching game later in the day. They were also told that they could use pencils and paper and could alter their drawing by using an eraser or by obtaining a new piece of paper, if they were not satisfied with their drawing. No time limit was set for the task.

The children did their drawing in the normal classroom situation. They were allowed to move about freely and to discuss their work with their peers. They were able to seek the teacher's attention or approval if they deemed this necessary. This created a normal, secure environment for the children. The finished drawings were collected and the children were given an activity sheet to complete.
6.4 The Data Gathering

Data were gathered in several ways:

- videotaping the drawing activity
- observing the matching activity
- interviewing the pupils

Videotaping the drawing activity
The drawing activity was videotaped without the children being aware that this was being done. This was achieved by setting up the cameras and commencing taping prior to the children entering the classroom. Nobody went near the cameras during the lesson and so the children were unaware that they were being videotaped.

Observing the matching activity
The matching activity took place later the same day. All the children were sitting on the carpet to watch the matching activity. The actual shells were placed along the chalkboard ledge. Individual children, one at a time, were given a drawing chosen at random which they were to match to a shell. When they had matched the drawing to the actual shell, the shell was placed back on the chalkboard ledge with the other shells. The drawing was returned to the teacher. The teacher made a record in pencil on the drawing of the ease with which the matching was done and the properties of the shell which were used to make the match.

Interviewing the pupils
The children were interviewed individually after the lesson, the interview being recorded on audiotape. The questions were designed to obtain data about the properties of the shell the children thought should be
communicated by means of the drawing, problems they encountered in doing the drawing, their satisfaction with their drawing, and their enjoyment of the activity.

6.5 Analyses of the data on Shells

As shown in Table 6.1 almost all of the children (92%) stated that they had enjoyed drawing their shell.

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of children in the class</td>
<td>25</td>
</tr>
<tr>
<td>Number of children who said that they enjoyed the drawing activity</td>
<td>23 (92%)</td>
</tr>
</tbody>
</table>

As reported in Hayes and Symington (1984)

**TABLE 6.1**

Data, gathered by interview, which indicates the children's enjoyment of the drawing activity

As shown in Table 6.2 the majority (76%) of the children expressed satisfaction with their drawing, although most had experienced difficulties in one form or another in producing it.

The interviews revealed three areas in which children experienced difficulties. One of these was the difficulty some children (40%) had with producing an appropriate colour. As a solution some children were happy to substitute one colour for another. For example, yellow was sometimes substituted for white. Another source of concern was the difficulty of
### Interview Data

- Number (percentage) of children who expressed satisfaction with their drawing: 19 (76%)
- Number (percentage) of children who expressed concern about their ability to adequately portray:
  - the colour of the shell: 10 (40%)
  - the shape of the shell: 8 (32%)
  - details of the surface of the shell: 7 (28%)
- Number of children who, when expressing concern about their ability to portray the properties of the shell, made reference to:
  - one property only: 14
  - two properties: 4
  - three properties: 1

### Observational Data

- Number (percentage) of children who discarded a drawing and began again on a new piece of paper: 3 (12%)
- Number (percentage) of children who used an eraser: 23 (92%)

As reported in Hayes and Symington (1984)

**TABLE 6.2**

Data gathered by interview and analysis of videotape that reflects the satisfaction of the children with their drawings.

portraying the shape of the shell correctly. Reference to this issue was made by 32% of the children. The third area of concern, as expressed by 28% of the children, was the difficulty of portraying surface details such as bumps, breaks or holes.

Three children rejected their first efforts altogether and used a new piece of paper. The data show that 92% of the children used an eraser during the drawing activity, this being assumed to reflect some dissatisfaction with an
aspect of their initial drawing. In many cases the problems appear to have been overcome, in the children's eyes, following the use of the eraser and further drawing.

It can be noted from the analysis presented in Table 6.2 that, where there was dissatisfaction, it was normally only with the representation of one of the properties of the shell.

Table 6.3 sets out the children's opinions about which properties of the shells should be communicated by the drawings. Almost all (92%) of the children believed that the shape of the shell should be communicated. Colour was mentioned by about half (48%) and surface features by a smaller number (16%).

<table>
<thead>
<tr>
<th>Number (percentage) of the children who thought that it was important to accurately communicate the:</th>
</tr>
</thead>
<tbody>
<tr>
<td>shape</td>
</tr>
<tr>
<td>colour</td>
</tr>
<tr>
<td>surface features</td>
</tr>
</tbody>
</table>

As reported in Hayes and Symington (1984)

**TABLE 6.3**

Data, gathered by interview, which reflect the properties of the shells the children thought it important to communicate

Table 6.4 represents an analysis of some of the data obtained when observing the matching activity. It will be noted that in the majority of cases
(76%) the shell and drawing were matched on either the first or the second attempt.

<table>
<thead>
<tr>
<th>The shell and drawing were:</th>
</tr>
</thead>
<tbody>
<tr>
<td>matched on the first attempt</td>
</tr>
<tr>
<td>matched on the second attempt</td>
</tr>
<tr>
<td>matched on the third attempt</td>
</tr>
<tr>
<td>not matched in three attempts</td>
</tr>
</tbody>
</table>

As reported in Hayes and Symington (1984)

**TABLE 6.4**

Data, gathered by observation, which indicate the ease with which the drawings were matched to the corresponding shell

6.6 Case Study

Probably the most effective means of seeing possible relationships between the various pieces of data is obtained by considering together all the information gathered about an individual pupil. One instance is provided here.

Robert stated, when interviewed, that the most important properties of the shell to be communicated were 'the right shape and the right colour'.

He had some difficulty in drawing the shell. As he said: 'It was hard to draw the curved shape'. However, despite the difficulties, he put a lot of time and effort into his drawing and expressed satisfaction with the result.
Robert's drawing would be classed as showing intellectual rather than visual realism (Barrett and Light, 1976) since he included details of the shape of the end not visible from the position from which he was viewing the shell. He also took great trouble to record the surface markings on the shell and to communicate the colours effectively.

During the matching activity his drawing was matched to the actual shell without difficulty using the shape, colour and surface markings.

When interviewed, Robert indicated that he was satisfied with his drawing and that he believed that he had communicated to the other children the properties he considered important.

6.7 Discussion of the shell study

The task presented to the children, being required to produce a representational drawing of an irregular solid, was, as evidenced by the data gathered, not an easy one. So probably the most important findings of the study, as far as primary teachers are concerned, is the fact that almost all of the children enjoyed the drawing activity, that the majority obtained satisfaction from it, and that in most cases the children could match the drawings to the corresponding shells, thus indicating that the drawings communicated effectively.

An important question to attempt to answer is: What was the source of children's satisfaction? Clearly most children had some difficulty in producing their drawings. However, for the majority of these, the difficulty was only with portraying one property of the shell. When it came to the
matching activity most found that their communication was adequate for the purpose despite the difficulty of representing one or more of the properties.

This study dealt with only one topic and involved a relatively small sample of children. In order to explore the matter further and to answer questions of the extent to which the findings of the study can be applied more generally it was decided to complete a similar study with a different group of children and another topic, rocks.

6.8 Rocks Study

At a later date another study on the topic 'Rocks' was devised to gather data using as a basis questions similar to those used in the shells study questions. Rocks was chosen for several reasons. Firstly, one of the children had been away on holidays and had returned with a container of rocks. All of the children in the class were interested in the shapes and colours of the rocks. Rocks is also a topic which is mentioned frequently in science courses for primary students. It is also from a non-biological area of study. The class was composed of 10 (grade 2) children and 8 (grade 1 children), 18 children altogether. This was the class taught by the author at the time.

The questions for this study were:

- "Do grade 1 and 2 children enjoy creating representational drawings of rocks for use in a matching activity?"

- "Do grade 1 and 2 children experience satisfaction in creating representational drawings of rocks for use in a matching activity?"
• "What properties do grade 1 and 2 children see as important to be communicated in representational drawings of rocks to be used in a matching activity?"

• "To what extent can grade 1 and 2 children produce drawings of rocks which communicate the identifiable features of the rock?"

In this study the matching activity was conducted in a somewhat different manner than that in the shell study. Children from a different grade (24 children) were invited to see if they could match the drawings to the actual rocks. The rocks were glued to pieces of cardboard, each one had a letter of the alphabet written on it. Each drawing had a number written on it. The children doing the matching each had a sheet with the letters of the alphabet listed. The children did the matching one at a time out in the hall while the rest of their class were completing another activity. The children took a drawing at random and proceeded to look at each rock to find the correct one. They wrote the number of the actual rock on the sheet next to the alphabet letter that denoted the drawing. The researcher acted as an observer.

Further data were collected by observation and interview as in the study using shells.

6.9 Analyses of the data on rocks

As shown in Table 6.5 almost all of the children (89%), during individual interviews stated that they had enjoyed drawing their rock.
• Number of children in the class 18
• Number of children who said that they enjoyed the drawing activity 16 (89%)

**TABLE 6.5**

*Data, gathered by interview, which indicate the children’s enjoyment of the drawing activity*

As shown in Table 6.6 the majority (83%) of the children expressed satisfaction with their drawing, although most had experienced difficulties in producing the drawing.

• Number (percentage) of children who expressed satisfaction with their drawing 15 (83%)

• Number (percentage) of children who expressed concern about their ability to adequately portray:
  - the colour of the rock 8 (44%)
  - the shape of the rock 10 (55%)
  - details of the surface of the rock 6 (33%)

• Number of children who, when expressing concern about their ability to portray the properties of the rock, made reference to:
  - one property only 14
  - two properties 4
  - three properties 1

**TABLE 6.6**

*Data gathered by interview that reflects the satisfaction of the children with their drawings*

Table 6.7 sets out the children’s opinions about which properties of the rocks should be communicated by the drawings. All of the children believed that
the shape of the rock should be communicated. Colour was mentioned by more than three-quarters (78%) and surface features by a third (33%).

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Number (percentage)</strong> of the children who thought that it was important to accurately communicate the:</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>shape</strong></td>
<td>18</td>
<td>(100%)</td>
</tr>
<tr>
<td><strong>colour</strong></td>
<td>14</td>
<td>(78%)</td>
</tr>
<tr>
<td><strong>surface features</strong></td>
<td>6</td>
<td>(33%)</td>
</tr>
</tbody>
</table>

**TABLE 6.7**  
Data, gathered by interview, which reflect the properties of the rocks the children considered important

As can be seen in Table 6.8, over half of the drawings were easily matched by all the children. Two-thirds of the drawings were matched by 16 children. Eight children were able to match 13 to 15 of the drawings. Three drawings were unable to be matched.

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Number of drawings that were able to be correctly matched:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>all (24) of the children matched 10 of the drawings</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16 children matched 11 or 12 of the drawings</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8 children matched 13, 14 or 15 of the drawings</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**TABLE 6.8**  
Data, gathered by interview, which reflect the ease with which the drawings were matched to the corresponding rock
**Figure 6.1:** a. Photograph of actual rock and b. Mathew's drawing of the rock for the purpose of identification/matching activity.
Figure 6.2: a. Photograph of actual rock and b. Prue's drawing of the rock for the purpose of the identification/matching activity.
Figure 6.3: a. Photograph of actual rock and b. Ben's drawing of the rock for the purpose of the identification/matching activity.
6.10 Discussion of the rocks study

The results from the rocks study appear to confirm the results of the shell study. The data collected show that the majority of children enjoyed the drawing activity, 89% in the study of rocks (92% in the shell study). The percentage of children who were satisfied with their efforts to represent the rock was also high: 83% in the study of rocks (76% in the shell study). Also, the children expressed similar concerns about their ability to adequately portray certain properties of both the shells and rocks. These data are shown in Table 6.9.

<table>
<thead>
<tr>
<th></th>
<th>Shells</th>
<th>Rocks</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>colour</td>
<td>10</td>
<td>8</td>
<td>18</td>
</tr>
<tr>
<td>shape</td>
<td>8</td>
<td>10</td>
<td>18</td>
</tr>
<tr>
<td>surface features</td>
<td>7</td>
<td>6</td>
<td>13</td>
</tr>
<tr>
<td>TOTAL</td>
<td>25</td>
<td>24</td>
<td>49</td>
</tr>
</tbody>
</table>

**TABLE 6.9**

Comparison of data that reflects the children's concerns about their drawing ability

In both studies, when interviewed the children suggested the same properties that they felt were necessary to portray. These data are shown in Table 6.10.
• Number of the children who thought it important to accurately communicate the:

<table>
<thead>
<tr>
<th></th>
<th>Shells</th>
<th>Rocks</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>colour</td>
<td>23</td>
<td>18</td>
<td>41</td>
</tr>
<tr>
<td>shape</td>
<td>12</td>
<td>14</td>
<td>26</td>
</tr>
<tr>
<td>surface features</td>
<td>4</td>
<td>6</td>
<td>10</td>
</tr>
<tr>
<td>TOTAL</td>
<td>39</td>
<td>38</td>
<td>77</td>
</tr>
</tbody>
</table>

**TABLE 6.10**

Comparison of data that reflects the features that the children thought were important to accurately communicate

6.11 Conclusion

It would appear from the data gathered that the majority of children at this level of schooling both enjoy and achieve satisfaction from this type of drawing activity. It would also appear that in the classroom where there are a number of properties about which the children can communicate, difficulty with one of these need not make the child's communication ineffective. For example, some of the children appeared to be able to compensate for an inability to convey the three dimensional shape of the shell or rock by paying adequate attention to the other properties such as colour and surface markings.
Chapter 7

DRAWING FOR A RANGE OF PURPOSES

7.1 Introduction

As suggested in Chapter 3, drawing may contribute both to classroom activities and to the development of the children. The investigation reported in this chapter was designed to gather data related to the purposes for using drawing in science activities. The choice of activities for classrooms is influenced by two conceptions of purpose. One is whether the activity will contribute to the 'flow' of the lesson. For example, one purpose for asking children to do a drawing may be to provide a quiet, individual task to help the children settle down after a boisterous, group activity. In this thesis such purposes are labelled as 'process purposes'.

