# Drawing as a Tool for Thought:

The development of the ability to use

drawing as a design tool

amongst children

aged 6 - 8 years.


## Gillian Hope

**Goldsmiths College, University of London**


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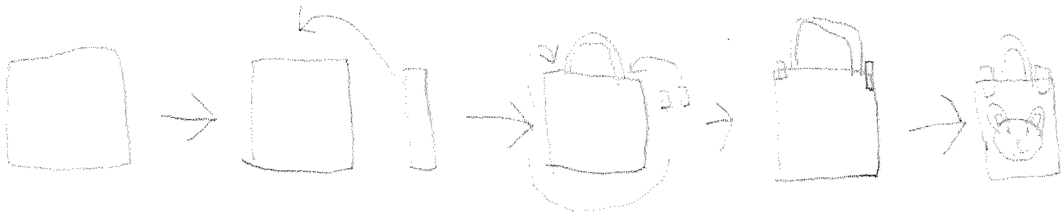

# Abstract

My research into young children's understanding of using drawing to support designing was undertaken in a rural First School (children aged 5-9 years) across the years 1998-2002.

Since little previous research had been conducted in the field, the first phase of the research aimed to discover how young children could use drawing to support designing, through analysing drawings produced in Design and Technology lessons. It appeared that below age 8, although children could record design ideas, they did not use drawing to support their design thinking or develop their ideas towards making. Understandings gained through reading, led to the belief that the metaphor of design drawing as both a Container and a Journey could be used to teach younger children to use drawing as a design tool.

The second phase of the research, therefore, involved devising a Programme of four school term's duration, for a Year 2 class (average age 6.10 at start of Programme), that embedded the Container / Journey metaphor. These children's developing capability with design drawing was compared at intervals with that of a parallel class who did not receive the Programme.

The evaluation of the Programme used both qualitative and quantified analysis to assess both process and products of using drawing to support designing. The analysis instrument for the products was based on a holistic view of the design process, placing Understanding the Purpose of the Drawing at the centre of capability and Dimensions of Design Drawing through which such capability were expressed in drawing as emanating from this central understanding. Besides demonstrating the success of the Programme, the analysis showed how children adapt their use of drawing for different activities (problem-solving or product design) and revealed the importance of discussion whilst drawing for the development of viable design ideas.

# Acknowledgements

*My thanks for support and encouragement throughout the whole process of researching and writing this thesis go to:*

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Sue Hammond, good friend of long-standing, Literacy Co-ordinator , whose own research into young children's developing writing skills contributed to my understanding of place-holding meaning; Thérèse Smith, Special Needs Co-ordinator, whose knowledge of cognitive development assisted my thinking about symbolic manipulation skills; Maggie Robinson, Art Co-ordinator, who, in 1996, initially suggested that "Flat Stanley" might be a suitable starting point for some small-scale research into Design and Technology;
Chris & Caroline, Claire & Hilary: Teachers of the Focus and Comparison Classes of the Structured Phase of the research, who agreed to me teaching their classes, and to teaching mine whilst I did so; Teaching Assistants : Wendy, Sheron, Jackie, Donna, Carol and Julia, who became so well-tuned to just how much help (or not) to give.
And, not least, the children, especially my Focus Class, on whose willingness to become part of what I was doing, the success of the whole project depended and to whom saying Goodbye was difficult.

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# Contents Lists :

# Contents of Thesis

# Examples of Children's work

## Frontispiece:



## SECTION 3 - Exploratory Phase



## SECTION 4 - Structured Phase



## SECTION 5 - Analysis of the Assessment Tasks

# Figures, Tables & Charts

## Figures

### SECTION 1 - Introduction


### SECTION 2 - Research methodology


### SECTION 3 - Exploratory Phase


### SECTION 4 - Structured Phase


### SECTION 5 - Analysis of the Assessment Tasks


### SECTION 6 - Conclusions and Reflections

# *Tables*

## Charts

# Colour Conventions for Charts

*Where the two classes are represented:*

= Focus Class    = Comparison Class

*Where the Assessment Tasks are represented:*

= Pizza    =Frosty    = Easter

= Card    = Suitcase    = Maze

*Where the Drawing Types are represented:*

= Picture    = Single-draw    = Multi-draw

= Multi-design    = Progressive    = Interactive

*Where the Dimensions of Design Drawing are represented:*

=Generating and Developing Ideas

= Exploring the Possibilities of the Task

= Addressing the Constraints of the Task

= Planning the Look of the Product

= Communicating Design Ideas

= Planning Construction

= Evaluating Whilst Drawing

= A Basis for Making the Product

*Where other data are represented, other colours have been chosen.*

# Appendices

# SECTION 1 - Introduction

# 1.1 Overview of Thesis

This Introduction to the thesis briefly indicates the perceived problem that I wished to investigate, the question that I formulated and sought to address within my chosen setting, the organisation of the task and how it was structured and how the thesis is written to reflect this.

## 1.1.1 The Elements of the Study

***The Research Problem:*** There was little research into the way in which young children could use drawing to support their design thinking and yet the implications of the National Curriculum for Design and Technology were that they would do so.

***The Research Question:*** To what extent could young children use drawing to support their design thinking and could this be enhanced through teaching?

***The Research Setting:*** All investigative work for this study was conducted at a rural First School in Southern England where I worked for most of the duration of the research, as Year 1 Co-ordinator and Co-ordinator for Design and Technology. I began by looking at drawings in Design and Technology lessons across the whole school (ages 5-9 years) and then conducted a programme lasting four terms with children from the beginning of Year 2 (mean age 6.8 years) through to the end of their first term in Year 3 (mean age 8.1 years), with the aim of improving their facility with design drawing.

***The Constructs:*** In order to answer both halves of the research question, I needed not only to discover what young children *could do* but also *why* (or *why they did not*) in order to discover how to enhance their performance. I needed to discover what was at the root of being able to use drawing for designing, not just as skills that could be observed but also in relation to cognitive development and learning.

The theoretical constructs centred on the metaphorical nature of drawing and how new learning can be created by metaphorical extrapolation from the known to the unknown. By using a specific metaphor for design drawing (drawing as both Container and Journey), I sought to enable the children to use drawing to support the generation and development of design ideas.

The building of theoretical constructs came after the answering of the first half of the research question (to what extent could young children use drawing to support their design thinking), thus dividing the research into two phases: an Exploratory Phase (1998-2000) in which I investigated what children could do and a Structured Phase (2000-2003) in which I attempted to implement a Programme to enhance performance:

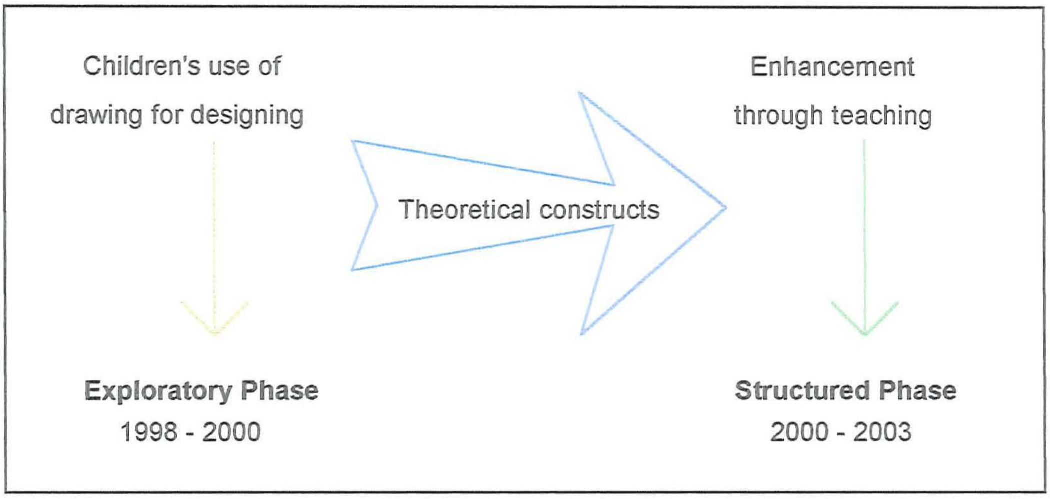



*Fig. 1 Research Structure*

***The writing:*** The way the thesis is organised reflects those two phases and the style in which it is written reflects my constant interaction with my material, whether reading the literature or observing the children. It talks about children's design journeys but it is also the story of my research journey. An end came when I needed to draw a line under the process and write about it. That it will be a spring-board for more enquiry is shown in the key themes that emerged and are discussed in Section 6: Conclusions and Reflections, each of which could become the start of another new journey.

### 1.1.2 Thesis Outline

*Section 1*, the Introduction to the thesis sets the scene by illustration, rather than by trying to tightly define, the area of investigation which I set out to explore.

*Section 2* discusses the research methodology issues as it pertains to my study: paradigms, epistemology and choices affecting research design and organisation.

*Section 3* details my first forays into researching young children's design drawings. The account of this Exploratory Phase is organised under three major headings: the literature search, the observations of young children (aged 5-9 years) drawing for designing and the theoretical constructs which evolved as a result of the interaction between the two.

*Section 4* explains how this led into the more Structured Phase of the research and briefly outlines and evaluates the Programme delivered to one class of children (Focus Class) in Year 2-3 (aged 6-8 years) and how their capability would be compared with a parallel class who did not receive my input (Comparison Class).

*Section 5* contains the analysis of the Assessment Tasks that were conducted with both classes during the Programme. Qualitative analysis of the children's performance is followed by the account of the quantitative analysis instrument by which the drawings were analysed. The results of that analysis are then given, divided into sub-sections relating to the layers of the analysis instrument. Also within Section 5 is a brief discussion of gender differences within the sample.

*Section 6* pulls together the themes which have emerged from the thesis and draws conclusions from the research undertaken.

## 1.2 Starting Places

People use drawings in a whole range of contexts; even people who say they never draw. Since beginning to look at the way children might be taught to use drawing as a modelling tool to explore and convey their ideas about objects they wish to make, I have become increasingly aware of the use people make of sketches in the course of everyday life, quite apart from workplace use of plans and diagrams for buildings, electrical circuits, flow charts of productivity or traffic movement, layout and product design:

- Sketch maps are frequently drawn to give directions.

- People can be seen walking around DIY stores clutching sketches of ideas and diagrams of room sizes.

- Drawings are frequently used to aid explanations: when our hot water tank needed changing, my husband came home with a diagram from his brother showing him what to do; when making clothes for my daughter when she was little, I used to draw her the range of possibilities for the garment: puffy sleeves, square neck etc.; when I want to tell a teaching assistant what I want the children to make, I draw the parts and use arrows and captions to indicate how it fits together.

- Abstract ideas are frequently modelled by drawings and diagrams. This can be generative as well as illustrative.

- The use of CAD packages has had its impact on drawing. I have found that manipulating screen objects can be just as fruitful a means of generating new ideas and seeing new combinations as pencil sketching.

- And the area of my greatest interest - to generate and record ideas to support thinking and planning.

But like artist's sketch books, these drawings rarely get seen by others. They are redundant once the product is made and apart from professional designers who might want to keep them for future reference, they are discarded. On the following pages are some examples of these uses of drawing that I have collected since beginning to research drawing for designing. They illustrate rather than define or justify. They demonstrate the facility with which many people use drawing as a tool to support their thinking.

## 1.2.1 How adults use drawing

This section illustrates some of the ways in which adults use drawing.

***Explanatory Drawings***

These are frequently drawn as the person is talking and serve to illustrate and support a verbal explanation.