The second notion of purpose which guides the choice of activities is whether the activity is likely to lead to the achievement of the learning objectives the teacher has in mind. For example, whilst it may be decided to use drawing to settle the children down quietly, the nature of the drawing task should be related to the learning objectives the teacher has in mind. In this thesis the purposes related to learning objectives will be described as 'objective purposes'.

The study to be reported was designed to allow for exploration of both types of purpose.

7.2 The Research Question

The study was designed to investigate the extent to which a range of purposes for drawing in primary school science lessons could be achieved in
junior classes. The main research question was: "To what extent do drawing activities in science lessons in junior primary grades achieve the purposes for which they are included in lessons?"

7.3 Context

It was decided to gather the data in a context which was as near as possible to the normal classroom setting. The series of lessons was developed for junior primary grades. The topic 'snails' was chosen due to its obvious interest and appeal for children of this age and the frequency with which the study of this animal is recommended in primary science programs, for example Science in the Primary School, (Education Department of Victoria, 1981), The Science Framework P-10, (Ministry of Education [Schools Division] 1987). Snails, being harmless and slow moving, are ideal animals for young children to study first hand. Further they are something accessible from the children's environment.

The unit was based on the Interactive Teaching Approach (Biddulph and Osborne, 1984), with the children providing the questions they wanted answered, predicting outcomes, sharing information and ideas, and suggesting how different aspects of the topic could be investigated. The teacher took on the role of fellow investigator, resource person, challenger of the children's ideas and facilitator of learning as outlined in the Interactive Teaching Approach.
7.4 The Lessons

Lesson 1
The first lesson was designed to clarify the children's ideas about the topic and to provide the teacher with drawings and information regarding the children's knowledge and understanding of snails.

After a brief introductory discussion of pictures related to animals found in the garden the children were asked to draw a snail to show the teacher what it looked like, as she had been unable to find a picture to show them. When the drawings were completed each child worked with a partner to discuss and list the characteristics such as shell and eyes that the partner's drawing of a snail showed them. From the drawings the children were able to identify what their partners saw as the main observable features of the snail.

The children were then able to interact with their partners while observing an actual snail. They were encouraged to compare their initial drawing with the snail, then have a free activity/exploration time with their snail.

The short class discussion that followed this exploration was used to list any questions that the children wanted answered and any relevant observations they had made. Next they were asked to draw their individual snail so that they could identify it in the next session. The children approached this activity with eagerness and proceeded to observe and draw their snails. The resulting drawings were collected and stored by the teacher.

With the completion of this drawing task the children again participated in a class discussion and any additional questions or observations were listed. The children then grouped together the questions that they felt should be
investigated. Questions were grouped into the categories of food, movement and trail, body and shell. The children decided that an investigation of food would be the subject of the next lesson.

**Lesson 2**

The second lesson started with the matching/identification activity, that is the children used the drawing produced in the previous lesson to find the particular snail they had observed. When the partners thought they had found their snail and their selection had been verified they were required to inform an observer of the reasons for the ease or difficulty of matching.

In a class group the children looked at the question about food preferences of snails that had been suggested for investigation; 'What does a snail eat?' They then suggested ways of finding answers to the question, viz.

- look in an encyclopedia
- follow a snail
- try food samples with a snail.

Class discussion led to the adoption of third method. A list of food samples prepared for the investigation included sliced orange, grass, spaghetti, soil, flowers, lettuce, rice and dead leaves. The children drew or wrote their predictions from the listed options, then proceeded with the investigation. Children worked with a partner and after collecting the necessary equipment proceeded with investigating the question which had been amended to "What do snails prefer to eat?"

After the investigation they were asked to record, using a drawing, what they had observed, so that the teacher and the other children would be able to see what they had done and observed. The drawings produced by each pair
of children were shown, one at a time, to the class, and the other children given an opportunity to suggest what the drawings communicated. The suggestions were listed, then the children who had completed the drawings checked these for accuracy; they added any information that their peers had not identified from their drawing and corrected any wrong interpretation.

A short discussion concerning this investigation highlighted two areas of concern among the children, namely,

- they did not have enough time to try all samples; and
- some snails didn't eat anything.

There was a class discussion about these issues, in which the possibility that snails ate at night was raised. As a result a separate investigation was set up that could remain in the room for the following week and test this idea. Extra questions and information were listed and the children decided that they would like to look at 'Movement and trails' during the next session.

**Lesson 3**

A short discussion started the lesson. This focused on:

- a poster that the children had in their classroom (A Garden Snail);
- a large snail picture that the teacher had brought.

Links with the previous lesson were generated through the pictures. Then the questions related to this topic were read and discussed. Suggestions for methods of investigation were listed. These were as for the previous session with the additional suggestion "Look at a snail". This was the method that the children considered most appropriate. They then chose one or two of the
questions and predicted the answers to these before proceeding to the investigation.

For the investigation the children worked with a partner within a group of four. Free flow of comments related to observations was encouraged. The children were asked to record their observations by means of individual drawings for the class discussion segment. The class discussion, as in the previous lesson, included communication of information observed in the drawings to members of their peer group. The answers to questions were listed. Unanswered questions and the reasons for the children's inability to find information were discussed. Alternative sources of information were listed to enable the children to find answers to these questions. Any further questions were listed and the children asked if some reference books could be obtained for the next session which was about "Body and shell".

Lesson 4
This lesson was about "Body and shell". The children had asked numerous questions related to this aspect of the topic.

The lesson commenced with a simple, factual story about snails (O'Hagan, 1980). As the story progressed the children pointed out or discussed information related to 'food' or 'movement', areas that had already been investigated. The children who had proposed questions read them for their peers and methods of investigation were discussed.

Looking at a snail using a magnifying glass was chosen as the most appropriate means of exploring the topic for the lesson. The children made predictions for one or two of the questions. Investigation of the questions was
carried out. The children found answers to most of the questions on 'body and shell' and also asked additional questions.

The children were able to find extra information in the reference books provided by the teacher and shared this with their peers. During the final class discussion the children provided information relating to the original questions, and also asked extra questions.

Lesson 5
This lesson took place two weeks after the session on 'body and shell'. This session was used to evaluate the unit of work. The evaluation procedure was composed of two parts:

- the children were asked to complete a drawing to show the teacher what they knew about the structure of a snail;

- a worksheet, developed by the teacher, was used to enable the children to express their opinion of the unit and, by drawing, to communicate information they had gained related to some of their questions which had been investigated during the unit.

7.5 Data Gathering

The data collected during this unit came from two sources:

- notes made by observers during the lessons;
- individual interviews with the children after the lessons.
The Observers

The observers were the class teacher, a parent and two Victoria College second year teacher education students. Each observed a group of children and recorded dialogue and any other significant events during each session. An observer's guide sheet was supplied prior to each session with the activities listed and indicating what type of record to make related to each activity.

Individual interviews

The drawings were collected after each session and used as the basis for class discussions and individual interviews. Individual interviews with the children took place on the morning following the actual science lesson. After each session the children were interviewed regarding:

- their satisfaction with the drawings they had produced in that session;
- factors that influence their ability to use drawings as a means of communication;
- whether their drawings achieved the purpose for which they were set.

The children spoke freely about their drawings as most of them knew the interviewer well. The interviewer wrote the children's comments either on the drawings themselves or on a separate sheet. Where the children had completed a drawing with a partner the children were interviewed together.
7.6 Analyses of the Data

7.6.1 Achievement of Process Purposes

Data were collected regarding the extent to which the children's drawings of natural phenomena achieved the purpose for which they were designed. As discussed in Chapter 3 these purposes are either process or objective related. In these lessons the process purposes for drawings included:

- to focus the children's attention on the phenomenon;
- to facilitate communication between children in the class;
- to assist the teacher to understand the children's ideas;
- to help the children formulate questions about the topic.

The data were analysed and will be discussed in relation to these purposes.

To focus the children's attention on the phenomenon

Evidence regarding the achievement of this objective can be seen in the comparison between the children's initial drawing and their identification drawing. The extra detail that the children put into their identification drawing came from their observations of a real snail. Data were collected by the observers when the children were discussing their drawings as they completed the task. Some examples are included in Table 7.1.

Whilst being interviewed the children had both of their drawings of a snail, and they discussed the differences between their initial and identification drawings, and the reasons for those differences. Some information is shown in Table 7.2.
Group 1

*Catherine* - "Don't forget that bit of yellow then we will be able to recognise it."

- "Oh yes, there's some back bits."

*Holly* - "That's not plastic."

*Catherine* - "It's something stuck on."

Group 2

*Annabelle* - "It's got spots on it's neck."

*Miranda* (constantly studied snail) - "It's got spots all over it."

*Annabelle* - "It's got a white bit in the middle. Maybe ours has different patterns."

As reported in Hayes and Symington (1988)

**TABLE 7.1**

Segments of dialogue as children completed their drawings while observing the snails

<table>
<thead>
<tr>
<th>Feature</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shell detail</td>
<td>82%</td>
</tr>
<tr>
<td>Antennae</td>
<td>79%</td>
</tr>
<tr>
<td>Body detail</td>
<td>57%</td>
</tr>
<tr>
<td>Size</td>
<td>43%</td>
</tr>
<tr>
<td>Colour</td>
<td>32%</td>
</tr>
<tr>
<td>Tail</td>
<td>21%</td>
</tr>
<tr>
<td>Eyes</td>
<td>21%</td>
</tr>
<tr>
<td>Trail</td>
<td>21%</td>
</tr>
</tbody>
</table>

As reported in Hayes and Symington (1988)

**TABLE 7.2**

Percentage of children who reported that the identification drawing provided more detail than their initial drawing with respect to various features of the snail
The children's reasoning for the differences between their drawings can be illustrated by comments such as "I copied a real snail" or "What a real snail looked like" (for identification drawing) as opposed to "What I thought it looked like" (for initial drawing). This evidence suggests that the drawing activity had forced the children to carefully observe the snail.

Table 7.3 presents data related to the extent to which the identification drawings of the snails achieved their purpose, that is that they assisted the children to identify their snail.

<table>
<thead>
<tr>
<th>Number of groups who correctly identified their snail on:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>first attempt</td>
<td>57%</td>
</tr>
<tr>
<td>second attempt</td>
<td>24%</td>
</tr>
<tr>
<td>third attempt</td>
<td>19%</td>
</tr>
</tbody>
</table>

As reported in Hayes and Symington (1988)

**TABLE 7.3**

Percentage of groups that were able to use the drawings to successfully find their snail in the Matching Activity

As can be seen in Table 7.3, 81% of the children were able to match their snail in the first two attempts. The 19% of the children who had difficulty suggested that it was due to deficiencies in their drawings.
The ease with which the children used their drawings to identify their snail provides evidence that they had been forced to carefully observe the snail to produce an adequate drawing.

After the matching activity, when the children were interviewed again, the children who had most easily identified their snail talked about 'shell detail' and 'size' as factors that had been helpful. The children who had experienced difficulties in completing the matching activity gave as reasons: differences in partner drawings; lack of shell detail in drawings; or only one means of identification shown in drawings, for example, measurements.

<table>
<thead>
<tr>
<th>Drawing and object matched on the first attempt (n = 12)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of pupils who reported using shell details</td>
</tr>
<tr>
<td>Number of pupils who reported using size</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Drawing and object matched on the second attempt (n = 5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of pupils who reported using shell detail</td>
</tr>
<tr>
<td>Number of pupils who reported using size</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Drawing and object matched on the third attempt (n = 4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of pupils identifying as a cause of difficulty :</td>
</tr>
<tr>
<td>lack of shell detail</td>
</tr>
<tr>
<td>differences in drawing of group members</td>
</tr>
</tbody>
</table>

As reported in Hayes and Symington (1988)

**TABLE 7.4**

The factors identified by students as being crucial in the ease/difficulty of Matching Activity
Observers recorded the dialogue between the children when they had successfully matched their snail. An example of the data recorded is given in Table 7.5. Some examples of children's work is given in figures 7.1 and 7.2.

<table>
<thead>
<tr>
<th>Miranda</th>
<th>&quot;It was easy to match because it had lots of patterns on its shell.&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annabelle</td>
<td>&quot;Yes lots of lines on top of the shell and a bit of white on top.&quot;</td>
</tr>
<tr>
<td>Holly</td>
<td>&quot;It's got plastic like last time. It's the same size.&quot;</td>
</tr>
<tr>
<td>Catherine</td>
<td>&quot;There was a yellow squiggly line and there was black outside and the plastic was yellow.&quot;</td>
</tr>
</tbody>
</table>

As reported in Hayes and Symington (1988)

**TABLE 7.5**

Segments of dialogue as children completed their drawings while observing the snails

Again the evidence gathered points to the children having focussed their attention on the snail when required to produce a drawing for the Matching Activity.

**To facilitate communication between children in the class**

In lessons 2 and 3 all of the children were asked to complete a drawing to show their peers what they had done during the investigation and what they had observed. To assist in evaluating the achievement of this purpose the children in the grade were asked to interpret their peers' drawings related to 'food'(lesson 2) and 'movement and trails' (lesson 3).
Figure 7.1: Robert's snail drawings completed in lesson 1. (a) Drawing to show the teacher what a snail looks like with no model present and (b) identification/matching drawing completed with model present.
Figure 7.2: Miranda's snail drawings completed in lesson 1. (a) Drawing to show the teacher what a snail looks like with no model present and (b) identification/matching drawing completed with model present.
In lesson 2 when each drawing was shown to the class the rest of the children said what they could see in the drawing. This information was listed on the board and the children who had completed the drawing said whether the interpretation was correct and whether any information they had included in the drawing had been overlooked. The observers and the children then filled in a simple checklist with a 'yes' or 'no', as to whether they felt the drawing had achieved its purpose, that is it had communicated what had been done and observed.