*Fig.2 Sketch map drawn by a colleague to show me how to get to a school in Maidstone*

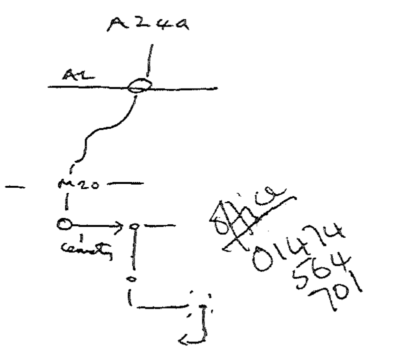



*Fig. 3 Suggested organisation of my web site drawn by Paul Shallcross, Kent D&T advisor.*

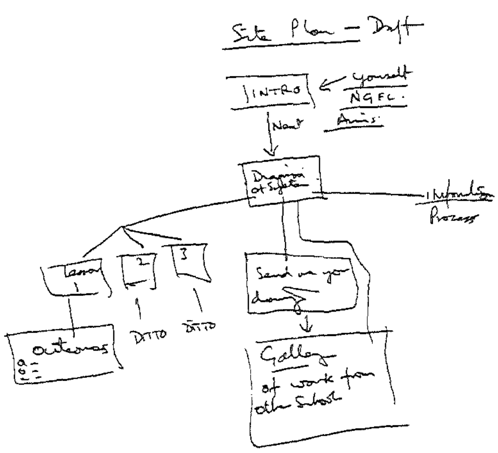
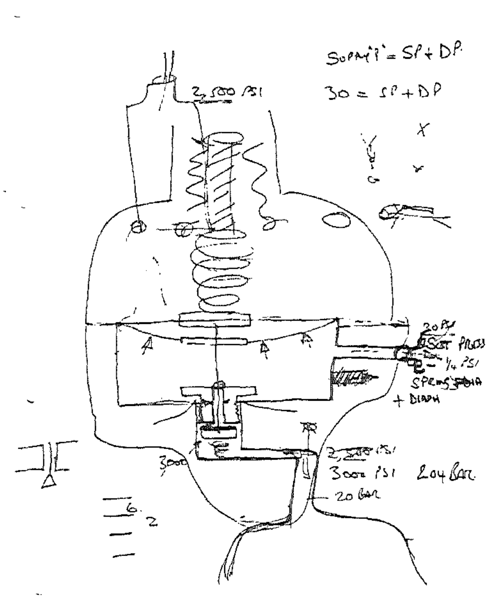
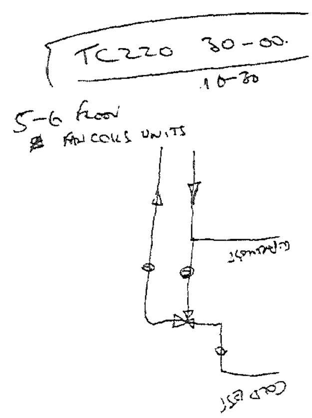



*Fig. 4 My husband drew this as he was explaining to our daughter how a diaphragm valve worked.*




The example below, Fig. 5, also by my husband, is part of an explanation to a site engineer of the layout of the air-conditioning pipe-runs in a building. The paper was turned round partway through the explanation.

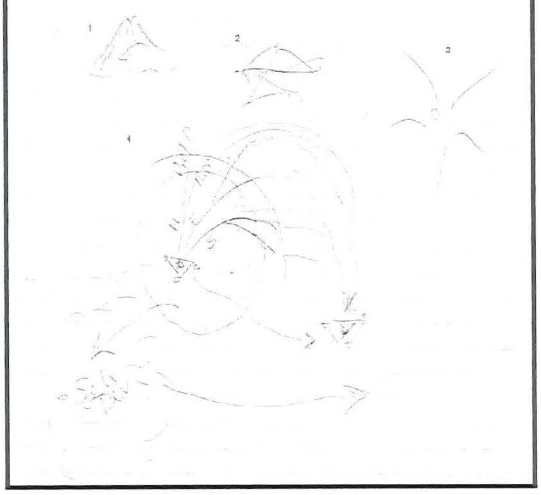
*Fig. 5 Pipe-runs in a building*



***Drawing to model and develop abstract ideas***

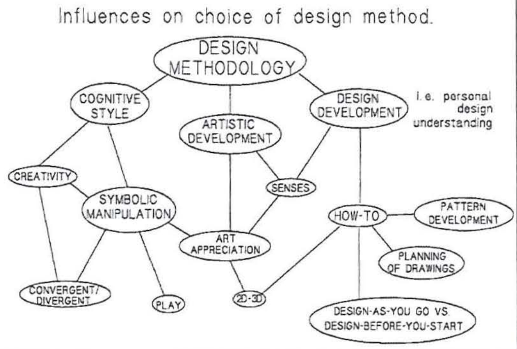
Fig. 6 was a response to the model of Performance Management with which we as a school staff were being presented. I disliked the "top down" approach and muttered as much to my colleague next to me, drawing diag.1 and saying that we worked as a team (diag.2). She responded with diag.3: "Now... this is us all going off in different directions." Which led me to create an alternative model of staff development (diag.4).

*Fig. 6 :*



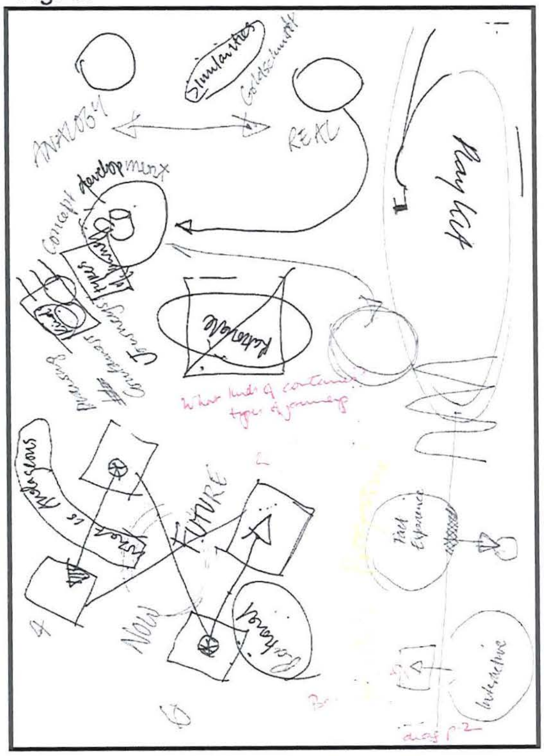
The following (Fig.7) is one of a series of diagrams which I created using a CAD package to help me work out the relationship between the various cognitive factors involved in using drawing for designing:

*Fig. 7 :*




The following is the first of four pages filled whilst discussing the nature of design drawing with a fellow researcher:

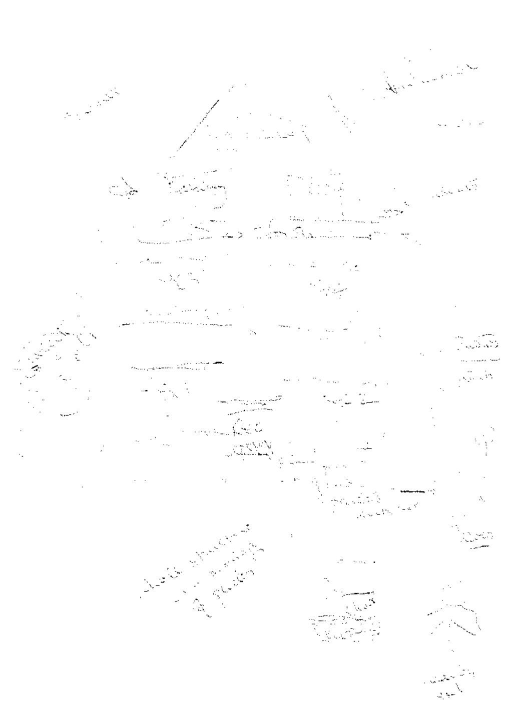
*Fig. 8:*



## *Drawing as a planning tool*

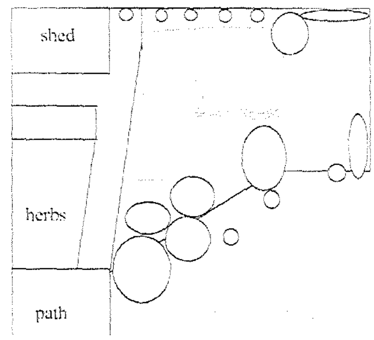
Fig. 9 is my thinking drawing for a display at the exhibition at the DATA Millennium Conference. I then worked out an assembly order for the card panels, to be attached by slots and tabs.

*Fig. 9*



When I wanted to play with some ideas for re-designing part of the garden, I measured it out and drew it on a CAD package. I then experimented with ideas based on the shape of the plot. There were several sheets of these, of which Fig. 10 is one:

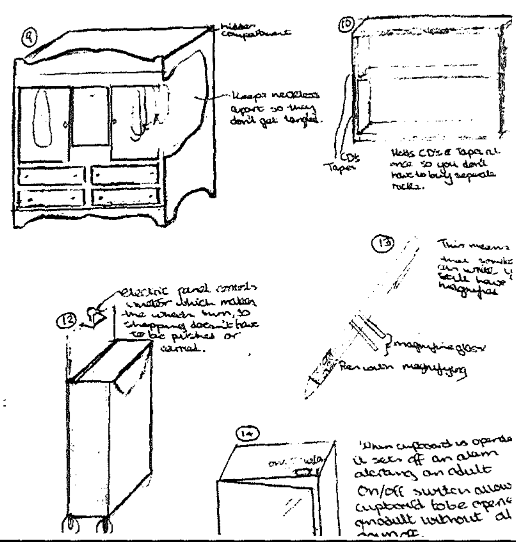
*Fig. 10*




## *Drawing for Exams*

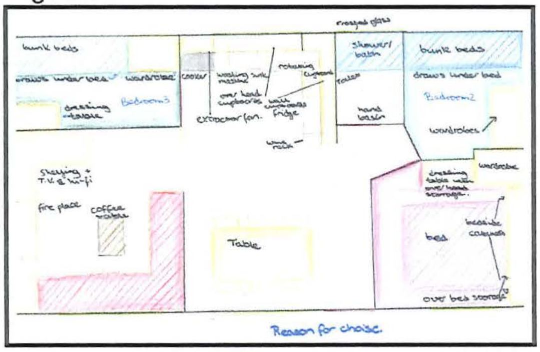
Excerpts from my daughter's GCSE Design & Technology Course Work:

*Fig. 11: Ideas on the theme of "safety":*



The following is a plan for a mobile home suitable for disabled people. She produced a whole series of different views and projections of this and a beautifully-made 3D model from balsa wood complete with furniture, fittings and soft furnishings.

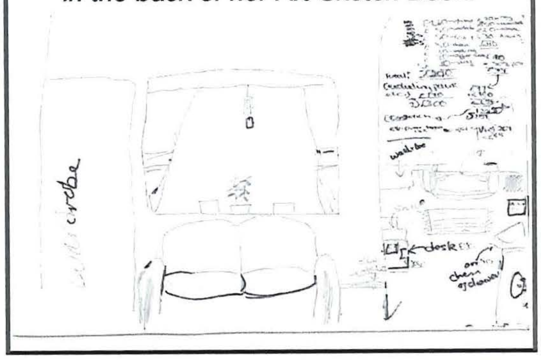
*Fig. 12:*




Completely missing are all her initial ideas sketches. All the scraps of paper onto which she played with ideas, crossed things out, redrew them and tried again have long since been assigned to the bin. The Course Work folder is itself a work of art.

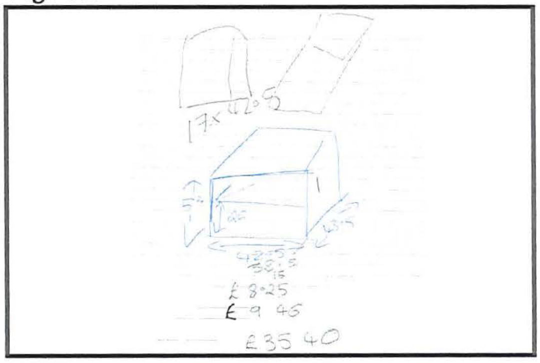
That she did use drawing to play with ideas about real things that she intended to make is preserved in the spare pages at the back of old school exercise books.