In lesson 3 a similar method was used, except there was no formal checklist for the class members to complete. The success of the drawing was judged by the children on the basis of the amount of correct information that the children gained after looking at the drawings and whether they had overlooked any relevant information. The results are shown in Table 7.6.

<table>
<thead>
<tr>
<th>Drawing concerning:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Food preferences of snails (24 drawings)</td>
<td>62.5%</td>
</tr>
<tr>
<td>Movement and trails (46 drawings)</td>
<td>87%</td>
</tr>
</tbody>
</table>

**TABLE 7.6**

**Percentage of communication drawings that were assessed by the children in the class as achieving the purpose**

The observers also rated the drawings for achievement of purpose. In lesson 2 the observers completed the same formal checklist as the children. In lesson 3 the observers again rated the success of the children's drawings. The data from the observers for the achievement of purpose for these two lessons are presented in Table 7.7.
As can be noted the observers rating for achievement of purpose was very similar to that of the children. The rating for the 'Movement and trails' drawings was exactly the same. The observers rating for the 'Food preference' drawings was slightly lower than that of the children.

<table>
<thead>
<tr>
<th>Drawing concerning:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Food preferences of snails (24 drawings)</td>
<td>58.3%</td>
</tr>
<tr>
<td>Movement and trails (46 drawings)</td>
<td>87%</td>
</tr>
</tbody>
</table>

TABLE 7.7
Percentage of communication drawings that were assessed by observers as achieving the purpose

To keep the teacher informed of the children's thinking
During the course of this unit of study the teacher wanted to collect data related to the children's level of knowledge of the topic. The children were asked to visually depict what they knew about snails.

In both the first and last lessons the children were asked to draw a snail to show the teacher what one looked like. These drawings were completed with no model present. The list of main characteristics of a snail, compiled by the children during the first lesson and individual interviews were used by the researcher to evaluate the changes in the children's final drawing, and whether they had omitted any information that they considered important. Table 7.8 shows the differences in the drawings.

There are several different interpretations that can be placed on the results in Table 7.8. One is that the children had increased their knowledge of the
characteristics of snails. Another suggestion may be that the children's
drawing ability had increased. There is the likelihood that both of these
factors are operating. Therefore one cannot with any real certainty draw
inferences from the data. However the data can be seen as supporting the
notion that the drawings are a useful source of knowledge for the teacher
about the children's development during the lesson series.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Present in initial drawing (per cent)</th>
<th>Present in final drawing (per cent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shell</td>
<td>98</td>
<td>100</td>
</tr>
<tr>
<td>Spiral on shell</td>
<td>73</td>
<td>100</td>
</tr>
<tr>
<td>Antennae</td>
<td>71</td>
<td>100</td>
</tr>
<tr>
<td>Colour</td>
<td>64.5</td>
<td>80.5</td>
</tr>
<tr>
<td>Shape of foot</td>
<td>35</td>
<td>46</td>
</tr>
<tr>
<td>Foot detail</td>
<td>19</td>
<td>19</td>
</tr>
<tr>
<td>Shell detail (patterning)</td>
<td>4</td>
<td>29</td>
</tr>
</tbody>
</table>

**TABLE 7.8**

List of those characteristics of snails as depicted in the
drawings identified by the pupils.

In order to ascertain the degree to which the drawings produced during the
evaluation lesson did communicate the children's understanding to the
teacher the researcher drew inferences from the children's drawings and
recorded these in writing. These were then checked against what the child
said during the individual interviews and any additional information was
recorded. If the researcher's inference was substantially the same as what
the child said then that drawing was rated as achieving the purpose. The
results of this process are shown in Table 7.9.
Drawing to answer the question:

<table>
<thead>
<tr>
<th>Question</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>What does a snail eat?</td>
<td>95%</td>
</tr>
<tr>
<td>How does a snail move?</td>
<td>88%</td>
</tr>
</tbody>
</table>

**TABLE 7.9**

Percentages of evaluation sheet drawings for which the inferences made by the researcher from the drawings were validated by the children who did the drawing (43 individual sheets)

To validate the judgement of the author a sample of 20 evaluation sheet drawings chosen at random were judged by 5 teachers. The level of agreement concerning the inferences made from the drawings is shown in Table 7.10.

**Level of agreement:**

<table>
<thead>
<tr>
<th>Level</th>
<th>Drawings</th>
</tr>
</thead>
<tbody>
<tr>
<td>5/5</td>
<td>16</td>
</tr>
<tr>
<td>4/5</td>
<td>3</td>
</tr>
<tr>
<td>3/5</td>
<td>1</td>
</tr>
</tbody>
</table>

**TABLE 7.10**

The level of agreement by teachers of achievement of purpose of evaluation sheet drawings

As shown in Table 7.10, the independent judges' inferences from 16 of the sample drawings were in agreement with those of the researcher.

*To help the pupils formulate questions about the topic*

This is an extremely important objective, as it is both the basis of this teaching approach used in the lessons and also an important skill for young children if
they are to make sense of their world. The data shown in Table 7.11 were collected during lesson 1. The children completed their initial drawing of a snail and then had the opportunity for free exploration and observation of their snail. Following this the children were able to ask any questions they wanted investigated. These questions were recorded on charts. The children then completed their identification drawing. Upon completion of the drawing the children were again invited to suggest questions, these questions also being recorded. The drawing activities appeared to stimulate the formation of questions as shown in the Table 7.11.

<table>
<thead>
<tr>
<th>Before drawing activity</th>
<th>After drawing activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of questions proposed</td>
<td>15</td>
</tr>
<tr>
<td>Number of children who asked questions</td>
<td>15</td>
</tr>
</tbody>
</table>

**TABLE 7.11**

The number of questions, and the number of pupils proposing questions, before and after the drawing activity

As can be seen in this table more questions were proposed by more children following the drawing activity. Throughout this unit of work the children continued to suggest questions following each drawing activity.

The questions were classified in two ways to see if there was any significant difference between the questions asked before and those asked after the drawing activity. The first method of classification was based on the content of the questions. This information is shown in Table 7.12.
<table>
<thead>
<tr>
<th>Content of question</th>
<th>Before drawing activity</th>
<th>After drawing activity</th>
<th>$\chi^2$</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical characteristics</td>
<td>11</td>
<td>20</td>
<td>2.61</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Food preferences</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Movement and trails</td>
<td>3</td>
<td>11</td>
<td>4.57</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Habitat</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

**TABLE 7.12**

Content of questions asked before and after the drawing activity

This analysis shows that the additional questions asked were not all in one area. There was a statistically significant increase in questions asked about movement and trails. This may have been due to the fact that the children were interacting with a live snail that was mobile during the drawing activity.

The second method of classification divided the questions into those that were 'Investigable' and those which were 'Non-investigable'. The basis for this classification came from an earlier study (Symington, 1977). An investigable question is one for which a group of children could obtain a meaningful answer by investigation using simple everyday materials and with the aid of the teacher. A non-investigable question is one where the children could not obtain meaningful answers to scientific questions through working with available materials and with the aid of the teacher. The data are shown in Table 7.13.
<table>
<thead>
<tr>
<th>Type of question</th>
<th>Before drawing activity</th>
<th>After drawing activity</th>
<th>$\chi^2$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Investigable</td>
<td>9</td>
<td>20</td>
<td>2.61</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Non-investigable</td>
<td>6</td>
<td>13</td>
<td>2.57</td>
<td>&gt;0.05</td>
</tr>
</tbody>
</table>

**TABLE 7.13**

The number of Investigable and Non-investigable questions asked before and after the drawing activity

The data show that there was a significant increase in the number of Investigable questions.

7.6.2 Achievement of Objective Purposes

As explained at the beginning of the chapter the study was designed to investigate the impact of the drawing not only on process purposes but also on objective purposes.

The objective purposes explored in this study were:

- to help the children understand what type of drawing is appropriate for a particular purpose and
- to help the children develop their ability to communicate graphically.
To help the children understand what type of drawing is appropriate for a particular purpose

Understanding the purpose

During interviews data were collected concerning the children's ideas about how to make an effective drawing for different purposes in science activities. The drawings for the different purposes could be labelled as:

- knowledge and understanding drawings;
- identification drawings;
- communication drawings.

Knowledge and understanding drawings

The majority of the children when interviewed said that the information that they had included in their initial snail drawing was 'what they thought it looked like', and they had recorded all this information. Some children included features that were inappropriate in the initial drawings. Thirteen children included a face (eyes and mouth) on the body of the snail. During the interviews this was mentioned and these children said they included the face because 'they wanted to' or because 'they wanted the snail to look happy'. However, in the final drawing only 2 children included a face. This suggests that the children had developed in their ability to understand the purpose of the drawing and to respond accordingly.

Identification drawing

When interviewed following the identification drawing activity, but before the drawings were used for the matching activity, most of the children were satisfied that their drawing would help them to identify their snail as they had
included "clues," such as shell detail or size. This indicated their grasp of the purpose of the drawing.

**Communication drawings**

As the unit proceeded the children were developing recording skills that would help them to make more effective drawings to communicate information to their peers. Their first attempt related to 'food' was only partially successful. When interviewed after this drawing some of the children suggested that they could have used colour or labels to help them make their observations clearer. The second drawing, related to 'movement and trails', was more successful as many children learnt from their first experience and adopted techniques which had proved successful for their peers. These techniques were displayed again in the drawings on the evaluation sheets, and when interviewed some of the children commented on the successful ideas they had used as being ones such as labels, and ticks for food identification that they had seen in other children's drawings. Again, these data suggest that the pupils were able to understand the features which would assist the achievement of a particular purpose.

**To help the children develop their ability to communicate graphically**

There are two issues related to the development of children's ability to communicate graphically. The first is the satisfaction of the children with their drawing. This has been discussed in Chapter 6. It is revisited here because the children's satisfaction is likely to provide a guide to their developing ability. Further, satisfaction is likely to be critical to motivation to be further involved in drawing activity.
The second issue to be considered is the graphical techniques which the children were developing as the unit of work progressed.

*Satisfaction*

One of the issues which has been pursued in earlier investigations is that of pupil satisfaction with their ability to produce appropriate drawings. It is believed that if the children are satisfied with their efforts this is likely to provide positive motivation for similar experiences. An earlier study reported in Chapter 6, suggested that, in general, the pupils were satisfied with what they could achieve.

When interviewed after the first session in this series of lessons all the children expressed satisfaction with their identification drawings. Detailed data are not included here because the results are in line with the findings reported in Chapter 6. After the matching activity, 9.5% of the children expressed dissatisfaction with their drawings as a result of difficulties encountered during the activity. When interviewed about their food drawing, 65% were satisfied. Satisfaction with drawings related to movement and trails was stated by 78% of the children. The reasons for this satisfaction/dissatisfaction, as outlined by the children, are shown in Table 7.14.
Peers’ ability to state information shown in drawing (Satisfaction) & Peers’ inability to state information (Dissatisfaction) & Unfinished Drawing (Dissatisfaction) & Messy Work (Dissatisfaction) & Food Drawing & Movement and Trails Drawing & 46% & 87% & 17% & 13% & 33.3% & 22% & 4% & 6.5%

TABLE 7.14

Reasons that the children gave for their satisfaction or dissatisfaction with their drawings

Techniques and skills.

During this study data concerned with the types of techniques the children used in their drawings and their relationship to the development of recording skills were collected.

The children had not experienced this type of recording before and some of them experienced difficulty with their first communication drawing (related to food). The requirement of representing their observations and results by drawing without making an oral report was a problem to many of them. The second communication drawing (related to movement and trails) was easier for the children for a number of reasons:

- It was their second experience with this type of recording.
- The children noted the value of techniques used in the first drawings.
- The children produced individual drawings.
Data from the drawings completed in lessons 2 and 3 and from individual interviews were used as a guide to the techniques that the children had used.

When interviewed after the first drawing activity, 29% of the children said that they could have used colour, labels and made their drawings clearer to help their peers to identify their observations. After the second drawing activity, 28% of the children said that they had improved their drawings by using colour and signs or writing. These improvements had enabled their peers to draw correct conclusions from the information shown in their drawings. In the majority of cases the children's evaluation sheet drawings were easier for them as they had developed techniques and skills during the unit of work that they could use. For example, ticks and crosses were used to represent food preferences, holes in leaves to indicate that the snail had been eating, colour and in some cases labelling were also used effectively.

### 7.7 Conclusion

Based on the analysis of the data gathered during this study it would appear that the drawing activities in science lessons in junior primary grades can achieve the purposes for which they are included in lessons. To collect more data and explore this question further it was decided to complete a similar study involving a different topic, 'oils'.

During this study it was noticed that the children were using a number of different techniques in their drawings and that the use of these techniques appeared to be spreading throughout the class. Therefore, it was decided to collect specific data related to these techniques in the following study that will be reported in Chapter 8.
8.1 Introduction

The study that was conducted on 'oils' and reported in this chapter was developed for a dual purpose. The first purpose was to replicate major aspects of the study reported in Chapter 7. The second purpose was to collect data related to the development of drawing techniques and skills in young children, based on observations made during the study reported in Chapter 7.

In Chapter 3 it was shown that there is very little guidance given to teachers as to the value of drawing in science lessons, how to use drawings effectively, or how to help the children to develop drawing techniques and skills. The investigation reported in this chapter is part of an attempt to gather information that will assist teachers in determining the most effective ways of using drawings in science activities.

8.2 The Research Questions

Data were collected related to the research question in Chapter 7, that is "To what extent do drawing activities in science lessons in junior primary grades achieve the purposes for which they are included in lessons?"