*Fig.13 : This scheme for her bedroom was in the back of her Art Sketch Book:*



In the back of her history notebook was a series of designs for new bedroom furniture that she might make. Fig.14 shows one page on which details of sizing and costing were calculated for the inside of the wardrobe. After costing, she decided that cutting up her brother's old wardrobe to make the shelves was the right option. She and her Dad spent a happy weekend making it:

*Fig. 14:*




***Comment:***

To me all these examples show adults using drawings to support real thinking about real spatial, organisational and conceptual problems. It was these skills that I aimed to encourage amongst the young children I taught.

## 1.2.2 Drawing in conversation

From my colleague Sue Hammond's study of Early Years children engaged on Independent Group Activities comes this snippet of four children (aged 5 years) interacting and negotiating their drawing experiences. The children are engaged in making a "Family and Friends Dictionary" :

**Robert:** Ip, dip, doo.....

**Kathy:** Eeny, meeny, miny, mo..... square, Mrs.H. I want `square'.

**Mrs.H.:** No K., you're doing family and friends - remember?

**Kathy:** Oh, yes.

**Emma:** If you do a square you could do some arms and legs and make an Iron Man.

**Robert:** I'm going to draw his whole body. *(Draws round figure on his page, watched by A.)*

**Alex:** When my brother was football training, this boy had all paint on him. He said it was chicken pox. *(Laughs)* Easy, peasy, lemon squeezy, Apple pie, take your squeezy.

*(Robert put dots of pen on his face.)*

**Emma:** You've got chicken pox. My mum's going to have chicken pox. *(Drawing Mum.)*

**Robert:** I'll tell my Mum and Dad I've got chicken pox. Who likes brown the best?

**Emma:** Not me. I like pink and red the best.

**Robert:** I've got an alien bedroom.

**Kathy:** You haven't.

**Robert:** This is Henry *[his twin]* with chicken pox.

**Emma:** My Mum's going to have brown chicken pox.

**Robert:** Who wants brown? Who wants brown?

**Emma:** I'm going to do `Ip, dip, doo'.

It is clear from this short excerpt that the children are thinking interactively as they draw. The serendipity of Kathy's desire to draw a square sparks Emma's memory of the Iron Man; Alex's anecdote of football training begins the whole cycle of chicken pox spots; What made Robert think of his bedroom? Despite Kathy's put down, the thought of home and the image of their shared room sparked the idea of drawing his twin brother Henry with chicken pox. Emma wants to add his dip rhyme which began the excerpt as a caption to her picture.

The phrase which I gleaned from Sue's study was "place-holding" (Hammond 1997). As shown by Ex.10 (Section 3.2.7), at the emergent writing stage, young children, use pictures and single letters, occasionally odd words, but often just marks and squiggles to place-hold their ideas so that they can record and later recount the ideas which were flowing in their heads at the time. This caused me to wonder: Why could that facility not be harnessed for understanding designing? Surely sketching and recording design ideas is a form of place-holding? Could not this intuitive understanding of place-marking of developing ideas function as a spring-board for understanding how to use drawing to develop a design for making a product to fit a specific purpose?

## 1.2.3 What do I mean by "Drawing as a Tool for Thought"?

All of the above examples illustrate the way in which drawing is used to support thinking and communicating thought. The range of contexts, ages and intentions of those who drew these examples were varied. The common thread is the need to record visually and graphically that which could not be considered, manipulated or communicated by words alone.

I presented the phrase "drawing as a tool for thought," as the thesis title at the very beginning of my exploration of children's use of drawing to support designing. However, it was over a year before I felt I knew for myself what I meant by that phrase. I needed to read and to observe young children in action.

Drawing occupies a middle ground between the imagination and the real world. Even drawings of minimal clarity can be discussed and explored as if they were real, as they extend and make visible the inner thought processes of their creator. By objectifying these inner thoughts and images, the drawing enables these to be observed by the thinker. The imagination becomes visible and takes form. Changing and developing ideas now have something tangible on which to work, allowing review and reflection, return another day, with other ideas both new and old, which can be incorporated with the ideas recorded.

I perceive there to be a distinction between drawing as *product of* thought and drawing as *tool for* thought. The first describes an artefact, the second a process. The first brings closure to the activity on the completion of the act of drawing, the second describes a way of recording thoughts in action. They frequently occur together, especially in the action of designing. Several completed drawings may form a chain of products which together map out the path that thought has taken. It is not an "either / or" dichotomy, rather a "together / and" interaction, which supports thinking in process and, through the creation of visible products, enhances reflection and evaluation of thoughts and ideas.

It is this process to which I attach the phrase "drawing as a tool for thought". It was the development of this facility amongst young children that I set out to study, document and, once I felt I sufficiently understood it to explain it to them, to enhance capability.

# SECTION 2: Research Methodology

# 2.1 Introduction to Section 2

Morgan (1983) provides a "framework for analysing the logics of different research strategies" under the following three heads:

- Constitutive Assumptions (Paradigms)
- Epistemological Stance (Metaphors) and
- Favoured Methodology (Puzzle-solving)

I have adapted Morgan's headings to frame this section of the thesis:

***Research Paradigms (Section2.2)***

This section looks at the way in which researchers engage with their research and its subjects. It does not provide a conventional overview of research paradigms, but rather discusses issues which are common to all research endeavours and discusses how researchers within different communities of practice have sought to deal with them. The concluding section (Section 2.2.6) indicates how these considerations relate to my research by addressing the question "Where do I fit?"

***Epistemological Metaphors (Section2.3)***

Claims to knowledge through research lay open to question unless certain safeguards are applied. This section of the thesis briefly discusses some of the major issues: ontology and epistemology (Section 2.3.1), validation of research findings (Section 2.3.2), credibility (Section 2.3.3) transferability to other populations (Section 2.3.4) and ethical issues (Section 2.3.5) The final sub-section (Section 2.3.6) discusses how these issues relate specifically to my situation: conducting research in the school in which I was also a teacher.

***Choosing a Methodology(Section2.4)***

As a researcher of designing, I could see parallels between the two processes and was pleased to find that this had also been observed by others. This section explains how I have applied my reflections on designing to my research processes and provides a resolution of the dilemmas posed in Sections 2.2.6 & 2.3.6

***Research Organisation (Section 2.5)***

My research process fell into two distinct phases, one exploratory and one more structured, as indicated in Section 1.1.1. This, together with the way in which the data have been collected and handled, led to the decision that the way in which the thesis would be written would reflect these two phases of my research process.

Section 2.6 concludes Section 2 with Reflections on the issues raised throughout Section 2.

# 2.2 Research Paradigms

The chapter from which my framework for Section 2 of the thesis is taken (Morgan, 1983) has as its sub-heading "Modes of Engagement." I have chosen this as the title of Section 2.2.1, which attempts to dis-engage from the dichotomous presentation of research paradigms that many "how to do research" textbooks for novice researchers frequently present. Since making observations is the primary activity of researchers in the field, this seemed to be the next topic to discuss (Section 2.2.2). Multiple perspectives are frequently advocated to help eliminate a one-sided view of events and this issue is discussed in Section 2.2.3. Amongst competing and frequently conflicting philosophies and methodologies the question of what counts as data is often not far below the surface. Section 2.2.4 discusses some of these issues. All this must be placed in context for educational research and so the penultimate sub-section of this part of the thesis (Section 2.2.5) looks at the purpose of educational research. The Applications (Section 2.2.6) draw these discussions together into a brief indication of my personal position.

## 2.2.1 Modes of Engagement

The multiple *modes of engagement* in educational research range from the collation of nation-wide statistics of exam results and league tables to detailed descriptive/analytical studies of one child's development in a single area of learning. Each of these is underpinned by beliefs about the *values* of research, about what counts as data, about the role of the researcher, about how the research should be presented or disseminated. These are congruent with the pragmatics of what is available at the time, both in terms of the researcher's own knowledge and expertise and in terms of the opportunities which present themselves or are able to be sought. There were times when, contrary to the order in which textbooks are written, I felt like "researcher in search of a paradigm" and that "where I fit" was a conclusion I came to as part of the process of researching.

Paradigms of research in the social sciences are often classified as simple either-ors:

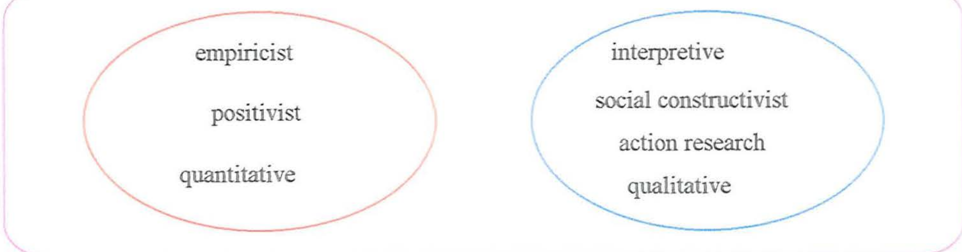


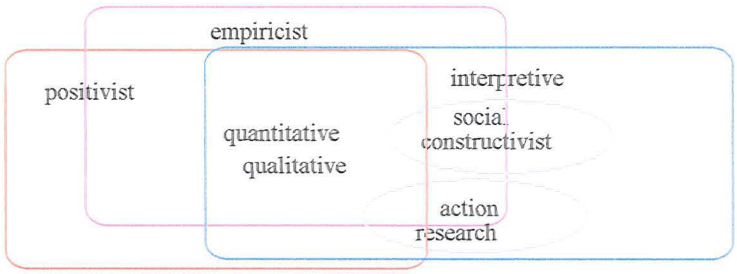

*Fig.15: Research Paradigms (a)*

The "how to do research" textbooks usually deal with either quantitative or qualitative methodologies. Quantitative methodology books typically write as if the other camp does not exist; qualitative methodology books imply that they have the higher moral ground because they are not using numbers to analyse or report results.

From the experience of being a psychologist by day and an avid reader of literature by night, Bruner (1962) asserted that there exists two ways of knowing, which he calls the *narrative* and the *paradigmatic* (the positivist viewpoint), which he perceived as incompatible because the positivist seeks validity through the pursuit of abstract truth (of mathematics, logic and science), whereas the narrative mode is validated through its truth-likeness and the ability to perceive universals through parallels. This difference, claims Bruner, precludes corroboration of the one by the other.

The reality of research is that the boundaries are much more blurred :

*Fig.16: Research Paradigms (b)*




## 2.2.2 Making Observations

All science, whether physics or social science, is based on observation. The basic tenet of empiricism is that only observations made by the senses counts as research data; ideas, viewpoints, intuition and other internal states do not. Thus scientists attempted to gain a "pure" view of external reality. However, by Heisenberg's (1958) uncertainty principle, observation is affected by the presence of its observer and failure to realise this has led social science researchers of all persuasions into difficulties.

The positivist tradition within the social sciences has its roots in the desire to be seen as scientific. Its consequent methodology entails the collection of data against which a hypothesis is tested, with statistical techniques often applied to test the validity of the hypothesis. The experiment and its environment is set up and controlled by the researcher and rigorous measures are undertaken to exclude unwanted influences.

The dangers of attempting to ignore the differences between the context of the experimental laboratory situation and everyday life are inherent in the construction of problems "off-stage" (Lave 1988). Because the "construction process" is hidden from the experimental subjects, they are then deemed to have "failed" if they do not produce the intended response:

> "This absence of a normatively defined response as failure is so central a hallmark of experimental (and school) practice that it may be surprising to note that there are substantive alternatives in most other social situations"
>
> (op cit.: 36)

Thus the positivist paradigm is often rejected by teachers undertaking research, for example:

> "The motivation for engaging in research of this kind is a search for answers: it is not reliant on preconceived notions, but a pragmatic response to an issue of concern or interest which will result in praxis. It is imperative that the researcher is responsive to the patterns and surprises that emerge from the intensive examination of seemingly familiar events."
>
> Hammond (1999: 23)

The interpretive tradition, as a reaction to laboratory-based work, had its roots in anthropology and ethnography, aiming to observe and report on a natural human situation, frequently using descriptive analysis rather than numerical data. Researchers went out of the laboratory to become "participant observers", mixing with the people being observed as an honorary participant. The researcher did not originate from and was not part of the culture being described, which, they assumed, gave them an objective and, hence, scientific perspective. That they, as "trained observers", should be able to interpret their observations in an appropriate manner, even if this conflicted with the interpretations of the observed, raises issues of privilege, status and power.