The process purposes for drawings considered in this study are:

- to focus the children's attention on the phenomenon;
- to help the children to formulate questions about the topic.
The main research question related to the second focus of the study, that is children's use of techniques in their drawings, is: "What techniques are used by the children when completing drawings in the science activities?"

If this investigation is to provide valuable information for teachers another important question to be answered is: "What is the source of the children's knowledge of the techniques they use in drawings in science activities?"

In the earlier study related to snails it appeared that the teaching strategies being used promoted the spread of drawing techniques amongst the children. Children appeared able to discern when techniques applied by others were successful and able to adopt and adapt these techniques in their own drawing.

Accordingly it was decided in this study to explore two further questions:

- "Do drawing techniques spread amongst class members when individuals use them successfully?"
- "How are the techniques adapted by the children?"

8.3 Context

This study was based on a part of the normal Grade 2 science program. The topic of study was "Oils". This topic was chosen since the topic used for the previous study, snails, was concerned with biological phenomena, and it seemed appropriate to investigate the children's use of drawing during exploration of a physical science topic.
Oils has been suggested as a topic for study in Victorian Ministry of Education science guides since 1981. The children participated in a series of five lessons using a modified Interactive Teaching Approach (Biddulph and Osborne, 1984). Drawing was used as the primary method for the pupils to communicate what they had done and observed during each lesson. The teacher did not teach the children any graphical techniques.

8.4 The Lessons

Lesson 1

The first lesson was designed to clarify and explore the children’s ideas about the topic “Oils”, and provide the teacher with information regarding the children’s knowledge and understanding of this topic.

The lesson started with a brief introductory discussion centred around trying to identify the liquid in a large jar. The children made suggestions which were listed. They also gave reasons for their suggestions.

Next, the children were divided into groups of four and each group was given 6 small oil samples to examine and discuss. After this activity time the children came together as a class group for a class discussion. This discussion was used to list any questions that the children wanted answered and any relevant observations that they had made.

After the discussion the children were asked to draw their oil samples so that they would be able to identify each one at the start of the next lesson. For this activity the children were provided with a sheet on which the outlines of six containers were already drawn. This was to save the children wasting time
drawing the containers; recording the features of the oils was the important part of the activity. These drawings were then collected.

After the drawing task the children again participated in a class discussion and any additional questions or observations were recorded. The children then decided which question they would like to investigate in the next lesson.

**Lesson 2**

The second lesson commenced with the matching/identification activity, that is the children worked in their groups and used the drawing produced in the previous lesson to identify each of the six oil samples. After identifying the samples the children told one of the adult observers which sample was which and the reasons for the ease or difficulty of identification. This information was recorded by the observers.

In the whole class group the children read the question that was to be investigated during this lesson. The question was, "What happens when you mix oil and water?" The children completed a drawing to show their prediction of what would happen. They then worked in their groups of four to investigate the question.

When they had completed their investigation the children were asked to do a drawing to show their peers and the teacher what they had done and what they had observed.

Each group of four children reported back to the rest of the class by showing their drawings without any supporting verbal comment. The other children in the class had the opportunity to describe their interpretation of the drawings.
Members of the reporting group then were able to react to the interpretations and verbally add any information included in their drawings that their peers had missed.

The results of the activity were compared to predictions and any new questions or pieces of information were recorded. The children then decided which question was to be investigated next time.

**Lesson 3**

This lesson began with a short discussion of the observations and conclusions made during the previous lesson. Some pupils had also conducted some simple experiments at home using oil, water and food colouring. These pupils explained to the class what they had done and shared their results.

Following the introduction the children read the question to be investigated during this lesson: "What would happen if we mixed baby oil, olive oil and engine oil together?" The children again used a drawing to show their predictions.

Working in their groups of four the children completed their investigation. The children were asked to do a drawing to show their peers and the teacher what they had done, their observations and results.

These drawings were shown to the class, each group having a turn. No verbal report was given, but the class members talked about their interpretation of the drawings. The reporters then responded to the interpretations and added any information that their peers had not identified.
in their drawings. Results were compared to predictions. New questions and information were recorded.

The children then decided which question was to be investigated in the next lesson.

Lesson 4
This lesson began with a number of children reporting to the class on simple experiments that they had conducted at home. Most of the children had mixed several liquids or several oils together. They explained what they had done and showed their results. The rest of the children made comments or asked questions.

After this introduction the class looked at the results of the investigation from the previous week and could easily see the layers of the different oils in their jars.

The children then read the question to be investigated during this lesson: "Which oil has the most bubbles?" A class chart was made listing the children's predictions. The children again worked in their groups of four. They used the six oil samples - baby, olive, general purpose, engine, coconut and peanut. On completion of their investigation the children were again asked to do a drawing to show their results. They used a prepared sheet with the six oil containers already drawn.

Each group again showed their drawings and the rest of the class interpreted the results. Each group's results were listed and the results were compared to the predictions. Any new questions or information were recorded.
Lesson 5
This lesson was used as an evaluation of the topic. The lesson started with a discussion of the previous week's investigation.

The children then completed some evaluation activities. These included:

- an individual written evaluation of the topic from the children's point of view;
- individual drawings to show something that the children had found out;
- a class review of the questions that had been asked and the information that had been collected during the unit.

8.5 The Data Gathering

The available data comprised:

- the children's drawings;
- notes made by observers during the lessons;
- interviews with the children after each lesson.

The Drawings
These were collected after each lesson. They had been used as the basis of communication in the classroom after each investigation. They were also used as the basis for the interviews of the children after the lesson.

Observers' Notes
The observers were the class teacher and three Victoria College first year student teachers. Each observed a group of children and recorded the
dialogue and any other significant events during each lesson. An observer's guide sheet was supplied prior to each lesson with the activities listed and indicating what type of data should be recorded.

**Interviews**

The interviews were conducted on the morning following the lesson. During the interviews the children were asked questions related to:

- their satisfaction with the drawings they had produced in that session;
- factors that influence their ability to use drawings as a means of communication;
- whether the drawings achieved the purpose for which they were set;
- the techniques they had used;
- the source of the techniques.

After lesson 2 the interviews were conducted on a group basis, this was because the children had worked in groups during the matching/identification activity and data were collected related to the value of the groups' drawings in being able to match/identify the oils. After lesson 1, 3, 4 and 5 the interviews were conducted on an individual basis.

**8.6 Analyses of the Data**

As stated earlier in this chapter the purpose for this study was twofold:

- to collect data related to several process purposes, as outlined earlier in this chapter;
to collect data concerning the techniques the children used in their drawings. The four research questions provided the framework for analyses of these data.

8.6.1 To focus the children's attention on the phenomenon

Evidence regarding the achievement of this objective was collected by the observers when the children were discussing their drawings as they completed the drawing task. Some examples are shown in Table 8.1.

<table>
<thead>
<tr>
<th>Group 1</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Joseph</td>
<td>It's going to be tricky to draw the same coloured oils to make</td>
</tr>
<tr>
<td></td>
<td>them look different.</td>
</tr>
<tr>
<td>Annabelle</td>
<td>Perhaps we could measure them.</td>
</tr>
<tr>
<td></td>
<td>(The children measured the amount of oil per container and drew</td>
</tr>
<tr>
<td></td>
<td>the exact amount in their pictures.)</td>
</tr>
<tr>
<td>Robert</td>
<td>How could I draw this clear one - I might leave the picture</td>
</tr>
<tr>
<td></td>
<td>blank.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Group 2</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Ross</td>
<td>Baby oil looks more clear than the coconut oil.</td>
</tr>
<tr>
<td>Ray</td>
<td>Peanut oil is a light yellow colour, then comes general purpose</td>
</tr>
<tr>
<td></td>
<td>oil.</td>
</tr>
<tr>
<td>Ross</td>
<td>Olive oil is the darkest yellow.</td>
</tr>
</tbody>
</table>

**TABLE 8.1**

Segments of dialogue as children completed their drawings while observing the oils
Table 8.2 presents data related to the extent to which the identification drawings of the oils achieved their purpose, that is, that they assisted the children to correctly identify the various oils.

<table>
<thead>
<tr>
<th>Number of groups who correctly identified the various oils on:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>first attempt</td>
<td>64%</td>
</tr>
<tr>
<td>second attempt</td>
<td>21%</td>
</tr>
<tr>
<td>third attempt</td>
<td>15%</td>
</tr>
</tbody>
</table>

**TABLE 8.2**

Percentage of groups that were able to use the drawings to successfully identify the oils in the Matching Activity

As can be seen in Table 8.2, 85% of the children were able to match their oils in the first two attempts. The 15% of the children who had difficulty found it was due to deficiencies in their drawings.

The ease with which the children used their drawings to identify their oils provides evidence that they had been forced to carefully observe the oils to produce an adequate drawing.

After the matching activity when the children were interviewed again, the children who had easily identified the oils said that the use of the right colour was the most important feature of their drawings for the purpose of matching. The children who experienced difficulty in completing the matching activity gave as the main reasons the differences in drawings within the group and the use of the wrong colours.
Observers recorded the dialogue between the children when they had successfully matched their oils. This was congruent with what the children later said during the interviews. An example of such dialogue is included in Table 8.3.

<table>
<thead>
<tr>
<th>Miranda</th>
<th>&quot;Number 3 is handy (oil), it matches the colour on my picture.&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annabelle</td>
<td>&quot;Number 4 is engine oil, it's the only one that I made brown.&quot;</td>
</tr>
<tr>
<td>Andrew</td>
<td>&quot;Coconut oil is darker than olive oil in my drawing.&quot;</td>
</tr>
<tr>
<td>Cameron</td>
<td>&quot;Olive oil is darker than peanut oil in my picture.&quot;</td>
</tr>
</tbody>
</table>

**TABLE 8.3**
Dialogue recorded when the children had successfully matched/identified the oil samples

The data collected and recorded in Chapters 7 and 8 appear to indicate that drawing can be used as a means of making the children look closely at whatever phenomenon they are studying.

8.6.2 To help the pupils formulate questions about the topic

As in the previous unit on snails the children asked questions during the first lesson. The number of questions asked by the children is shown in Table 8.4.
<table>
<thead>
<tr>
<th></th>
<th>Before drawing activity</th>
<th>After drawing activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of questions proposed</td>
<td>10</td>
<td>29</td>
</tr>
<tr>
<td>Number of children who asked</td>
<td>10</td>
<td>21</td>
</tr>
</tbody>
</table>

**TABLE 8.4**

The number of questions, and the number of pupils asking questions, before and after the drawing activity

As can be seen in this table more questions were asked by more children following the drawing activity.

The questions were classified in two ways to see if there was any significant difference between the questions asked before and those asked after the drawing activity. The first method of classification was based on the content of the questions. This information is shown in Table 8.5.

<table>
<thead>
<tr>
<th></th>
<th>Before drawing activity</th>
<th>After drawing activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visible features of oils</td>
<td>6</td>
<td>19</td>
</tr>
<tr>
<td>Uses of oils</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>General questions</td>
<td>2</td>
<td>7</td>
</tr>
</tbody>
</table>

**TABLE 8.5**

Content of questions asked before and after the drawing activity
The majority of questions that the children asked both before and after the drawing activity were related to the visible features of oils. General questions included those concerned with production and exploration.

The second method of classification divided the questions into those that were 'Investigable' and those which were 'Non-investigable'. The basis for this classification was reported in Chapter 7. These data are shown in Table 8.6.

<table>
<thead>
<tr>
<th></th>
<th>Before drawing activity</th>
<th>After drawing activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Investigable</td>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td>Non-Investigable</td>
<td>6</td>
<td>20</td>
</tr>
</tbody>
</table>

**TABLE 8.6**

The number of Investigable and Non-investigable questions asked before and after the drawing activity

As noted the questions that the children asked during the oils unit covered a wide range of aspects of oils. However, as can be seen in Table 8.6, the majority of questions were not suitable for the children to investigate.

From the data collected and reported in Chapters 7 and 8, it would appear that the drawing activity stimulates the children and encourages them to ask more questions.
<table>
<thead>
<tr>
<th>Technique</th>
<th>No. of children reporting use of the technique</th>
<th>Reported source of the technique</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lesson 2</td>
<td>Lesson 3</td>
</tr>
<tr>
<td>i Using a numbering system</td>
<td>24</td>
<td>9</td>
</tr>
<tr>
<td>ii Using labels to explain drawings</td>
<td>18</td>
<td>8</td>
</tr>
<tr>
<td>iii Using arrows to show sequence of movement</td>
<td>12</td>
<td>5</td>
</tr>
<tr>
<td>iv Using colour to assist in identification</td>
<td>12</td>
<td>-</td>
</tr>
<tr>
<td>v Using sentences</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>vi Using code letters to identify drawing parts</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>vii Using letters of alphabet to show sequence</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>viii Using small pictures to show observations</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>ix Using line to divide page into sections for drawings</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>x Using bigger and clearer drawings</td>
<td>8</td>
<td>-</td>
</tr>
<tr>
<td>xi Using more detail in drawings</td>
<td>1</td>
<td>-</td>
</tr>
</tbody>
</table>

(As reported in Hayes and Symington 1989)

**TABLE 8.7**

Reported origins of the techniques used by the pupils in their drawings
8.6.3 What techniques are used by the children?

When interviewed after lessons 2 and 3, the children identified the techniques that they had included in their drawings. This information is shown in Table 8.7.

As can be seen in Table 8.7, six of the techniques used and identified after lesson 2 were again used in lesson 3. Three techniques were not used again. The children who had used these techniques in lesson 2, when interviewed after lesson 3, said that they hadn't used them again because they had either found a technique that worked more effectively or because the techniques they had used in lesson 2 had not assisted the other children in working out what had taken place during the investigation. These children were among the ones who later used more detail and/or made their drawings bigger and clearer.