Gitlin, Seigel & Boru in "The Politics of Method" (1989) observed that researchers from the interpretive traditions were just as likely as the constructor of the laboratory experiment to write themselves out of the script, frequently using their privileged position to say what things mean, since understandings of the situation expressed by subjects to the researcher are treated as data on which the researcher acts as arbiter. In their discussion of Apple & King's (1979) studies of Reception classrooms, they comment that the reader is expected to take the researchers' interpretations as givens. Despite studying the social constructs of the children and teachers, they do not consider their own. Apple and King are not alone, say Gitlin, Seigel & Boru, of being guilty of:

> "a naive realism by editing themselves out of their text. they assume that non-reflexive, spectator-like research is possible and even essential to the writing of thick descriptions. In a sense these researchers use the language of traditional positivist research."
>
> (Gitlin, Seigel & Boru, 1989:.203)

For example, one of the contributors to Ely et al. (1997) found herself in immediate problems when she, as a college administrator tried to be unobtrusive in a professor's seminar (pp.26-8) and concluded that to be a participant observer in one's own workplace was just "too close to home". Another of Ely et al.'s contributors commented on the role conflict:

> "To observe is an unintrusive role. All my training has been geared to an active, participatory role." (op cit.: 47)

If "participant observation" implies "fly-on-the-wall" (and many interpretive studies adopt that stance), then the researcher is essentially a "non-participant observer", whereas teachers conducting research in their own classrooms are almost certainly acting as full participants. Most teacher research, including my own, is not of unobtrusive observing but of observing whilst participating, frequently as the power figure in the situation. In its original connotation (in contrasting field methodologies with laboratory methodologies) the term "participant observer" had meaning, but early researchers of all persuasions did not anticipate their subjects turning into researchers and researching themselves and their own setting, nor of seeking to change it as a result of their own findings. This led to the evolution of "action research" (practitioners researching action in which they are involved) and has important implications for issues of validity and reliability (Section 2.3)

### 2.2.3 Multiple Perspectives

Using different methodologies to examine a phenomenon is generally agreed to be a good thing. Trochim (2002), for example, expresses a commonly held view that multiple methods or viewpoints are essential to claims to validity. Triangulation is advocated as the way to reduce the risk of distortions inherent in the use of a single method.

However, there is little agreement between researchers of different traditions as to the nature of validity, let alone whether different methods either corroborate or contradict each other. Thus "methodological triangulation" (Denzin & Lincoln, 2002), defined as "a complex process of playing each method off against the other so as to maximise the validity of field efforts" (p.304), leading to a reduction of "threats to internal and external validity" (p.308), becomes reduced to a mix-and-match of qualitative data collection techniques.

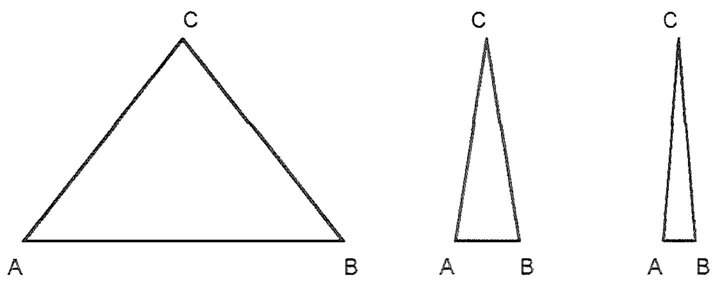
Brewer & Hunter ("Multimethod Research" 1989) begin their first chapter:

> "diversity of methods implies rich opportunities for cross-validating and cross-fertilising research procedures, findings and theories..... we must develop more cosmopolitan research strategies."
>
> (p.13)

Qualitative perspectives and methodologies, however, get no mention and form no part of this proposed cosmopolity. Thus Brewer & Hunter (1989) can discuss differing research methods as differences in *style* (p.11) and warn that in multimethod research one must ensure that mutual biases are not being re-inforced, without considering that any mix-and-match of methods from within one tradition will automatically re-inforce the biases of that tradition, unless those biases are made explicit and presented as part of the research setting.

Methodologically, there are two ways of viewing triangulation: as a process of cumulative validation or as a means of producing a more complete picture of a phenomena. Campbell & Stanley (1963) borrowed the triangulation metaphor from surveying. As can be seen by examining three different triangles (below), the closer A and B are to each other, the harder it is to determine the exact position of point C.

*Fig.17 : Triangulation (a)*




Denzin (2002) was only partly successful addressing some of the issues (practical as well as theoretical) inherent in the triangular metaphor, mainly because he looked only within the quantitative tradition for its application. From a theoretical perspective, it would seem almost incumbent upon every researcher whose aim is the production of a complete picture of a social situation to use as wide-ranging techniques as possible.

The ability of the two dominant traditions (qualitative and quantitative) to talk to one another certainly seems limited and attempts to create dialogue flounder (claim Fielding & Schreier, 2001) on the quantitative researchers' lack of understanding of qualitative methodologies and perspectives. However, from my reading of texts from both sides, the lack of understanding (and respect) appears mutual.

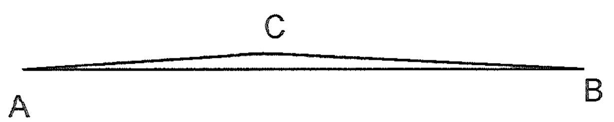
However, it seemed to me that in the social research context, both ways of knowing could be desirable and mutually supporting. Among the things that qualitative data can contribute to quantitative research are depth, an idea of the range of core concepts, and the ability to solve puzzles that quantitative data cannot address (Sieber, 1979). This can provide context, interpretation and reasons behind the trends which quantified data can identify and, perhaps, possible solutions or ways forward from dilemmas thus identified as significant. Quantitative data can, in turn, enhance qualitative studies through giving a breadth of view, counteracting the tendency to focus on the easily accessible, to pursue topics of personal interest or bias which could threaten the validity of the analysis, through salience, ease of recall and previous cognitive schemas (Taylor, 1982).

Cross-paradigm approaches are, however, fraught with difficulty. Creswell (1994) points out the purely practical point of researcher time and energy expended in immersion in each in order to do both. The idea that research results produced across different paradigms can be used for mutual validation assumes the existence of a common epistemological framework (Fielding & Fielding, 1986), who argue that, although such combinations of methods may add breadth or depth to the analysis, the results may be no more valid. They emphasise instead the potential complementarity of qualitative and quantitative research methods, as does Flick (1998):

> "Triangulation is less a strategy for validating results and procedures than an alternative to validation (...) which increases scope, depth and consistency in methodological proceedings." (p.230)

Extending the triangulation metaphor, devised by researchers within the quantitative tradition as a way of espousing multimethod research, to also include qualitative methodologies, may in fact make determining point C on the triangle just as difficult through distance of points A and B from each other:

*Fig.18 : Triangulation (b)*




By focusing on how the two methods might be complementary, such aspirations ignore the issue that far from being complementary, underlying ideologies, and hence research methods, may actually be contradictory. The debate over the relationship between philosophy and methodology lies at the heart of the question of what counts as data (the subject of Section 2.2.4, below).

In the Exploratory Phase of the research, I was trying out a range of ideas, whilst also trying to maintain a consistency of approach so that results could be directly compared. I discovered that these two aspirations were not mutually compatible within the limitations of time and opportunity available to me. The drawings from whole school studies (Section 3.3.2) were subjected to quantified analysis, and my understanding of the range of techniques that children were likely to use at certain ages and in response to certain activities developed as a result of this work. The deeper understanding of reasons behind children's choices came through the evaluation of a wide range of activities undertaken by a large number of children across several years of their school life, supported by reading of the literature on children's drawing development and cognitive growth.

In the Structured Phase, the issues of validity and reliability were more focused on maintaining consistency in Assessment Task presentations and marking, whilst using a multi-method approach to evaluation (Section 4.2.3).

## 2.2.4 What Counts as Data?

Data are observed phenomena, which become informative when infused with meaning, through being interpreted by an observer who endows them with significance. The significance which is attached to the observation, and hence to the data, is coloured by the observer's previous experience, training, beliefs and world-view. Frames of reference hold the lens through which observations are made, recorded and classified.

Quantitative studies reduce all data to numbers. Qualitative research, essentially, tries not to, but the problems of having the research accepted by the wider research community as valid and reliable, leads many qualitative studies to have quantitative elements bolted on, for fear of attracting such criticism as that articulated by Hammersley & Atkinson (1983), that when such analyses are challenged, researchers claim the unassailable "ethnographic authority" based on "they were there" and having the esoteric expert's view on the meaning of the data. This fails to gain support amongst the quantitative community's concerns for establishing systematic, externally-validated analytical procedures.

Equally disparaging of the opposing camp's ideology and methods, Cupchik (2001), from within in the social constructivist tradition, typifies empirical research as:

> "analytical in orientation and, while it acknowledges the facticity of social phenomena, it fractionates them and reduces them to simpler and more or less analogous models. .....With an emphasis on productivity to ensure advancement within the field, the experimental paradigm can become *functionally autonomous*, floating free of its original mooring in ecologically meaningful processes. Reference to the original phenomenon that first attracted the community of researchers may be lost."
>
> http://www.qualitative-research.net/fqs-texte/1-01/1-01cupchik-e.htm
> accessed March 2002

At the heart of the issue, it seems, but rarely stated by either side of the debate, is the distinction between data and information and the point of entry (or exit) of meaning. Information is meaningful; data becomes meaningful by employment. Information can be disputed; data is brought on as evidence to buttress or demolish. Problems emerge in this dialogue when each party's frame of reference does not allow the admission of the other's evidence by inability or unwillingness to grant it the status of data.

This has more often been a problem for qualitative researchers attempting to gain recognition for their chosen methodology than for those engaged in quantitative research. The previously established traditions within science militated against qualitative researchers' desire for recognition whilst unable or unwilling to assert their methodology as scientific. Thus the criteria which positivist researchers use to evaluate their own research strategies (reliability, repeatability) continue to be applied to other forms of research, without regard to the relevance to either the underlying ideology or the research setting.

## 2.2.5 The Purpose of Conducting Educational Research

As an advocate of action research, McNiff (1988) is wary of the direct application of either empirical and interpretive research traditions to educational research:

> "It is not part of their methodological design to ask such practical, problem-based questions and .... it is not part of their conceptual repertoire to answer them. They can make predictions and give descriptions of the phenomena of social settings. They cannot give ... explanations for the events within those settings."
>
> (McNiff,1988: 18)

Her objections rest on the purpose of the research, that neither empirical nor interpretive researchers aim to make direct changes in the lives of their research subjects, whereas in most research in education, the burning question is frequently, what changes can be made here to improve children's learning?

Stenhouse's (1975) work was highly influential in advocating action research. However, his view of curriculum research was that of pedagogical development, of improving the teacher's practice. Elliott (1991), who was part of the Humanities Curriculum Project discussed by Stenhouse, voiced several objections to the latter's analysis of the project. One of these objections was the focus of Stenhouse's team on the quality of the teaching rather than on the quality of the curriculum materials which the HCP team was developing. This is hardly surprising given Stenhouse's own definition of curriculum as

> "a particular form of specification about the practice of teaching and not as a package of materials or a syllabus of ground to be covered."
>
> (Stenhouse, 1975: 142)

In educational research, there is no clear-cut division between research and development (Roberts, 2001). The action researcher expects their research to be useful, initially to themselves, and then, perhaps, also to others, in informing future professional practice:

> "Educational action research is a form of educational research which places control over processes of educational reform in the hands of those involved in the action."
>
> Kemmis (1988) in Hammersley (ed.), 1991: 189

In the three years between the publication of Kemmis' paper in Keeves (ed.) (1988) and its inclusion in Hammersley's selection for the Open University's Course Reader (1991) lay the Educational Reform Act and the National Curriculum. As Hammersley pessimistically comments in the closing paper of this book:

> "..the influence of research on the local and national policies that shape schools is extremely limited. If this were not so, the educational reforms of the late 1980s would not have occurred, since they involve assumptions that run counter to the results of most research over the previous thirty years." (p.220)

Over ten years later, the weakness of the links between practitioners and researchers is commented on by Foray & Hargreaves (2003) but these authors ignore the effects of a government-issued curriculum through which innovation is severely curtailed (the National Literacy and Numeracy Strategies being its most extreme manifestations). It is against this background that teachers (including myself) attempt to question, research and initiate changes.

### 2.2.6 Application : Where do I fit?

The issues discussed here in Section 2.2 are those of concern to all researchers and which relate to their ideology rather than to specific methodologies. Inevitably the two are inter-related and, coupled with the complexity of the mixture of ideologies, it is often easier to typify researchers by the strategies they use than by the ideology they adhere to, and which is so frequently unstated.

I found that I did not know where I fitted.

Both the empiricist and interpretative traditions assume that the researcher is an outsider. As teacher I am the power figure. Initially, action research did not fit me either, because improving my classroom performance was not my focus. I wanted to know if young children could access drawing as a modelling tool for Design and Technology. I then wanted to know what was behind the ability to do so and whether that shed any light on the age at which a child could be expected to use drawing to support designing.

Having a two-phase research project meant, I came to realise, that I had a paradigm shift mid-way through the research. At that axis point, I wrote:

> "What excites me is finding out what is going on inside these little heads and whether they are able to grasp these big ideas about planning and modelling and taking ideas on a journey across the design sheet. I am on a journey of discovery, not about me and my professional performance, but about the children and their developing understanding of designing. I would, therefore, describe myself as a participant researcher: a participator who is also researching, a researcher who participates in the research scenario."

Now at the completion of the thesis, I would say that is only half of the story. From researching what existed, I moved into researching how I could enhance children's capability. Improving my teaching, although not an aim of the research, was an inevitable result of knowing more about children's learning. My purposes became those of the action researcher, whilst my methodological preference remained for mathematical modelling rather than descriptive analysis.

Methodological design and its associated conceptual repertoire determine the questions which can be addressed (McNiff, 1988). So as I took ideas and methods from different traditions, I needed to be careful that they would contribute appropriately to answering the questions I wanted to answer. My awareness of the link between ideology and methodology grew across the duration of the Exploratory Phase, together with a realisation of the need to formalise moderation procedures in order to ensure validity and reliability in the Structured Phase. The evolving nature of the validation process, from a series of observations about children's drawings with which the Exploratory Phase began, to an multi-method analysis tool for making comparative statements about children's understanding of design drawing based on their work in Assessment Tasks conducted over a period of fifteen months, required not just planning, delivery, assessing and moderating, but also reflection on my place in the ideological spectrum.

The paper that I presented at IDATER 2001 (from which comes the above quotation) was entitled "Participant Research from the Point of View of a Participant Researcher" (Hope, 2001). I took the term from Phil Roberts' Keynote address at IDATER 2000 in which he advocated the necessity for research to be carried out by educational participant researchers rather than by observers.

If I am to answer the question *"Where do I fit?"* then I have to use Phil Robert's term "Participant Researcher". I am a participant in this research, the power-figure in the classroom, the designer of the Programme. I am not one of Ely et al.'s (1997) non-participating participants, although once the children are working I become the taker of field notes, operator of the video and the interviewer. I am not an empiricist because I believe that the interviewer / researcher affects the data by the constructs implicit in the hypothesis, the choices about what to observe and record, as well in the subsequent methodology employed in data handling, yet I used quantitative analysis in both phases of the research. I did not begin as an action researcher because I was not researching my own actions but the actions of the children and the nature of their learning. I am still not sure that the Structured Phase does not have more in common with empiricism than with action research paradigms.

So, with so much uncertainty about where I might fit, I accept the "Participant Researcher" title quite gladly. It allows me to be a full participant in the educational situation and does not tie me to any particular stance or tradition, with the embracing of favoured methodologies or the eschewing of others. It allows me to be myself: a teacher conducting research into children's learning.

## 2.3 Epistemological Metaphors

The way in which words are used is determined by our beliefs about their meaning. Part of the problem of initiating debate across paradigms, or of seeking combine insights from differing paradigms, is in unpicking the meaning of words, especially those words used in common to mean different things. Heated debates rumble around what a concept *is* rather than exploring *what the word means* in the contexts in which it is being used.

I have attempted, therefore, to stand back from these debates and have sought for words to use for headings which express the essence of the debate, rather than terms which particular traditions use to validate their own work and to judge others.

### 2.3.1 Ontology and Epistemology

Eisner (1993) bases his analysis of the issues surrounding the problem of objectivity on the distinction made by Newell (1986) between ontological and procedural objectivity, that philosophical debate about the essence of being and the nature of reality is different from the debate about methods employed in order to make credible observations about that reality.

> "Objectivity is one of the most cherished ideals of the educational research community. In fact, it is so important that if our work is accused of being subjective, its status as a source of knowledge sinks slowly into the horizon like a setting sun.....To use the vernacular we want to see and tell it like it is."
>
> (Eisner,1993: 49)

What we believe about what we can know will inevitably colour what we attempt to discover. Our beliefs about valid means for doing so will drive the search for strategies to find out what we want to know. For example, an awareness of the way the presence of a researcher can alter the social balance, coupled to a dis-belief in the validity of statistical models, will sway a researcher towards a qualitative methodology. Whereas a belief in mathematical models as good analogies for representing knowledge, plus a belief that random sampling by impersonal questionnaires would eliminate reactions to the researcher, would probably result in qualitative methods being chosen.

Eisner (1993) paraphrases Kant as saying :

> "Percepts without frameworks are empty, and frameworks without percepts are blind.... It is in the transaction between objective conditions and personal frames of reference that we *make* sense."
>
> (op. cit.: 53)

and calls for a recognition of the constructed nature of knowledge based on the questions we ask and the frameworks which we apply, judged for validity by the application of reason and experience.

Jung's (1966) idea that humans meet themselves in the symbolic constructions that they create to negotiate the social world, is parallel to Nietzche's (1968) view that human treat the "frozen" words that they create as if they were the realities to which they relate, to Wittgenstein's (1969) "language games" and "seeing as" and also to Heisenberg's (1959) idea that the scientist confronts only themselves, not reality, since it is how one has engaged with the world that is being investigated. The photon in the box exists alone only in Einstein's thought experiment. In reality, if measured, it would not be alone. If these things are important for theoretical physicists to realise, then it is even more important for those who research the behaviour of people.

On the basis of multiple ontologies, Morgan (1983) speaks of "knowledges" (p.389) in his chapter entitled "Knowledge, Uncertainty and Choice." Uncertainty about what *is* has major implications for what we can claim to *know*. However, he does not view this as a problem, so much as an opportunity for celebrating multiple viewpoints on social reality: "uncertainty ultimately involves choice":

> "in choosing a research strategy the scientist in large measure determines how the phenomenon being studied will be revealed, and indirectly, the consequences of the knowledge thus generated."
>
> (Morgan, 1983: 391)

For the researcher, however, this is not just a matter of personal choice in order to come to a rounded viewpoint and deeper knowledge of a social situation. For research to be authenticated by others, issues of validity and reliability must be convincingly addressed. If claims to knowledge are to be made, especially if recommendations about the actions of others are based upon it, then the basis of that claim to knowledge needs to be firmly established. What begins as a personal quest for knowledge metamorphoses into a statement of personal belief based on observations or experimentation and then the researcher "goes public" and the questions come in: How do you know? Can you prove it? How valid, reliable, generalizable are the results?

Knowing for oneself and believing in the honesty of one's own endeavours is only the first stage in a claim to knowledge. Throughout the research process, I attempted, to the best of my ability, to put in safeguards against bias and halo effects. However, in the Exploratory Phase, when I was mapping the field and trying to discover what children could do, I swiftly came to the conclusion that for the sake of consistency and comparability between classes and ages of children, I needed to present and supervise the activity. Other teachers' interpretations of the activity and the level of help given to children would only add an unwanted variable to the data. In order to place this work in context and be able to claim a measure of objectivity in what I was doing, I needed to collect sets of children's drawings from a range of other activities conducted by colleagues.

Discussions of objectivity seem often to assume that the observer stands outside the situation, apart from the observed, in order to make evaluative judgements about them. Its inverse, subjectivity, is pejorative in the empirical tradition and qualitative researchers try hard to establish that their research cannot have this accusation made against it. Hence, Ely et al.'s (1997) advice on the difficulties inherent in researching in one's own place of work. For the teacher, this is inevitable. McNiff (1988) contrasts the professional researcher coming from the outside to observe and report on what they see and the teacher in the classroom whose heuristic knowledge and professionalism is inevitably part of the data set.

Claims to knowledge are not predicated on observations of the senses alone, as empiricists traditionally claimed. The knowledge that one brings to the situation is the driver behind the choice of what to observe as well as the interpretation that it is put upon it. For the professional researching their professional concerns, the richness of their professional knowledge and expertise cannot be discounted and the judgements that they make within that context cannot, I would contend, be pejoratively dismissed as subjective.

Such issues have impact on claims to validity and reliability of research methodology and findings.

## 2.3.2 Validation

> "How validity is defined and treated varies according to what researchers do, what tasks they are undertaking, and in what phase or stage of the research they are in...Consequently, although we urge scholars to discover and formulate what their research philosophy is, we believe that it is only one factor contributing to how validity is defined"
>
> (LeCompte and Preissle, 1993: 325-6)

As Polanyi (1958) observed, knowledge communities establish for themselves a language and methodology for establishing truth, by which claims to truth by other communities are measured, judged and, with unfortunate frequency, dismissed. This hinders communication between communities of practice, diminishes mutual respect and limits opportunities for dialogue. The way in which educational researchers from different practice communities classify and codify observations on phenomena and, hence, the way in which validity and reliability issues are viewed, is coloured by the paradigm in which they work.

Researchers from within the empirical tradition typically seek quantifiable data from which relationships can be calculated. Validity and reliability are closely linked to replicability and predictability. Texts on conducting quantitative research deal with topics of internal, external and construct validity, prior to discussing random sampling, questionnaire design and (numerical) data analysis.

For example, Judd et al (1991) give the following definitions of reliability and validity:

> "The *reliability* of a measure is defined as the extent to which it is free from random error components. In turn, *validity* is the extent to which a measure reflects only the desired construct without contamination from other systematically varying constructs. Note that validity requires reliability as a prerequisite."
>
> (p.51)

Large random populations are the most desirable source of such data, since Tversky and Kahneman's (1982) "law of small numbers" demonstrates the problems inherent in small-scale studies, in that the smaller the sample, the more likely it is to deviate from the norms of the whole population (in the same way that tossing a coin ten times is far less likely to produce 50% heads than tossing the same coin 100 times). Thus extrapolation from any small-scale study to the whole population it represents, based on mathematical modelling, is methodologically suspect.

That "other systematically varying constructs" can be isolated from the system being researched and their variance within that system plotted and their effects calculated and accounted for, seems a tall order for investigations within classrooms. The "contamination" might be the richness, the interesting corollaries, the reasons for action by actors within the social construct. The basis on which such constructs are dismissed as contaminating are, frequently, not mathematically determined but decided by the researcher's personal goals, interests and frames of reference. Unless these are declared and made clear as pertinent "systematically varying constructs," the data lacks validity by Judd et al.'s (1991) definition.

However, the belief that validity and reliability are as defined by Judd et al. (1991) is itself a "systematically varying construct."

The qualitative approach views itself as holistic, searching for patterns within the phenomenon as a whole system, producing descriptive analyses of complex relational structures in order to strengthen understanding of both the complexities and of the underlying structures. Texts on how to conduct interviews, collect field notes and make observations (for example, Ely et al., 1997) discuss the development of the researcher's own skills in social analysis and awareness.