8.6.4 Where do the techniques come from?

After each lesson the children were interviewed and asked where the techniques they had used originated. These results are shown in Table 8.7.

In Table 8.7 it can be noted that, when interviewed after lesson 2, the children stated that the majority of techniques they had used had been seen or used previously at school. Others were based on ideas they had noticed out of school. These included the use of numbers to show order, this technique had been seen on television. Another technique was the use of arrows, these had been noticed by a child on road signs. A child reported that people wear tags at 'Little Athletics' to show order and she had adapted this
idea. Quite often the children suggested that a technique, e.g. use of colour, was their own idea.

When interviewed after lesson 3, the majority of children again stated that the techniques they had employed had been seen or used at school. Again a number of children used techniques which they reported as their own idea, the most noteworthy being to make their drawings bigger and clearer.

8.6.5 Do the techniques spread to other children when used?

Data related to this question were collected during the interviews and are presented in Table 8.8.

<table>
<thead>
<tr>
<th>Technique</th>
<th>No. of children reporting use of the technique</th>
<th>Reported source of the technique</th>
</tr>
</thead>
<tbody>
<tr>
<td>i Numbers</td>
<td>24</td>
<td>Use by children in other topic</td>
</tr>
<tr>
<td>ii Labels</td>
<td>18</td>
<td>1</td>
</tr>
<tr>
<td>iii Arrows</td>
<td>12</td>
<td>3</td>
</tr>
<tr>
<td>iv Colour</td>
<td>12</td>
<td>-</td>
</tr>
<tr>
<td>v Sentences</td>
<td>5</td>
<td>-</td>
</tr>
<tr>
<td>vi Code Letters</td>
<td>3</td>
<td>-</td>
</tr>
</tbody>
</table>

As reported in Hayes and Symington (1989)

**TABLE 8.8**

Spread of techniques among the pupils

It appears that several techniques were used by children as a result of seeing them used by their peers. This indicates a spread of techniques through observation. For example over half the children who had used numbers in
their drawings had seen other children using this technique. About a third of the children used labels in their drawings as a result of seeing this technique used by other children.

During the interviews the researcher recorded the children's ideas on the source of the techniques they had used. Some extracts from these interviews are shown in Table 8.9. A sample of a child's work is shown in figure 8.1.

<table>
<thead>
<tr>
<th>Source of the technique - School</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ben:</strong></td>
</tr>
<tr>
<td>&quot;I used arrows to show the other children where the oil and water was. The idea came from when we were doing snails and other people used them to show the snail moving.&quot;</td>
</tr>
<tr>
<td>&quot;I used arrows again but this time I used them to show movement of oil, not just for labels.&quot;</td>
</tr>
<tr>
<td><strong>James:</strong></td>
</tr>
<tr>
<td>&quot;I used numbers to show the order of things. I had seen and done exercises on ordering in class.&quot;</td>
</tr>
<tr>
<td><strong>Laura:</strong></td>
</tr>
<tr>
<td>&quot;This time I used numbers to show the sequence, these were better 1st to 4th. I saw that on Stefan's work.&quot;</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Source of technique - Out of School</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Laura:</strong></td>
</tr>
<tr>
<td>&quot;I used the numbers 1st to 4th to help the other children to know the order. Sometimes at races. (Little Athletics) you see people wearing tags.&quot;</td>
</tr>
<tr>
<td><strong>Claire:</strong></td>
</tr>
<tr>
<td>&quot;I used arrows so people would know which is which. I have seen arrows used as pointers on road signs.&quot;</td>
</tr>
</tbody>
</table>

As reported in Hayes and Symington (1989)

**TABLE 8.9**

Extracts from interviews which reported on the source and adaptation of the techniques

143
Figure 8.1: Ben's drawings to show what happened during his group's investigation of the question, "What happens when you mix oil and Water?" As reported in Table 8.10, other members of Ben's group used his idea.

8.6.6 How are the techniques adapted by the children?

A number of the techniques that the children used in their drawings had been adapted by the children to fulfil a specific purpose. These included the use of arrows and numbers. During the interviews the children said where they had seen the techniques and how it had been adapted. Some of these are reported in Table 8.10.
Used by children in other topic

Andrew: "I used arrows to show what went in here. I saw arrows on other people's work when we were doing snails."

Used by children in same group

Sarah: "Ben shared his idea about drawing four pictures with the other people in our group. The girls used Ben's ideas. Robert sort of used Ben's idea."

Claire: "I added numbers to show the order that we did it. I saw Katie and Ryan using numbers and I thought it was a good idea."

Used by children in other groups

Jessica: "I used numbers to show the order of what I did. I saw them on Sarah's and Anna's work last time."

Ryan: "I used numbers to show the order to what we did. I saw them on Stefan's drawing last time.

As reported in Hayes and Symington (1989)

TABLE 8.10

Extracts from interviews which reflect the spread of techniques amongst the children

Many children who had used numbers in their drawings said that they had seen them before on pages in books or had seen them used as a numbering system on worksheets at school. These children used numbers in their drawings to show sequence or the number of drawings completed.

8.7 Conclusion

The data collected and analysed during this study appears to confirm the results of the study reported in Chapter 7. That is that it would appear that the drawing activities in science lessons in junior primary grades do achieve the purposes for which they are included in lessons.
It is apparent from the data that children use a wide variety of techniques to aid the clarity of their drawings and that they are able to discriminate between them.

The data support the value of the teaching method used, where drawings were used as the principal means of communication between the children.

The study has shown how, without any teacher instruction on drawing techniques, the children have been able to identify and adapt ones which they see as meeting their requirements.

The study has established one teaching method which, following further investigation, could be presented to teachers as a useful strategy during science lessons.
Chapter 9

REVIEW OF THE RESEARCH

9.1 Introduction

This concluding chapter is concerned with three matters.

- the extent to which the research questions have been effectively addressed, including consideration of the issues of reliability and validity;

- decisions for further research;

- implications for school curriculum, particularly the development of teacher guidance materials.

9.2 The Research Questions

During the studies reported in this thesis many research questions have been raised related to children's drawing in science activities in junior primary classes. The questions have ranged from those concerned with the children's personal enjoyment and satisfaction in their drawings to those related to the benefits of using the actual drawing activity and covered in the questions has been the use and spread of graphical techniques.

A summary of the research questions and the relevant research findings will be presented here.
9.2.1 Enjoyment and satisfaction

As described in Chapter 3, one of the important reasons for including drawing activities in a class program is the resulting children's enjoyment. Linked closely to enjoyment is the children's feelings of satisfaction and success.

Both of these areas were investigated in the studies reported in Chapter 6. Analyses of the data collected suggest answers to the following questions.

- Do grade 1 and 2 children enjoy creating representational drawings of shells and rocks for use in a matching activity?

The data collected and presented in Chapter 6 appear to support the idea that children in grades 1 and 2 do enjoy this type of drawing activity. The data showed that the majority of children when interviewed expressed their enjoyment with the activity.

- Do grade 1 and 2 children experience satisfaction in creating representational drawings of shells and rocks for use in a matching activity?

One of the issues pursued in a number of the studies has been that of satisfaction. Satisfaction may lead to positive motivation for future similar experiences. The data analysed and presented in Chapters 6 and 7 show that the majority of the children at this level of junior primary school were satisfied despite some of the difficulties they experienced with their efforts to represent natural phenomena.
• What properties do grade 1 and 2 children see as important to be communicated in representational drawings of shells and rocks to be used in a matching activity?

The children were very clear on the features that they considered important in communicating. The most important feature to be communicated for both shells and rocks was the shape. The second most important feature was the colour and the least important to the children were the surface features.

• To what extent can grade 1 and 2 children produce drawings of shells and rocks which communicate the identifiable features of the shell or rock?

In all of the studies that are reported in this thesis the children produced a drawing for a matching / identification activity. The majority of these drawings were able to be used to complete the task successfully, even though some of the children had experienced difficulty in completing their drawing. If they experienced difficulty with communicating one of the properties of a phenomena they needed to portray, then they appeared to be able to compensate by paying adequate attention to another of the features.

9.2.2 Purposes for completing a drawing

It was suggested in Chapter 3 that drawing may contribute to both classroom activities and to the development of the children. The purposes for using drawing were labelled as either 'process' or 'objective'. Process purposes were those that contributed to the flow of the lesson. Objective purposes were those that related to the learning objectives the teacher had in mind for the children.
Data related to both types of purposes were collected and analysed in Chapters 7 and 8. The main question related to these studies was:

To what extent do the children's drawings of natural phenomena achieve the purposes for which they are included in lessons?

The process purposes that were investigated were:

- to focus the children's attention on the phenomenon;
- to facilitate communication between children in the class;
- to assist the teacher to understand the children's ideas;
- to help the children formulate questions about the topic.

**To focus the children's attention on the phenomenon**
The data which were collected did suggest that the drawing activity focussed the children's attention on the phenomenon. The measures were indirect. For example, the content of the children's discussions during the completion of the identification drawings, and the increase in the number of questions asked regarding the physical characteristics of both snails and oils after the drawing activity were taken as measures of the extent to which the children's attention was focussed on the phenomenon. However, the results all pointed in the same direction, suggesting the drawing activity did focus attention.

**To facilitate communication between children in the class**
From the data reported in Chapter 7 it would appear that the children were able to communicate with their peers through their drawings. There was an increase in the success rate as the unit of work on snails progressed and the
children became familiar with this type of recording. They were also making choices about drawing techniques which indicated an improvement in the children's ability to communicate graphically.

To assist the teacher to understand the children's ideas
During the course of the unit of study on snails, the teacher wanted to gather data related to the children's level of knowledge of the topic. The children were asked to visually depict what they knew about snails. In both the first and last lessons the children were asked to draw a snail to show the teacher what one looked like. A comparison of the initial and final drawings of snails, in both instances completed without a snail present, was conducted in an attempt to analyse what the children knew of the physical characteristics of a snail. The list of main characteristics of a snail, compiled by the children during the first lesson and individual interviews were used by the researcher to evaluate the changes in the children's final drawing and whether they had omitted any information that they considered important. Data collected and reported in Chapter 7 indicates that the drawings did assist the teacher to be informed of the children's thinking.

To help the children formulate questions about the topic
As stated in Chapter 7 helping the children to formulate questions is an extremely important objective, as questioning by children is the basis of the teaching approach used in the study, and also an important way for young children to make sense of their world.

Relevant data were collected in both the snails and the oils studies and reported in Chapters 7 and 8. In both studies more questions were asked by more children following the drawing activity than before the activity.
The questions were classified in two ways to see if there was any significant difference between the questions asked before and those asked after the drawing activity.

The first method of classification was based on the content of the questions. In the snails study there was a significant increase after the drawing activity in the number of questions the children asked about movement and trails. As suggested in Chapter 7 this may have been due to the fact that the children were interacting with a live, mobile snail during the drawing activity.

In the oils study there was a large increase in the number of questions the children asked about the visible features of the oils after the drawing activity. This may have been due to the observations that the children were making to complete their oil sample identification drawing.

The second method of classification was to divide the questions into the categories of 'investigable' or 'non-investigable'. The data presented in Table 7.12 shows that in the snail study a significant increase in the number of investigable questions followed the drawing activity.

As noted in Chapter 8, although the children asked questions on a wide range of aspects of oils, the majority of questions were unsuitable for the children to investigate.

From the data collected and reported in Chapters 7 and 8, it would appear that the drawing activity stimulated the children and enabled them to ask more questions.
The objective purposes that were investigated were:

- to help the children understand what type of drawing is appropriate for a particular purpose;
- to help the children develop their ability to communicate graphically;
- to help the children understand what type of drawing is appropriate for a particular purpose.

During interviews data were collected concerning the children's ideas about how to make effective drawings for different purposes in science activities. Analysis of the data shows that the children were able to complete drawings appropriate for three different purposes. These purposes included drawing to show information, to enable identification, and to communicate information.

- to help the children develop their ability to communicate graphically

When considering how to help the children develop their ability to communicate graphically it is necessary to look at two issues. The first is satisfaction. As this has been discussed in some detail already in this chapter we will move on to the second issue.

The second issue to be considered concerned the children's developing repertoire of graphical techniques. Data collected during interviews, and from the children's drawings, showed that the children were using a number of different techniques in their drawings and that the use of these techniques appeared to be spreading throughout the class. This would be expected to lead to an improvement in the ability of the children to communicate by means of drawings.
9.2.3 Techniques children use in their drawings

In Chapter 3 it was shown that there has been very little guidance given to teachers as to the value of drawing in science lessons, how to use drawings effectively in that situation, or how to help the children to develop the techniques and skills which would assist them to produce drawings for particular purposes in science lessons.

The oils study reported in Chapter 8 was used to collect data that would assist teachers in determining the most effective ways of using drawings in science activities. The research questions about techniques which guided this study were:

- What techniques are used by the children when completing drawings in science activities?

Data gathered, and reported in Table 8.6, identified eleven different techniques used by the children when completing their drawings.

The most widely used techniques included the use of a numbering system, labels to explain drawings, arrows to show sequence or movement, and colour to assist with identification.

- What is the source of the children's knowledge of these techniques?

The origins of the techniques are also shown in Table 8.6. As was reported, the children stated that the majority of techniques they had used were ones
that they had seen or used previously at school. A number of children said that they had based their techniques on ideas that they had seen out of school. The sources of these ideas were television, signs in the community and involvement in out of school activities. Some children stated that the techniques they used were their own idea.

• **Do drawing techniques spread amongst class members when individuals use them successfully?**

Data concerning the spread of techniques to other children were collected during interviews. The analysis of these data is shown in Table 8.7. It appears that several techniques were used by children as a result of seeing them used by their peers. These techniques included the use of numbers, labels, arrows, colour, sentences and code letters. The teaching strategy used in the lessons needs to be noted when considering this result. It provided opportunity for all the children to see the techniques others were using and to judge the effectiveness of these techniques. Further the children knew that their own efforts would be put under class scrutiny, and this was likely to provide strong motivation to adopt effective strategies.