Respect for each others view of what counts as validity seems hard to find, although interpretive researchers are more likely to have a working knowledge of some aspect of quantitative method (and use it in their research) than the other way around. Many studies begin with descriptive methods then lead into quantification of observations, perhaps because of a wavering of faith in the validity of qualitative research unsupported by quantified data. LeCompte and Preissle (1993) caution that moving from qualitative to quantitative processes without making explicit the inherent changes in ideology, prompts a single consolidated definition of validity, in which the quantitative paradigm becomes the arbiter of validity, and hence, of truth. I wanted to be able to use methodologies from both qualitative to quantitative paradigms without such implications.

During the Exploratory Phase of my research, databases were constructed to analyse the children's drawings, which proved to be a useful means of maintaining records of children's developing design capability. The database fields emerged in process of analysis of the drawings and were changed and added to over time in response to analysing more drawings. This is documented in Section 3.3.2. At the same time, I was making more detailed qualitative observations of children, such as those documented in Section 3.2.4b. This trend continued into the Structured Phase, in which both qualitative and quantitative methodologies were employed in order to give as full an account as possible of the development of the children's developing capability across the duration of the Programme. Section 5 reports the results of this dual method analysis.

At the start of the Exploratory Phase (see Section 3.3), I had a measure of awareness of the issues surrounding validity, especially in relation to the need to document the circumstances in which different ideas were tried. In the whole school studies, I attempted to keep the format of the lessons the same each time, and devised a script for task presentation so that each class received exactly the same introduction and instructions. I needed to make decisions over levels of assistance I would give to children who did not understand what to do. However, since I was essentially mapping the field, variations abounded. This was, however, an important part of the research process and, I believe, appropriate to my aims at that stage.

The Structured Phase, however, required a much tighter framework and for extraneous variables to be eliminated as far as possible. To make each Assessment Task comparable, for example, it was decided that the basic material of construction should be paper or thin card that could be easily cut and joined by all children. A small team of moderators was recruited to blind-mark a selection of children's work from each Assessment Task to ensure that the quantified data accurately represented the children's achievements. We met regularly throughout the Structured Phase to discuss both the children's work and the development of the analysis instrument (Section 4.2.3).

Section 4.2.4 details the data that was collected in the Structured Phase, as well as the way in which the qualitative and quantitative data were to be related. Although for clarity, Section 5 reports the qualitative and quantitative analyses separately, the report of the quantified analysis (Sections 5.5 - 5.9) is strongly related to the qualitative observations of children at work.

## 2.3.3 Credibility

The acceptance, either of concepts of validity and reliability as defined by quantitative research or of the definition of social reality created by the qualitative observer, could imply an acceptance of an ideology which hides the beliefs and viewpoint of the researcher behind the shield of expertise. Although a research project based on systematic data collection can appear to have more credence than one that is not, it does not necessarily follow that, because it is methodologically reliable, the results sufficiently meet the criteria of credibility. In order for research results to be credible, therefore, multiple perspectives are vital.

LeCompte and Preissle (1993) voice concerns for the researcher's audience and how the audience can be assured of the validity of results. They assert that researchers should enhance confidence in their results through: collaborative participation with the research subjects, congruency between theory and observation, inter-method and inter-observer checks, and personal reflection and introspection, to reduce the possibility that bias will affect the credibility of the research. Thus researchers must be "up front" about their own ideology, position in regard to the subjects and situation and their involvement and influence upon the data collection process. Each of the concluding sub-sections within Section 2 (Sections 2.2.6, 2.3.6, 2.4.3 & 2.5.3) provide an overview of where I stand with regard to the research that I have conducted. Sections 2.2.6 and 2.3.6 discuss the issues involved in being both researcher and teacher within the school.

The story of my research is related to the story of my developing understanding of Design and Technology education and my own capability in subject delivery. Whilst trying things in classrooms in the Exploratory Phase, I was finding out what worked in terms of delivering Design and Technology as well as what worked for research. This teaching journey was in partnership with colleagues from my own school and, through termly "Bridging Meetings", in tandem with colleagues from other local schools.

I was concerned that the constructs that were created from this exploratory work were reliable and were resultant from real Design and Technology lessons. The range of Design and Technology activities that contributed to the understandings that emerged during the Exploratory Phase are detailed in Section 3.3. Not all of these were from lessons that I taught, although they were all from within my own school. One of my first "Flat Stan" lessons was formally observed by the Deputy Headteacher as part of Quality Assurance.

I was fortunate in having colleagues who were themselves interested or involved in research, with whom I could discuss ideas and issues as they arose. But colleagues who did not see themselves as developing a research interest, were, nevertheless, interested in hearing about mine and contributing opinions and perspectives as well as becoming directly involved in trialling ideas. At the same time, I tried hard not to give the impression that I felt I was doing something of greater import than what they were doing. After all, their minds were totally focused on teaching their own class, whereas I was frequently elsewhere with other groups of children or inviting them to join my class and taking endless photographs of what they were making.

During the Exploratory Phase, I was given several class-sets of drawings from lessons that colleagues had devised and delivered. I was also obtained drawings made during lessons that I observed as part of my Co-ordinator role. If colleagues were especially pleased with lessons they had conducted, I would be invited to come and view the results. I organised annual Design and Technology competitions that would give me an overview of children's capability as well as encouraging children's enthusiasm for the subject.

However, not knowing the level of assistance that had been given to the children in lessons that I was not conducting myself, made direct comparison between lesson outcomes difficult. This was highlighted in a particular activity in the disparity between the performance of one Year 3 Year 3 class and that of the other two classes. It was intimated by one of the other teachers that this colleague would have helped her class rather more, so that they produced the best drawings. I arranged to teach all three classes as soon as possible and discovered that this class had the weakest understanding of the role of drawing for designing. Such experiences convinced me that the only way to ensure parity during the Structured Phase was to conduct all the lessons myself.

The Structured Phase Programme utilised many of the activities devised and conducted by myself and others during the Exploratory Phase (Section 4.3.1) in order to enhance the reliability and transferability of the research findings. For example, the Easter Assessment Task was developed from an idea by colleague on my moderation panel who worked at a neighbouring school. The Surprise Card Assessment Task was the post-input assessment task from the Enriching Literacy Through Design and Technology Project (Stables et al., 2001) and was conducted by one of the researchers from that project.

## 2.3.4 Transferability

In the light of Bruner's (1962) two ways of knowing (the narrative and the paradigmatic) and the parallels to the working methods of the interpretive and the empirical traditions, it is important to consider the ways in which both paradigms judged transferability of results and conclusions to other situations and populations. It appeared to me that the basis of the two camps claims to generalizability was largely based on their view of how Truth was to be known, and as McNiff (1988) comments, the concerns of educational researchers is not simply to document what is, however that "is" might be conceived. Educationalists conduct research with transferability in mind.

The positivist reliance on the ideals of science attempts to seek the truth of a situation through controlled environments, large numbers of randomly selected subjects yielding numerical data to be manipulated by statistical means. Applicability and transfer has largely centred on *"generalising to and across other populations"* (Schofield, 1991) and largely equated with repeatability: if a given study was conducted by someone else with equivalent subjects under the same test conditions, would the results prove to be the same. The larger the population studied, the more statistically accurate the conclusions may be claimed to be, and hence more likely "true". Thus, by Tversky and Kahneman (1982)'s "law of small numbers," in order for results to have generalizability, there is a requirement for the subject sample to be representative of a much larger population.

The interpretative tradition (which includes, by default, the action researcher with no access to laboratories and statistical method) has emphasised the narrative (Bruner's truth-likeness), relying on the observer's reflective and analytical skills to give meaning to field notes, seeking by "rich descriptions" to capture something truth-like in their observations which can be recognised as applicable to other similar social situations. Although the number of subjects in many such studies have been small, the attempt has been made to capture the essence of the situation, which illustrates the general human condition, or part of it. The microcosm speaks to the macro. In this sense, representativeness is not a statistical measure but a statement about the truth-to-life of the observations and subsequent analysis.

Although devised to answer the difficulties inherent in claiming generalizability from smaller studies using quantitative methods, Campbell's principle of Proximal Similarity ( as applied in Trochim, 2000) seems a useful concept and equally applicable to qualitative research. Campbell's basic premise is that the greater the similarity between the sample studied and the population to which conclusions are to be applied, the better the claim to transferability. For example, the conclusions of study on 5 year olds can be more readily be applied to 6 year olds than to a 15 year olds. When applied to qualitative research, the principle remains the same: truth-likeness is transferable to similar social groups; similar children in similar classrooms should react in similar ways.

Across the duration of the research, children's capabilities in Design and Technology rose throughout the school. This was evidenced by the results of conducting the same activities several years running with the same age group. For example, the Insect Kit was conducted with Year 4 children in 1997, 1998 and 2000 as well as with my Structured Phase Focus Class as Year 3s in 2001 (see Sections 3.3.1 & 4.4.7). Perhaps the higher profile that my research brought to the subject as well as direct conversations with colleagues had an enhancing effect on standards of attainment and that the things that I was discovering during the Exploratory Phase and sharing with colleagues about teaching Design and Technology and the role of drawing to support designing, were permeating across the school.

Since my research is grounded in real Design and Technology lessons, I believe that the findings of the research are directly transferable to other school settings. The "Emergent Themes " sections of the analysis of the Structured Phase (Sections 4.5.3, 5.3.2, 5.5.3, 5.6.4, 5.7.4 and 5.8.3) that then feed into Section 6.2 and 6.3, demonstrate how the findings of the research built towards the identification of key issues and recommendations that speak from both the qualitative and quantitative data. Section 6.3, in particular, discusses the way in which I believe young children's understanding and use of design drawing can be enhanced, based on the research that I have conducted.

### 2.3.5 Ethics

> ".... we must remember that we are, as researchers, stepping into others' lives - and our actions must make sense to them. In our research ethics, we must need to move beyond an egocentrism into an empathetic perspective. To this end, children and others with whom we research have a right to understand, and have some control over, our subjective research intentions, however honourable these may be."
>
> (Dadds, 2002: 13)

The discussion of the school records data in Section 4.2.2 highlights the ethical dilemma in being both teacher and researcher in the school where I worked. Although I could have pursued informal routes to obtaining more detailed data on children's performance in other subject areas and on entry to school (Baseline Assessment), I had to respect my Headteacher's concerns that information which he felt was confidential between school and parents did not enter the public domain. He was, however, consistently supportive of my research activities.

At the Structured Phase planning stage, the Headteacher and Year 2 teaching staff were given a copy of my Programme outline and rationale. All were quite happy for me to conduct the Programme of Lessons and Assessment Tasks. As all the lessons were conducted as part of the normal school day and, in the Structured Phase, constituted the Design and Technology Programme of Study for the Focus Class, informing parents of the detail of the Programme was not necessary, since I had the Headteacher's permission to conduct the lessons. If I used children's work in a published text or for display at conferences and exhibitions I gained their parents' permission to do so, especially if this involved photographs. Without exception, parents were delighted and proud when their children's work appeared in publications or was taken to conferences and exhibitions.

During the Structured Phase, however, discussing what I was doing became more difficult, especially since I was directly comparing the achievements of children who received specific teaching input to the work of those who did not. I was concerned that Miss N., the teacher of the Comparison Class, might perhaps have felt that her ability to teach Design and Technology was being compared to mine, especially when I could begin to see a clear difference between the two classes. We had worked as colleagues for some time and I had previously discussed my research with her freely. The opportunity arose to contribute some photographs to the magazine "Five to Seven" and I submitted some of the work she had done with her class, which were subsequently chosen for publication.

At the beginning of the Programme, I explained to the Focus Class children that I was using them to learn about the way that children learn to do Design and Technology. This meant that I would be taking photographs of them while they were working from time to time and occasionally use a video camera. I would be borrowing their drawings because that was the part that I was especially interested in. The Comparison Class children were also aware that when I was conducting lessons with them it was to find out about how children used drawing for designing, in order to maintain transparency with the children regarding my purposes.

I ensured that work from both classes was included in all publications and displays. I showed the children their work in print and brought back photographs of displays from exhibitions and conferences. I spoke to both classes always in terms of what "*we*" were doing which was *"so good other people want to know about it"* to encourage them to give of their best and feel part of a joint venture. At times I felt incredibly dependent on *them*. If they had not responded well or produced work which fell far short of their best, or even behaved badly whilst I was there, this could have posed problems, especially during Assessment Tasks.

## 2.3.6 Application : Myself as both Teacher and Researcher

Having worked at the school for 15 years, I was accepted and trusted by my subjects and their families and knew the children extremely well, unlike many researchers whose only knowledge of their subjects' performance relates to the tasks set to them. Disadvantages could perhaps be seen in my knowledge of my subjects. It could be argued that objectivity might be a problem if I know the children so well. Would I be looking at them and their work through rose-coloured glasses?

However, objectivity is not the same as detachment. That I know and like the children does not impede making appropriate judgements about the work that they do and the products which they create. If my relationship to them was social rather than professional, then this criticism might have validity, but by the very nature of my job my role was to constantly evaluate performance and attempt to improve it.

I tried to minimise the impact of my personal teaching style on the results so that it could not be said that this was the cause of any observable improvement in the work of the Focus Class in the Structured Phase (who received the Programme) rather than the content or method embodied in the Programme: firstly, by using activities that I had conducted previously with other classes and, secondly, by using my 1999-2000 Year 1 class as the Comparison Class, who would begin Year 2 completely saturated in my way of working.

I was not able, however, nor would I have wanted, to stifle the evolution of relationship and shared meanings with the Focus Class. Teaching them weekly for over a year, made it inevitable that a relationship developed between myself and the children. My way of presenting tasks, the vocabulary, syntax and body language I use to explain things, became part of the shared meaning which became established between us as the weeks progressed. I was aware that, as time elapsed since I taught the Comparison Class full-time, their heuristic grasp of my way of doing things was slipping away and that as each Assessment Task came and went that the Focus Class were at an advantage, and even though I purposely avoided using words such as "design journey" in my presentation of Assessment Tasks, these things were there, still understood between us, even though I did not say the words. The Comparison Class had no way of second-guessing such meanings from my words. I knew this was inevitable but I had not expected to be so aware of it experientially.

School environments are such that children are constantly expected to grasp and make sense of things through the establishment of shared meanings with their teacher. Where they do not understand fully, they create a temporary mental construct which they can manipulate until fuller understanding arrives. The scaffolding for this mental place-holding is provided by the teacher who supplies the terminology, the syntax and context for new learning. As the children begin to understand for themselves, so they become independent of the teacher's supporting role. I relied on this fluidity to develop the Focus Class' understanding of design drawing.

## 2.4 Choosing a Methodology

> "The designerly mode of enquiry is entirely appropriate to the study of education through Design and Technology."
>
> (Archer,1992 : 13)

Since my interest in researching children's design drawings began, I have been aware of the close similarity, duality almost, between design and research, creation and discovery. Both are teleological and similar processes take place en route: the form of the result of the process is not clear from the start; sources are consulted for information and ideas, which are generated, considered, played with, discussed with peers and experts, modified, rejected, and re-emerge in differing forms further down the line; the final product is a result of the interaction of all these previous processes:

> "Accumulation, parallelism. reinvestigation and the whole idea of development as multilinear, multifaceted and of unpredictable pace, speaks to a world of mental flexibility and diversity that artists and other creative practitioners of all kinds can empathetically recognise."
>
> (Paine,1992: 7)

### 2.4.1 Research and Design

Design, as well as research, has seen attempts by theorists to be seen as scientific. For example, Cross, Naught and Walker (1986), in discussing the need for the term "design science", suspected that:

> "this attraction lies not so much in the *method* of science, but in the *values* of science. These are the values ..... of rationality, neutrality and universalism."
>
> (p.20)

The close parallels between the articulations of the action research process by theorists in support of an alternative methodology and the defining of the design process has produced similar graphical representations (Bowen 1998), as shown overleaf in Figs. 19-23 : Models of Researching and Designing.

For example (Fig. 19), Lenin's four-stage research spiral (from McNiff, 1988) :

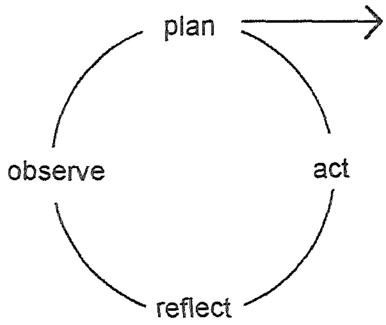



*Fig.19: Models of Researching & Designing (a)*

closely resembles design process theory, for example (Fig. 20), Kimbell (1986):

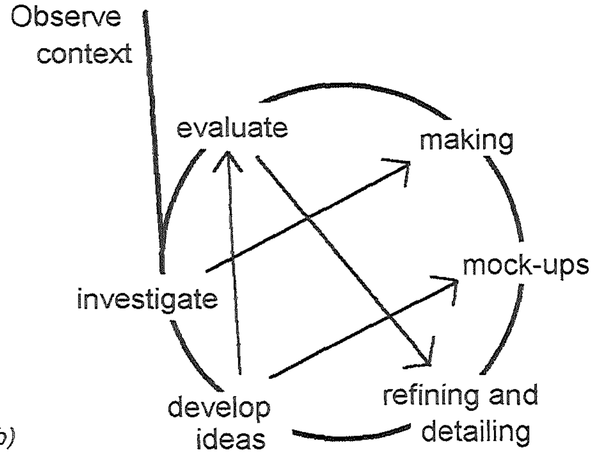



*Fig.20 : Models of Researching & Designing (b)*

and the model shown in Fig.21 developed by Kimbell et al. (1991) to attempt to capture the interaction between internal and external aspects of designing also can be seen as having parallels to research activity :

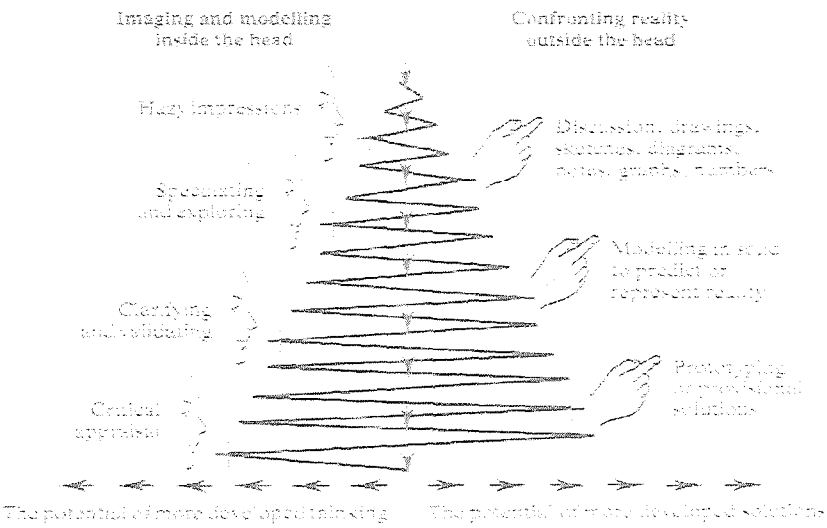



*Fig.21: Models of Researching & Designing (c)*

The centrality of reflection in designing, equally true in research, is shown in the following model (Fig.22) by Rogers & Clare (1994) :

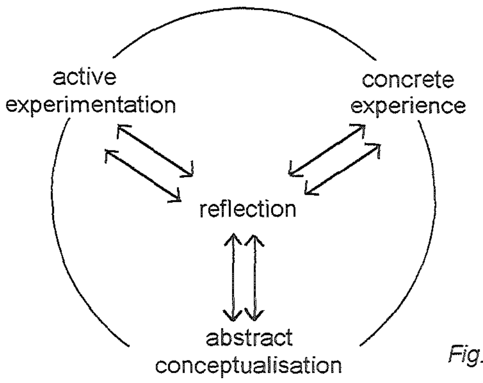



*Fig.22: Models of Researching & Designing (d)*

Both design and research are forms of Rittel & Webber's (1974) "wicked problems," social and systems problems whose goals are unclear at the start and indeterminate in character; the kind of problems that Ackoff (1979) calls "complex" and "messes". Middleton (2000) provides a model (Fig.23) for solving such ill-defined problems based on Newell & Simon (1972) which substitutes the latter's "goal state" with a "satisficing zone" and portrays the route to achieving this as the "search and construction space." Again, this is of equal application to research, since most research problems are ill-defined and gain definition, even in the mind of the researcher, in process of researching and there is rarely a "one right answer".

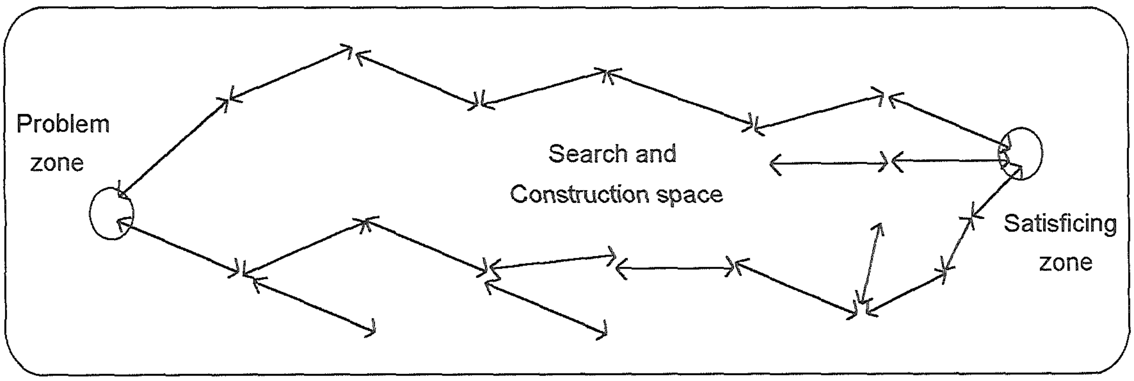



*Fig.23: Models of Researching & Designing (e)*

My personal view of how problems are solved is an expansion and development of Ryle's (1949) division of knowledge into *knowing how* (skills) and *knowing that* (facts). Factual information about appropriate processes affects the *knowing how* to approach a task. There seem to be inseparably woven threads combining *knowing how* and *knowing that* in the developing mind. One cannot say which comes first, how they might be separated or how they interact.

In problem-solving of any sort, I believe that *knowing how* and *knowing that* are combined in *strategy knowledge:* knowing a particular procedure will work best in the given circumstances. The procedure itself might be classed as *know how* but *know that* is needed to apply it. It is the development of this *strategy knowledge* in relation to using drawing to support design thinking that is the focus of my research, but I have been always conscious of a similar process happening in relation to my own research journey.

This view of the problem-solving process (equally true of design or research) summarises the duality which I perceive and experience in both. The parallelism between the two processes led to the creation of a epistemological model (Fig. 24), which I have adapted and developed to support a range of topics (for example, Hope 2000a, 2003a). This adaptability supports my belief in its validity and generalizability :

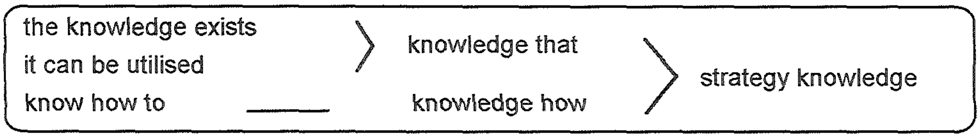



*Fig.24 Strategy knowledge (a)*

For example, children can be taught certain procedures (labelled diagrams, for example) at quite a young age but do not access this procedural knowledge because they do not see its applicability to problem solving. Thus, the problem-solver also needs to *know that* this knowledge can be harnessed to the solving of the current problem. *Knowledge that* only has power if linked to *knowledge of relevance* to the problem. Then *knowledge how* is needed. This may be a physical skill, a mental strategy, or previous experience of solving like problems.

This combination of *know that* and *know how* form the basis of the strategy to be employed to solve the problem. The choice of appropriate strategy in any problem situation depends on the depth and salience of the *know that* and *know how* which support it. Ryle's (1949) *knowing that* needs to be extended to cover not just factual information but also concepts and understanding, including perception of similarities to previously experienced problems and analogical insight.