• **How are the techniques adapted by the children?**

Some of the techniques, eg. use of arrows and numbers, used in the children's drawings had been adapted to fulfil a specific purpose. The children who used numbers for showing sequence or the number of drawings completed reported that they had seen this technique used in books or on worksheets.
The study reported in Chapter 8 has shown that without any teacher instruction on drawing techniques, the children have been able to identify and adapt ones which they see as meeting their requirements.

9.3 Reliability and Validity

As stated in Chapter 5 it was necessary in the studies to address issues of both external and internal reliability and validity.

Reliability

LeCompte and Goetz (1982), stated that "external reliability addresses the issue of whether independent researchers would discover the same phenomena or generate the same constructs in the same or similar settings". (page 32)

"Internal reliability refers to the degree to which other researchers, given a set of previously generated constructs, would match them with data in the same way as did the original researcher". (LeCompte and Goetz, 1982, page 32)

Where ever possible throughout the thesis there has been detailed instruction and explanation provided so that other researchers would be able to replicate the studies.

This detail has included specifying:

- the research questions
- the teaching strategies, including the use of matching / identification activities, drawing for a specific purpose and the use of drawing as the main means of communication
- the topics used, and the outlines of the lessons
• methods of collecting and analysing data
• details of the children used in the studies, including the number in the samples and their age and grade level

**Validity**

Internal validity refers to the extent to which scientific researchers actually observe or measure what they think they are observing or measuring.

External validity determines to what extent the abstract constructs and postulates generated, refined or tested by scientific research are applicable across groups.

In the thesis the studies that collected data related to enjoyment and satisfaction were conducted with children in grades 1 and 2. It would be inappropriate to generalise the findings beyond these grade levels. However, informal work with children in Prep and Grade 3 has shown that these children also appear to experience similar enjoyment and satisfaction with their drawings. There could, however, be very different reactions at the upper primary level.

The studies used to collect data concerning the purposes for using drawing activities in science and the techniques that the children use were conducted at the grade two level. Two separate grades were involved and although the lessons were conducted at different times both studies ran for the same duration and the data from both grades and topics were consistent. Again, although generalisation from these studies to other grade levels would be inappropriate informal work has provided data that support the success of these drawing activities at Prep level (the first year at school). Although the results show that these activities are suitable in the junior primary grades, it
would be inappropriate to generalise about the success level in upper primary grades.

As reported in this thesis a limited number of topics were used for the studies. These included shells, rocks, snails and oils. The topics did however come from both the physical and biological areas of the science curriculum.

The data collected and analysed from both the physical and biological topics provided very similar results. It could be expected that the findings of these studies could apply to a range of topics in primary school science programs.

9.4 Directions for further research

9.4.1 Purposes

Figure 3.1 suggests there are many possible process and objective purposes for including drawing activities in science lessons. In this thesis a number of these purposes have been explored. More research to gather extra data would enable more definite conclusions to be drawn, about the conditions under which these purposes can be achieved.

There were some purposes in the model which has guided the research that have not been investigated during the studies reported in this thesis. It would be valuable to research these in the future. These purposes are:

- to improve the children's ability to observe;
- to improve the children's knowledge of phenomena;
- to improve the children's understanding of phenomena.
9.4.2 Topics

As reported in this thesis a limited number of topics were used for the studies. It would be useful to investigate drawing for particular purposes in a wider variety of both biological and physical science topics.

The purposes for using drawing as outlined in this thesis have been used, apparently effectively, by the researcher when teaching other topics at the Prep class level. These topics have included magnets, seeds, sound, bones and floating and sinking. Informal evaluation suggests that the purposes were achieved.

Formal research using these and other topics would be, however, valuable in establishing the value of drawing activities when children are studying these topics.

9.4.3 Grade levels

The data collected, analysed and reported in this thesis came from junior primary grades. The children concerned were in grades 1 and 2. As noted, some informal work has also been conducted at grade 3 and Prep.

Some of the strategies outlined in this thesis may work at other grade levels. Investigations based on these strategies need to be conducted in grades 4 to 6 to provide further data on the usefulness of drawing for a range of purposes at the different grade levels.

However, if the children commence developing their graphic communication skills in the junior primary grades, by the time they reach the senior grades
they may be able to display a wide range of techniques and skills collected and adapted along the way.

9.5 Implications for classroom teaching

During the studies reported in this thesis some useful teaching strategies for using drawing activities in junior primary grades were developed. The first of these was the use of the children's drawings in a matching/identification activity. This was a simple activity where the children drew their object while observing it. Both the drawing and object were used as part of a matching activity for the class at a later time. The majority of children have expressed both satisfaction and enjoyment when taking part. Further, the strategy appears to contribute to the children's development in various ways.

A second useful strategy involved the children's use of a drawing to provide a report to their peers about something they had observed or done. This provided the children with a reason for making carefully detailed drawings and for adopting techniques that may assist them in fulfilling the purpose for the drawing activity.

Each of these strategies, with a little guidance would be simple for class teachers to implement as part of their science program. As reported in Chapter 3 there has been very little guidance in curriculum materials for teachers related to drawing and it seems important to develop curriculum materials which will assist classroom teachers to make the best possible use of drawing as an activity.

The strategies that were developed during the studies and reported in this thesis are useful additions to the classroom program not only in the science
context. They could be used in many subject areas and provide the basis for a variety of purposeful drawing activities.

The studies reported in this thesis have validated the role of drawing in science teaching and the lessons learned both through the conclusions of the studies (the product) and the conduct of the studies (the process) need to be communicated as widely as possible, with appropriate supporting materials.

From the author's point of view as a classroom teacher, the strategies that have been developed during this thesis have been simple and successful in relation to many aspects of the teaching and learning process. It would be unfortunate if other teachers did not have the opportunity to take advantage of the findings of this research and experience the benefits arising from the use of these simple but effective teaching strategies.

This study has broken new ground in a number of ways. First, as was revealed by a survey of the literature it is the first significant attempt to research the place of drawing in primary science activity. The findings of the research have been encouraging and it is to be hoped that others will extend what has been started.

Second, the study has developed a model (see Figure 3.1) for considering the contribution that drawing could make to the teaching and learning of science in the early years of school. This model should be useful in stimulating and guiding both research and curriculum development.

Finally, as part of the study the author has developed some strategies for the use of drawing in science activities in the primary school. The research
findings and the personal experience of the author suggest that they may be very acceptable to teachers and particularly fruitful in promoting pupil development.
Chapter 10

Bibliography


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APPENDICES
THE SATISFACTION OF YOUNG CHILDREN WITH THEIR REPRESENTATIONAL DRAWINGS OF NATURAL PHENOMENA

Dorothy Hayes and David Symington

INTRODUCTION

Asking children to communicate by means of drawing, painting, and modelling is very common at the primary school level. In science activities children are often required to record their observations of natural phenomena by these methods, particularly drawing.

Although psychologists have been researching children’s drawings for many years (e.g., Luquet, 1927; Eng. 1954; Freeman, 1980) educational researchers, with the exception of those interested in art education, have made very little contribution to our understanding of this area. It is probably not so surprising, therefore, that much of the research has been focussed on issues of perception, cognition, and child development and that less attention has been paid to some other issues of importance for teaching such as motivation.

From the teacher’s point of view an important consideration is whether the children themselves are satisfied with their efforts. Satisfaction is likely to provide motivation for the next similar experience, whereas lack of satisfaction is liable to lead to lack of motivation. Children’s satisfaction with their drawings has not been adequately explored in previous research and so was chosen as the focus of this study.

METHODOLOGY

A number of important issues had to be considered when making decisions about the methodology to be employed. The first was the context of the study. It seemed that if the study was to yield data useful to teachers about the children’s satisfaction with their drawings these should be produced in a setting as close as possible to that in which children would normally work. Accordingly the drawing activity was carried out in a normal class program, as one activity within a topic which the children were studying. There was a purpose for the drawing as far as the children were concerned, each was to communicate sufficient detail about the shell represented that the other children could identify the shell drawn. The children were able to talk with their peers and the teacher during the activity.

A second issue was how to obtain data on the students’ satisfaction with their drawings. It was decided that the most appropriate way was to ask the students themselves. Whilst appreciating the concerns that some may have about the validity of such data we felt that because the drawing activity had been part of the on-going life of the classroom, and since the question was to be asked by a person with whom the children had developed a trusting relationship, namely their class teacher, it seemed reasonable to gather the data in this way. Additional objective data were gathered by videotaping the activity and noting problems children had with the task.

Choosing the Topic

Psychologists involved in studying children’s representational drawing of three dimensional objects (e.g. Chen & Cook, 1984) have largely focussed on the problems involved in translating the model seen into a two dimensional set of lines, and show a preference for the use of regular solids as models. In the classroom setting when children are asked to draw a three dimensional object they are usually able to use a range of properties to communicate about the object. Even if they have difficulty representing the three dimensional shape they may be able to effectively convey information about the object by the use of colour. For this study it was decided to use the type of object the children would commonly collect, in this instance they were asked to draw shells.
The Research Question

The main research question was: 'Do grade 1/2 children experience satisfaction in creating representational drawings of shells for use in a matching activity?'

Since one of the factors which could influence the children's satisfaction is their perception of the properties they see as important to communicate, another question posed was: 'What properties do grade 1/2 children see as important to be communicated in representational drawings of shells to be used in a matching activity?'

The Context

The study of shells was part of a larger topic 'The Beach'. The children had become quite involved in the study and brought shells and relevant posters and books to school. Many class and small group activities had arisen from the topic and the children had numerous opportunities to handle and observe a variety of shells.

Several days prior to the drawing task the children were asked to select a shell that they liked. These shells were then mounted on cardboard for ease of handling.

#### TABLE 1

Data, gathered by interview, which indicate the children's reaction to the drawing activity

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of children in the class</td>
<td>25</td>
</tr>
<tr>
<td>Number (percentage) of children who</td>
<td>19 (76%)</td>
</tr>
<tr>
<td>expressed satisfaction with their</td>
<td></td>
</tr>
<tr>
<td>drawing</td>
<td></td>
</tr>
<tr>
<td>Number of children who said that</td>
<td>23 (92%)</td>
</tr>
<tr>
<td>they enjoyed the drawing activity</td>
<td></td>
</tr>
</tbody>
</table>

#### TABLE 2

Data, gathered by observation and interview, which reflect the difficulties that the children experienced in drawing the shell.

1. **Observational Data**
   - Number (percentage) of children who discarded a drawing and began again on a new piece of paper: 3 (12%)
   - Number (percentage) of children who used an eraser: 23 (92%)

2. **Interview Data**
   - Number (percentage) of children who expressed concern about their ability to adequately portray the colour of the shell: 10 (40%)
   - Number (percentage) of children who expressed concern about their ability to adequately portray the shape of the shell: 8 (32%)
   - Number (percentage) of children who expressed concern about their ability to adequately portray details of the surface of the shell: 7 (28%)
The data show that ninety-two percent of the children used an eraser during the activity, this being assumed to reflect some dissatisfaction with an aspect of their initial drawing. This dissatisfaction was confirmed verbally during the interviews. In many cases the problems appear to have, in the children’s eyes, been overcome by the use of the eraser. Three children rejected their first efforts altogether and used a new piece of paper.

The interviews revealed three areas in which children experienced difficulties. One of these was the difficulty some children (40%) had with producing an appropriate colour. As a solution some children were happy to substitute one colour for another, for example, yellow was sometimes substituted for white. Another source of concern was the difficulty of portraying the shape of the shell correctly. Reference to this issue was made by thirty-two percent of the children. The third area of concern, was expressed by twenty-eight percent of the children, was the difficulty of portraying surface details such as bumps, breaks or holes.

It can be noted from the analysis presented in Table 3 that where there was dissatisfaction it was normally only with the representation of one of the properties of the shell.

Table 4 sets out the children's opinions about which properties of the shells should be communicated by the drawings. Almost all (92%) of the children believed that the shape of the shell should be communicated. Colour was mentioned by about half (48%) and surface features by a smaller number (16%).

Table 5 represents an analysis of some of the data obtained when observing the matching activity. It will be noted that in the majority of cases (76%) the shell and drawing were matched on either the first or the second attempt.

Probably the most effective means of seeing possible relationships between the various pieces of data is obtained by considering together all the information gathered about an individual pupil.

**TABLE 3**

Number of children who expressed concern about their ability to adequately portray the properties of the shell in their drawing.

<table>
<thead>
<tr>
<th>Number of children who were expressing concern about their ability to portray the properties of the shell made reference to:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1 property only</td>
<td>14</td>
</tr>
<tr>
<td>2 properties</td>
<td>4</td>
</tr>
<tr>
<td>3 properties</td>
<td>1</td>
</tr>
</tbody>
</table>

**TABLE 4**

Data, gathered by interview, which reflects the properties of the shells the children thought it important to communicate.

<table>
<thead>
<tr>
<th>Number (percentage) of the children who thought that it was important to accurately communicate the:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>shape</td>
<td>23 (92%)</td>
</tr>
<tr>
<td>colour</td>
<td>12 (48%)</td>
</tr>
<tr>
<td>surface features</td>
<td>4 (16%)</td>
</tr>
</tbody>
</table>
TABLE 5

Data, gathered by observation, which indicate the ease with which the drawings were matched to the corresponding shell

<table>
<thead>
<tr>
<th>The shell and drawing were:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>matched on the first attempt</td>
<td>14</td>
</tr>
<tr>
<td>matched on the second attempt</td>
<td>5</td>
</tr>
<tr>
<td>matched on the third attempt</td>
<td>2</td>
</tr>
<tr>
<td>not matched in three attempts</td>
<td>4</td>
</tr>
</tbody>
</table>

One instance is provided here.

Robert (Grade 2) stated, when interviewed, that the most important properties of the shell to be communicated were 'the right shape and the right colour'.

He had some difficulty in drawing the shell. As he said: 'It was hard to draw the curved shape'. However, despite the difficulties, he put a lot of time and effort into his drawing and expressed satisfaction with the result.

Robert's drawing would be classed as showing intellectual rather than visual realism (Barrett & Light, 1976) since he included details of the shape of the end not visible from the position from which he was viewing the shell. He also took great trouble to record the surface markings on the shell and to communicate the colours effectively.

During the matching activity his drawing was matched to the shell without difficulty using the shape, colour and markings.

When interviewed, Robert indicated that he was satisfied with his drawing and that he believed that he had communicated to the other children the properties he considered important.

DISCUSSION

The task required of children - to produce a representational drawing of an irregular solid - was apparently not an easy one. Probably the most important finding of the study, as far as primary teachers are concerned, is the fact that almost all of the children enjoyed this activity, that the majority obtained satisfaction from it, and that in most cases the children could match the drawings to the corresponding shells.

An important question to attempt to answer is: What was the source of their satisfaction? Clearly most had some difficulty in producing their drawing. However, for the majority of these, the difficulty was only with portraying one property of the shell. When it came to the matching activity most found that their communication was adequate for the purpose. It would appear that in the classroom where there are a number of properties about which the children can communicate, difficulty with one of these need not make the child's communication ineffective. For example, some of the children appeared to be able to compensate for an inability to convey the three dimensional shape of the shell by paying adequate attention to the other properties such as colour and surface markings.
There is an obvious need for further research drawing upon other pupils and topics to see whether the interpretation made of these data is sound.

REFERENCES


PURPOSES ACHIEVED BY DRAWING DURING SCIENCE ACTIVITIES

Dorothy Hayes and David Symington

INTRODUCTION

This paper reports part of a larger study into the use by junior primary pupils of drawings in science lessons. There are a number of issues which come to mind when considering the significance of this activity. One of the issues which has been pursued in experiments reported by these authors is that of pupil satisfaction with their ability to produce appropriate drawings. It is believed that if the children are satisfied with their efforts this is likely to provide positive motivation for similar experiences. An earlier paper (Hayes and Symington, 1984) reported data which suggested that, in general, the pupils were satisfied with they could achieve.

A second issue is whether, as some researchers believe, the children's ability to produce appropriate drawings is governed by their stages of development. Barrett and Light (1976), proposed that there are three distinct developmental stages in children's drawings. These three stages are labelled "Symbolic", "Intellectual realism", and "Visual realism". Other researchers (Symington et. al., 1981) have produced data which has challenged this developmental orientation. Some are educators have explained the data on which the stages models have been developed in alternative ways. Eisner (1972) states that, "the characteristics that children produce in their drawings and sculptures are products of both purpose and skill. When coping with a problem, the child, like the rest of us, brings to bear upon it those technologies of mind that seem to be relevant to its solution". The children apply problem solving techniques to the drawing activity. As similar solutions occur this has been interpreted as evidence of developmental stages. In the present study the drawings developed by the children are viewed as reflecting their knowledge of appropriate techniques, rather than as evidencing a developmental stage.

A further issue which needs to be addressed is whether children's drawings are able to achieve the purposes for which they are included in classroom activity. The choice of activities for classrooms is influenced by two conceptions of purpose. One is whether the activity will contribute to the "flow" of the lesson. For example, one reason for asking children to do a drawing may be to provide a quiet, individual task to help the children settle down after a boisterous, group activity. In this paper such purposes will be labelled as "process purposes."

The second notion of purpose which guides choice of activities is whether the activity is likely to lead to the achievement of the learning objectives the teacher has in mind. For example, whilst it may be decided to use drawing to settle the children down quietly, the nature of the drawing task should be related to the learning objectives the teacher has in mind. In this paper the purposes related to learning objectives will be described as "objective purposes". The study to be reported was designed to allow for exploration of both types of purposes.

METHODOLOGICAL CONCERNS

It was decided to gather the data in a context which was as near as possible to the normal classroom setting. Accordingly, the study was built around a series of lessons developed for junior primary grades. The topic "snails" was chosen because the animal is of obvious interest and appeal to children of this age, is suitable for first hand study and comes form the children's environment.

The lessons are based on the Interactive Teaching Approach (Biddulph & Osborne, 1984), with the children providing the questions they wanted answered, predicting outcomes, sharing information and ideas and suggesting how different aspects of the topic could be investigated. The teacher took on the role of fellow investigator, resource person, challenger of the children's ideas and facilitator of learning. As might be expected the children were involved in drawing activities regularly during the lessons. The drawings were used for a variety of process and objective purposes.
The Lessons

Lesson 1. The first lesson was designed to clarify the children's ideas about the topic and to provide the teacher with drawings and information regarding the children's knowledge and understanding of snails.

After a brief introductory discussion of pictures of insects found in the garden, the children were asked to draw a snail to show the teacher what it looked like. When the drawings were completed the children worked with a partner to discuss and list the characteristics, e.g., shell, eyes, that the partner's drawings of a snail showed them.

The children were then able to interact with their partner while observing an actual snail. They were encouraged to compare their initial drawing with the snail, then have a free activity/exploration time with their snail. The short class discussion that followed this exploration was used to list any questions that the children would like to have answered and any relevant observations they had made.

Next they were asked to draw their particular snail so that they could identify it in the next session. The resulting drawings were collected. With the completion of this drawing task the children again participated in a class discussion and additional questions or observations were listed. The children then grouped together the questions they felt should be investigated. Questions were grouped in the categories of food, movement and trail, body and shell. The children decided that an investigation of food would be the subject of the next lesson.

This paper will deal in particular with the data gathered in, and immediately after, the first lesson. Accordingly, the later lessons will be described in outline only.

Lesson 2. The second lesson started with the matching/identification activity, that is the children using the drawing produced in the previous lesson to find the particular snail they had observed. When the partners thought they had found their snail they were required to inform an observer of the reasons for the ease or difficulty of matching/identifying.

The children then investigated the question "What does a snail eat?" After their exploration they used a drawing to communicate something they had observed to their peers and teacher.

Lesson 3. The third lesson was an investigation of the children's questions about "Movement and Trails". They again communicated something they had observed during their investigation to their peers and teacher through a drawing.

Lesson 4. The fourth lesson was an in-depth investigation of the children's questions about the snail's body and shell, the children using a magnifying glass. No drawing activity was included in this lesson.

Lesson 5. Evaluation. This lesson took place two weeks after the session on "body and shell". This session was used to evaluate the unit of work.

Data Gathering

The data collected during this unit came from several sources:

- the children's drawings;
- notes made by observers during the lessons;
- individual interviews with the children after each lesson.

Drawings

The drawings were collected after each session and used as the basis for class discussions and individual interviews.
Observer Notes

The observers were the class teacher, a parent and two Victoria College second year student teachers. Each observed a group of children and recorded the dialogue and any other significant events during each session. An observer's guide sheet was supplied prior to each session with the activities listed and indicating what type of data should be recorded.

Interviews

Individual interviews with the children took place on the morning following the science lesson. After each session the children were interviewed regarding:

(a) their satisfaction with their drawings;
(b) factors that influence their ability to use drawings as a means of communication;
(c) whether their drawings achieved the purpose for which they were set.

ANALYSIS OF THE DATA

Only part of the data analysis can be reported here. This paper focuses on the question: "To what extent do the children's drawings of natural phenomena achieve the process purposes for which they were designed?" As explained earlier, process purposes are those concerned with the contribution of the activity to the "flow" of the lesson.

Drawings were used for four such purposes in these lessons. These were:

(a) to focus the children's attention on the phenomenon;
(b) to help the pupils to formulate questions about the topic;
(c) to facilitate communication between children in the class;
(d) to keep the teacher informed of the children's thinking.

The data analyses reported here relate only to the first two of these. Further analysis will be reported at a later date.

A. To focus the children's attention on the phenomenon.

In the first lesson the children produced two drawings of a snail, the first from memory, the second as they observed the snail. The extra detail that the children put into their second drawing came from their observation of a real snail. The children's dialogue as they completed the drawing indicates how the task focussed the observation of many of the pupils. Some of the children's dialogue is shown in Table 1.

When interviewed, the children noted the differences between their first and second drawings discussing the increased detail in the latter. This information is shown in Table 3.
TABLE 1

Segments of dialogue as children completed their drawings while observing the snails

<table>
<thead>
<tr>
<th>Group 1</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Catherine</strong></td>
<td>&quot;Don't forget that bit of yellow, then we will be able to recognise it.&quot;</td>
</tr>
<tr>
<td></td>
<td>&quot;Oh yes, there's some black bits.&quot;</td>
</tr>
<tr>
<td></td>
<td>&quot;Did you do that bit of plastic?&quot;</td>
</tr>
<tr>
<td><strong>Holly</strong></td>
<td>&quot;That's not plastic.&quot;</td>
</tr>
<tr>
<td><strong>(Catherine)</strong></td>
<td>&quot;It's something stuck on.&quot;)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Group 2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Annabelle</strong></td>
</tr>
<tr>
<td><strong>Miranda</strong></td>
</tr>
<tr>
<td><strong>Belinda</strong></td>
</tr>
<tr>
<td><strong>Annabelle</strong></td>
</tr>
</tbody>
</table>

TABLE 2

Detail noted by the children as present in the second but not the first drawing

<table>
<thead>
<tr>
<th>Feature of Drawing</th>
<th>Percentage increase in presence of the feature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shell detail</td>
<td>82%</td>
</tr>
<tr>
<td>Antennae</td>
<td>78.5%</td>
</tr>
<tr>
<td>Body detail</td>
<td>57%</td>
</tr>
<tr>
<td>Size</td>
<td>43%</td>
</tr>
<tr>
<td>Colour</td>
<td>32%</td>
</tr>
<tr>
<td>Tail</td>
<td>21%</td>
</tr>
<tr>
<td>Eyes</td>
<td>21%^</td>
</tr>
<tr>
<td>Trail</td>
<td>21%</td>
</tr>
</tbody>
</table>

Table 3 presents data which indicates the number of attempts the children needed to choose their snail from the class's collection. As can be seen in this table 81% of the children were able to match their snail in the first two attempts. The success with which the children could identify their snail suggests that they had been forced to carefully observe the snail to produce an adequate drawing.
TABLE 3

Percentage of groups who identified their snail, using their drawing on the first, second or third attempt

<table>
<thead>
<tr>
<th>Percentage of groups, who using their drawing, correctly chose their snail on the:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(n = 21)</td>
<td></td>
</tr>
<tr>
<td>first attempt (12)</td>
<td>57%</td>
</tr>
<tr>
<td>second attempt (5)</td>
<td>24%</td>
</tr>
<tr>
<td>third attempt (4)</td>
<td>19%</td>
</tr>
</tbody>
</table>

TABLE 4

Segments of dialogue after identification of snail

Group 1

_Holly_  -  "It's got plastic like last time."
-  "It's the same size."

_Catherine_-  "There was a yellow squiggly line and there was black outside and the plastic was yellow."

Group 2

_Miranda_-  "It was easy to match because it had lots of patterns on it's shell."

_Annabelle_-  "Yes lots of lines on top of the shell and a bit of white on top."

After the matching activity when the children were interviewed again, the children who had easily identified their snail talked about using "shell detail" and "size" as factors that had been helpful.

B. To help the pupils to formulate questions about the topic.

This is an extremely important objective, as it is both the basis of this teaching approach and also an important way for young children to make sense of their world. The drawing appeared to stimulate the formation of questions as shown in Table 5.
As can be seen in Table 5 more questions were asked and more children were involved in formulating questions following the drawing activity. Throughout the unit of study the children continued to ask questions following each drawing activity.

The questions were classified in two ways to see if there was any significant difference between the questions asked before and those asked after the drawing activity.

The first method of classification was based on the content of the questions. No significant difference in the content of the questions asked before and those asked after the drawing activity emerged when the questions were grouped according to this criterion.

The second method of classification divided the questions into those that were investigable and those which were non-investigable. The basis for this classification came from an earlier study (Symington, 1977). The data from this second classification also showed no significant difference in the questions asked before and those asked after the drawing activity.

CONCLUSION

The data presented in this paper relate to the question of whether drawing activities met the process purposes for which they were designed. The choice of context in which the data were gathered and the methodology employed have shaped the form of answer which can be given to the question.

The data do support the assertion that involvement in drawing activities can encourage pupils to observe phenomena more closely and can stimulate questions. Further exploration of the issue using other topics, currently being carried out, will increase the confidence with which the findings of this study can be more generally applied.
REFERENCES


SYMINGTON, D.J. (1977) Primary school pupils' ability to see scientific problems in everyday phenomena. Research in Science Education, 7, 41-49.

TECHNIQUES USED BY PRIMARY SCHOOL PUPILS IN DRAWINGS DURING SCIENCE ACTIVITIES

Dorothy Hayes
David Symington

INTRODUCTION

This paper reports part of a study concerned with drawings completed by junior primary school pupils during science lessons. It deals with the techniques that pupils used to communicate information regarding their investigations, and the source and adaptations of those techniques.

Drawing is an activity that is frequently included in junior level science lessons. It is perceived as a simple, practical means of recording the pupils' observations. The latest science curriculum document produced by the Victorian Education Ministry "The Science Framework P-10" (Ministry of Education, 1987) refers to drawing as a means of evaluation.

Further, it is seen as an end as well as a means. For example, in "Science in the Primary School" (Education Department of Victoria, 1981), it is stated that by the end of year two the pupils should be able to "record information using tables, models, paintings and drawing" (Page 22).

In these documents, however, there is no guidance given to teachers as to methods of using drawings effectively in science lessons. Teachers are not informed about when to use drawings, or how to help the pupils to develop drawing techniques and skills.

To find any attempt to assist teachers in this area it is necessary to go back to the Nature Study days. In the 1930's two books were published by the Gould League of Bird Lovers in Victoria to assist teachers and bird observers in developing drawing skills.

The purpose of these books Sketches of Australian Birds was to assist a wide range of people, including children, to study native birds. These books proposed the learning of drawing techniques through instruction. The measurements, colours and construction lines to be recorded were shown in great detail.

Young pupils were included in the group who were to be encouraged to use these sketchbooks. Expectations were not as high as those for the adults; the children were to draw a simple outline and use coloured chalk to complete the drawing.

As stated previously, in Victoria no publications since then have included information for teachers about their role in relation to pupils' drawings in science lessons. Is it because it is perceived as a simple activity, or is it believed that the pupils have all the techniques they need, so no instruction is necessary?

RESEARCH QUESTIONS

The study reported in this paper is part of an attempt to gather data that will provide teachers with information on effective ways of using drawings in science activities.

The study addressed the following questions:
- What techniques are used by the pupils?
- Where do the techniques come from?
- Do the techniques spread to other pupils when used?
- How are the techniques adapted by the pupils?
CONTEXT OF STUDY

This research study was based on part of the normal Grade 2 science program. The topic of study was "Oils". The pupils participated in a sequence of five lessons using a modified Interactive Teaching Approach (Biddulph & Osborne, 1984). Drawing was used as the primary method for the pupils to communicate what they had done, and observed, during each lesson. The teacher did not teach the pupils any drawing techniques.

THE LESSONS

As the data collected relate to Lessons 2 and 3, only Lessons 1, 2 and 3 will be described here.

Lesson 1. The first lesson was designed to clarify and explore the pupils’ ideas about the topic "Oils", and provide the teacher with information regarding the pupils’ knowledge and understanding of this topic. During the lesson the pupils looked at oil samples, discussed oils, asked questions and completed a drawing that would assist them in identifying each of the six different oil samples at the start of the second lesson.

Lesson 2. This lesson commenced with a matching/identification activity. The pupils worked in their groups of 4, and most experienced no difficulty in using their drawings to determine which oil was which. After making their identification the pupils informed the teacher, or one of the observers, of the reasons for their ease or difficulty in completing the activity.

After reading the question that was to be investigated, “What happens when you mix oil and water?”, they used a drawing to predict what they thought the result would be. The pupils then worked in groups of 4 to find the answer.

When they had completed their investigation the pupils were asked to do a drawing to show their peers and the teacher what they had done and what they had observed.

Each group of 4 children reported to the rest of the class by showing their pictures without any supporting verbal comment. The pupils in the class had the opportunity to describe their interpretation of the drawings. The reporters then had the chance to react to these interpretations.

The outcomes were compared to predictions and any new questions were recorded.

Lesson 3. This lesson began with a short discussion of the results collected during lesson 2. Some pupils had also conducted simple experiments at home. These pupils explained to the class what they had done and shared their results.

The question to be investigated during this lesson was “What would happen if we mixed baby oil, olive oil and engine oil together?” The pupils again used a drawing to show their predictions. Working in groups of 4 the pupils completed the investigation. The pupils were again asked to do a drawing to show their peers and the teacher what they had done, their observations and results.

These drawings were again shown to the class, each group having a turn. No verbal report was given, but the class members talked about their interpretation of the drawings.

Results were compared to predictions and new questions were recorded.

DATA GATHERING

The data collected during this study were:

- the pupils’ drawings;
- notes made by observers during the lessons;
- interviews with the pupils after each lesson.
The Drawings. These were collected after each lesson. They had been used as the basis of communication in the classroom after the investigation. They were also used as the basis for the interviews of the pupils after the lesson.

Observers' Notes. The observers were the class teacher and three Victorian College first year student teachers. Each observed a group of children and recorded the dialogue and any other significant events during each lesson. An observer's guide sheet was supplied prior to each lesson with the activities listed and indicating what type of data should be recorded.

Interviews. The interviews were conducted on the morning following the lesson. During the interviews the pupils were asked questions related to:

(i) the techniques they had used;
(ii) the source of the techniques.

After lesson 2 the interviews were conducted on a group basis. After lesson 3 the interviews were conducted on an individual basis.

As stated earlier in this paper the focus for this study was the techniques the children used in their drawings. The 4 research questions provided the framework for analyses of the data.

(a) What techniques are used by the pupils?

When interviewed after lessons 2 and 3, the pupils identified the techniques that they had included in their drawings. This information is shown in Table 1.

As can be seen in Table 1, six of the techniques used and identified after lesson 2 were again used in lesson 3. Three techniques were not used again. The pupils who had used these techniques in lesson 2, when interviewed after lesson 3, said that they hadn't used them again because they had either found a technique that worked more effectively or because the techniques they had used in lesson 2 had not assisted the other pupils in working out what had taken place during the investigation. These pupils were among the ones who used more detail and made their drawings bigger and clearer.

(b) Where do the techniques come from?

After each lesson the pupils were interviewed and asked where the techniques they had used had originated. These results are shown in Table 1.

In Table 1 it can be noted that, when interviewed after lesson 2, the pupils stated that the majority of techniques they had used had been seen or used previously at school. Others were based on ideas they had noticed out of school. These included the use of numbers to show order, this technique was seen on TV, and arrows on road signs. A child reported that people wear tags at "Little Athletics" to show order and she had adapted this idea. Quite often the pupils suggested that a technique, e.g. use of colour, was their own idea.

When interviewed after lesson 3, the majority of pupils again stated that the techniques they had employed had been seen or used at school. Again a number of pupils used techniques which they reported as their own idea, the most noteworthy being to make their drawings bigger and clearer.

(c) Do the techniques spread to other pupils when used?

Data related to this question were collected during the interviews and are presented in Table 2.
TABLE 1
Reported origins of the techniques used by the pupils in their drawings

<table>
<thead>
<tr>
<th>Technique</th>
<th>No. of children reporting use of the technique</th>
<th>Reported source of the technique</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>School</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lesson 2</td>
</tr>
<tr>
<td>i     Using a numbering system</td>
<td>24</td>
<td>9</td>
</tr>
<tr>
<td>ii    Using labels to explain drawings</td>
<td>18</td>
<td>8</td>
</tr>
<tr>
<td>iii   Using arrows to show sequence of movement</td>
<td>12</td>
<td>5</td>
</tr>
<tr>
<td>iv    Using colour to assist in identification</td>
<td>12</td>
<td>-</td>
</tr>
<tr>
<td>v     Using sentences</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>vi    Using code letters to identify drawing parts</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>vii   Using letters of alphabet to show sequence</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>viii  Using small pictures to show observations</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>ix    Using line to divide page into sections for drawings</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>x     Using bigger and clearer drawings</td>
<td>8</td>
<td>-</td>
</tr>
<tr>
<td>xi    Using more detail in drawings</td>
<td>1</td>
<td>-</td>
</tr>
</tbody>
</table>
TABLE 2

Spread of techniques among the pupils

<table>
<thead>
<tr>
<th>Technique</th>
<th>No. of children reporting use of the technique</th>
<th>Reported source of the technique</th>
<th>Use by children in other topic</th>
<th>Use by children in this topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>i Numbers</td>
<td>24</td>
<td>-</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>ii Labels</td>
<td>18</td>
<td>1</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>iii Arrows</td>
<td>12</td>
<td>3</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>iv Colour</td>
<td>12</td>
<td>-</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>v Sentences</td>
<td>5</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>vi Code Letters</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
</tbody>
</table>

It appears that several techniques were used by pupils as a result of seeing them used by their peers. This indicates a spread of techniques through observation. For example over half the pupils who had used numbers in their drawings had seen other pupils using this technique. About a third of the pupils used labels in their drawings as a result of seeing this technique used by other pupils.

During the interviews the researcher recorded the pupils' ideas on the source of the techniques they had used. Some extracts from these interviews are shown in Table 3.

TABLE 3

Extracts from interviews which reflect the spread of techniques amongst the children

**Used by children in other topic**

Andrew: "I used arrows to show what went in here. I saw arrows on other people's work when we were doing snails."

**Used by children in same group**

Sarah: "Ben shared his idea about drawing four pictures with the other people in our group. The girls used Ben's ideas. Robert sort of used Ben's idea."

Claire: "I added numbers to show the order that we did it. I saw Katie and Ryan using numbers and I thought it was a good idea."

**Used by children in other groups**

Jessica: "I used numbers to show the order of what I did. I saw them on Sarah's and Anna's work last time."

Ryan: "I used numbers to show the order of what we did. I saw them on Stefan's drawing last time."
(d) How are the techniques adapted by the pupils?

A number of techniques that the pupils used in their drawings had been adapted by the pupils to fulfil a specific purpose. These included the use of arrows and numbers. During the interviews the children said where they had seen the technique and how it had been adapted. Some of these are reported in Table 4.

**TABLE 4**

Extracts from interviews which reported on the source and adaptation of the techniques

<table>
<thead>
<tr>
<th>Source of the technique - School</th>
</tr>
</thead>
</table>
| Ben: "I used arrows to show the other children where the oil and water was. The idea came from when we were doing snails and other people used them to show the snail moving."
  
  "I used arrows again but this time I used them to show movement of oil, not just for labels."
| James: "I used numbers to show the order of things. I had seen and done exercises on ordering in class."
| Laura: "This time I used numbers to show the sequence, these were better 1st to 4th. I saw that on Stefan's work."

**Source of technique - Out of School**

| Laura: "I used the numbers 1st to 4th to help the other children to know the order. Sometimes at races. (Little Athletics) you see people wearing tags."
| Claire: "I used arrows so people would know which is which. I have seen arrows used as pointers on road signs."

Many pupils who used numbers in their drawing said that they had seen them before on pages in books or had seen them used as a numbering system on worksheets at school. These pupils used numbers in their drawings to show sequence or the number of drawings completed.

**CONCLUSION**

It is apparent from the data that pupils use a wide variety of techniques to aid the clarity of their drawings and that they are able to discriminate between them.

The data support the value of the teaching method used, where drawings were used as the principal means of communication between the children.
The study has shown how, without any teacher instruction on drawing techniques, the children have been able to identify and adapt ones which they see as meeting their requirements.

The study has established one teaching method which, following further investigation, could be presented to teachers as a useful strategy during science lessons.

REFERENCES


SCHEDULE FOR QUESTIONS ASKED AT INTERVIEWS

(i) SHELLS STUDY
These questions were asked at individual interviews after completing the shell drawings for the matching activity:

- Did you enjoy drawing your shell? Could you please tell me why?
- Were you satisfied with your drawing of your shell? Could you please tell me why?
- What did you think were the most important features of your shell that you needed to show in your drawing?

(ii) ROCKS STUDY
The questions for the rocks study were the same as for the Shells study.

(iii) SNAILS STUDY
The first four questions were asked at the beginning of each interview.

- Did you enjoy doing your drawing? Could you please tell me why?
- Were you satisfied with your drawing? Could you please tell me why?
- Would you like to have changed your drawing? Could you please tell me why?
- How would you have changed it?

After lesson 1, during the interview, the children were asked to look at and compare their initial drawing and their identification drawing and they were asked:

- Are your two drawings the same?
- What are the differences?
- Why do you think the two drawings are different?
- Why did you draw a face on your snail? (This question was asked of the few children who had drawn a face on their snail.)

After lesson 2, when the children had used their identification drawing to help them find their snail, they were asked:

- Was it easy to find their snail? Could you please tell me why?

After the final lesson when the children completed their evaluation sheet drawings they were asked:

- Where did that idea (labels, ticks) come from?
- In the drawing what were you telling me about the things a snail eats?
- In this drawing what were you telling me about the way a snail moves?

The data gathered from the last two questions were used to confirm inferences the researcher had made based on her interpretations of the children's evaluation sheet drawings.
OILS STUDY

The first four questions were asked at the beginning of each interview.

- Did you enjoy doing your drawing? Could you please tell me why?
- Were you satisfied with your drawing? Could you please tell me why?
- Would you have liked to have changed your drawing? Could you please tell me why?
- How would you have changed it?

After lesson 2, when the children were interviewed they were also asked:

- Was it easy to identify the different oils using your identification drawing? Could you please tell me why?

After lesson 2 and 3 the children were also asked questions related to the graphic techniques they had used in their drawings. The questions were:

- Where did that idea (eg using a number system) come from?
- Did you use that idea in the same way as you had seen it used before or did you change it?
SNAIL UNIT OBSERVER SHEET

Choose 2 pairs of children to observe and write comments about related to each activity.

Write children’s names here: ____________________________.

When recording data it is only necessary to use the first letter of the child’s name.

Please record children’s dialogue and any other significant thing you observe during each activity.

You have been provided with blank paper, please head each section as on this sheet.

A. **CONCEPT DRAWING**: record children’s dialogue and any other significant thing you observe during each activity.

B. **GROUP DISCUSSION**: identification of main characteristics. Record children’s dialogue related to drawings in the group.

C. **COMPARISON ACTIVITY**: list any dialogue made by children when comparing their drawing to the actual snail.

D. **FREE ACTIVITY**: list any dialogue and questions related to the actual snail.

E. **CLASS DISCUSSION**: list any questions suggested by the children you have been observing.

F. **IDENTIFICATION DRAWING**: record any dialogue between the children related to the snail or their drawing and any other significant thing you observe.

G. **COMPARISON OF DRAWING TO REAL SNAIL**: in groups of 4 children, record any dialogue between children related to drawings.

H. **CLASS DISCUSSION**: list any more question or information suggested by the children you have been observing.