## 2.4.2 "Hands on" or "Plan ahead"

Of design research strategies, Pye (1964) comments wryly:

> "It must be emphasised that design, of every kind, is a matter of trial and error...We have to make the things we have designed before we can find out whether our assumptions are right or wrong...Research is very often a euphemism for trying the wrong ways first."
>
> (op. cit.: 36)

Strategies for designing and making could be typified as two approaches: "hands on" or "plan ahead". The former is more characteristic of children and un-schooled adults. The latter is the way of industrial practice and National Curriculum Design & Technology.

***The hands-on approach:***

By "hands on" designing, I mean that design decisions are made through direct engagement with the materials of construction. It is the one-shot approach, in which designing and making happen altogether. At its most extreme, decisions about what the product might eventually be or look like are only partially formed in the mind's eye and re-imaging of the design solution occurs as the product itself takes shape.

The advantages of this approach are in its immediacy. It is tactile, satisfying to the senses and appears to make instant progress towards goal. The real object can be manipulated for size, shape, fit, match. However, the disadvantages are that it eliminates other choices once started (other approaches may have been better). It is potentially wasteful of materials and therefore could be expensive if it does not work, leading to disappointment and the project being abandoned. If the project has to be continued at a later date, it could end up looking nothing like original intention because what was being made, what was to be used, and so on, has been forgotten. The project cannot be continued by others.

***The plan-ahead approach:***

This approach involves a much greater measure of decision-making before engagement with construction materials. There might be some drawing, note-taking, discussion with peers or experts, making of mock-ups or practising of techniques.

Advantages here are that this method of working takes account of material requirements before cutting which enables costing and resource management. There is a clear sense of purpose and direction to the activity so there is less chance of messing things up. Several ideas, techniques or materials can be tried ahead of task, which can reduce the possibility of major failure later on. The project can be continued at later date without forgetting what had been decided already and the making can be performed by others.

The disadvantages are in the level of cognitive development required to utilise such a technique due to the knowledge base required with regard to the handling of materials (and their properties), techniques, measurements, calculations, where to look for information not to hand - even the knowledge of not having all the information required. It seriously delays the start of the activity, which is the sensually satisfying part of the task, and appears to delay the final completion of the task - time is spent *doing* nothing. It could mean sticking rigidly to a design even though it is clearly not working. Finally, having solved the problem mentally, is there the incentive to carry it out?

What usually occurs in practice is a task-appropriate interaction of both, which derives from the experience and knowledge of the practitioner, i.e. their personal *know how* and *know that* which allows them to start at a particular point on a continuum between the two:

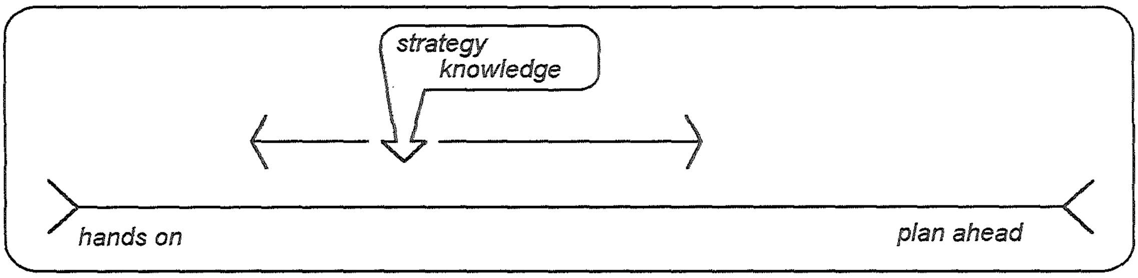



*Fig.25 Strategy knowledge (b)*

The knowledge base of the expert allows them to apparently adopt a “hands on” approach but the decisions being made are based on prior knowledge and experience, which enables decisions to be made about the planning process. External modelling, whether by drawing or practice piece, is used to clarify uncertainty about the best procedure to be adopted. Novices and children are far less likely to have appropriate internalised models to which they can relate the present problem and thus are less able to gauge (and hence under-estimate) the level of external modelling support that their design ideas require. Being unable to manipulate a visual image of the problem and identify areas in which modelling would aid success, they tend towards using “hands on” strategies, with subsequent lower likelihood of success.

As I observed children at work on design activities, I could see parallels to my own research activities and, through reading accounts of other researchers, felt that these two approaches were also in evidence in research activity.

### 2.4.3 Applicability to my Research Methodology

It could be said, therefore, that the *"hands on"* approach typified the first phase of my research. The activities which I conducted with the children before December 1999 were exploratory. I tried out activities across the whole school or with single classes to see how the children would respond, what strategies they would use and whether there would be progression, patterns or features which emerged at different ages. The insights which resulted from these activities formed the foundations of my theoretical understanding from which a pre-planned Programme developed. I was certainly a research novice. My procedural knowledge was low and I was trying things out in classrooms and reading research literature all at the same time.

As I amassed data and came to conclusions, I formed a hypothesis which I wished to explore and for which I needed to devise a Programme to test the hypothesis - *"plan ahead"*. The Structured Phase.

This was surprisingly hard and extremely daunting. I could not now just try something out and see how it worked. I had, to my view, a "big idea", and it needed extensive development. On the basis of my hypothesis I had to design a Programme to try to prove it. I spent several weeks wandering around with the word "How?" hovering spectrally in my head.

Many of the tasks used as part of the Exploratory Phase could be re-used. The same task, presented differently, would give me a strong feel for the validity of my hypothesis. But I felt concerned about how far this would swing me towards an empiricist methodology, when I felt that one of the strengths of the "hands on" approach in which I had so far proceeded allowed me to be reflexive along the way and react to insights which emerged. More importantly: what if my hypothesis was wrong?

The Exploratory Phase was not devoid of number crunching (an empiricist trait). The tasks had been analysed through the use of databases to produce reports and spreadsheets to produce charts. These had yielded the evidence of the characteristics of children's design drawings on which much of my understanding was based. My original intention was, therefore, to continue to use such techniques to analyse the data produced by the Programme. However, on further consideration, they did not give the detailed view that I wanted. They had produced broad categories from data spanning ages 5-9 years. I was now looking closely at 6-7 year olds and trying to find out exactly what was going on. A new analysis instrument needed to be devised that incorporated the understandings gleaned from the original studies.

The Programme and its analysis methodology was, therefore, designed ahead of task, in April 2000. There were, inevitably, changes along the way and these are documented in Section 4.3.5 (Programme) and Sections 5.4.2 & 5.4.3 (Analysis Instrument).

One feature of qualitative research methodology which I did not want to abandon in my "planned ahead" Structured Phase was the ongoing analysis of the data, which could influence the course of the research. I did not want to have set a Programme which I would feel duty bound to stick to rigidly even if it was not working. This, to me, is the biggest disadvantage of the "plan ahead" approach and of the positivist model: analysis comes at the end, as a summary of what happened. This might be acceptable for molecules but it could not be so for children, especially since I was delivering a programme which would form a significant part of their overall educational experience in Year 2 (5% of their lesson time).

Therefore, it was important to me at the start to remain flexible and be prepared to change aspects of the Programme in the light of analysis, informal as well as formal. In practice, however, changes were made due to circumstances which could not be predicted ahead of task, rather than in response to analysis.

# 2.5 Research Organisation

The word "structure" suggests organisation and planning. At the beginning of my research I was not planning anything more organised than a single lesson or two that could be carried out with different classes around the school to find out how children responded. However, as the project grew, so structure and organisation had to be imposed on it in order to avoid a management crisis. This section of the thesis outlines the structure which developed, the kind of data collected and the decision to structure the writing of the thesis to reflect the research process.

## 2.5.1 Research Structure

The classic positivist research structure can be likened to an hour-glass (Fig.26) :

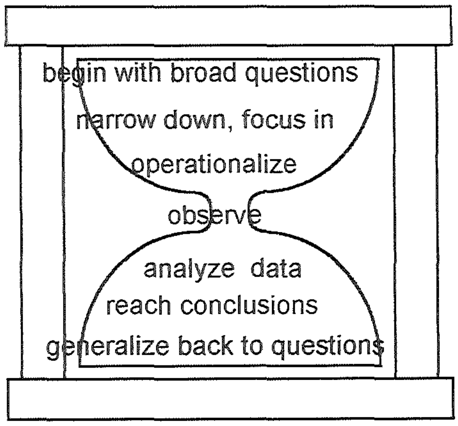



*Fig. 26: Research Structure (a)*

http://trochim.human.cornell.edu/kb/strucre.htm
accessed June 2003

Researchers from other traditions, would not recognise these stages. For example (Fig.27), McNiff's (1988) used spirals to model the way that action research might explore issues which caught the interest of the researcher and proceed on parallel paths and contribute insights to the main issues :

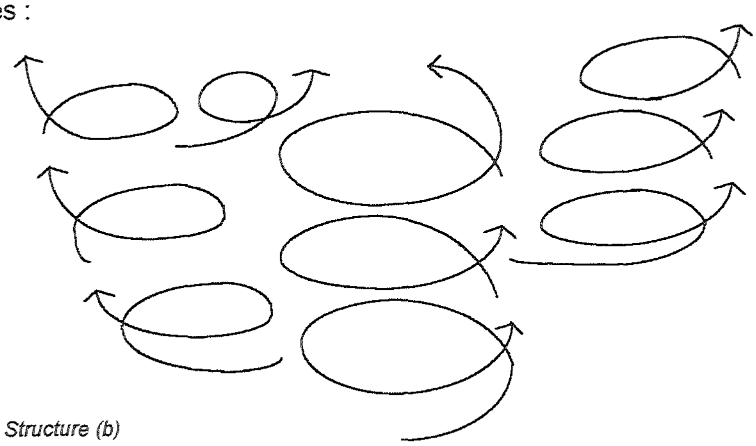
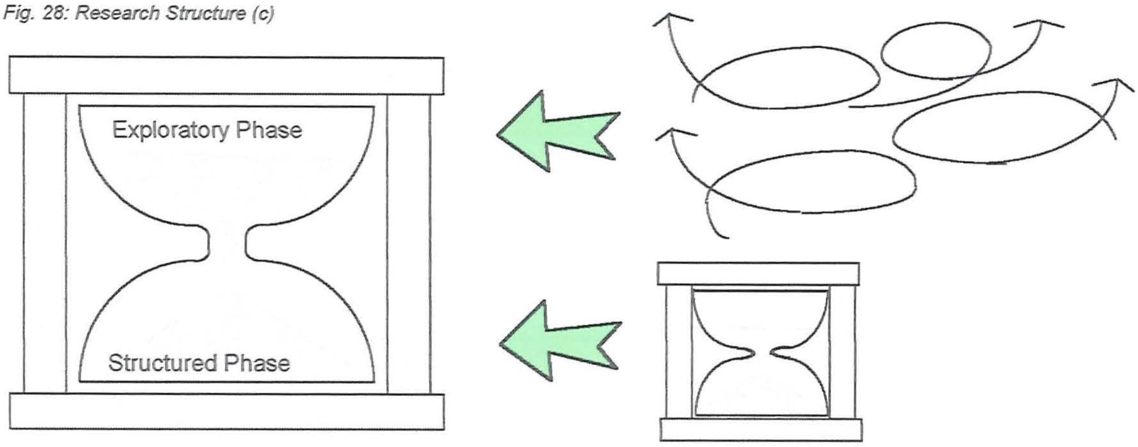


*Fig. 27: Research Structure (b)*

These two models represent very different, and in many ways conflicting, views of the research process. Trochim (2002)'s model funnels down, not deviating from its pre-determined goal. McNiff's spreads out, almost in danger of losing the plot.

My research, however, has been in two phases, the first of which (the Exploratory Phase) cascaded into the subsequent Structured Phase and, although the hour-glass analogy is useful, it needs some adaptation to describe my personal research endeavours. The Exploratory Phase was far more like McNiff's spirals, following my own interests and opportunities, trying things out and changing and adapting in the light of observations. The Structured Phase, however, was much more like the hour-glass. There was a Programme to deliver and an analysis instrument against which to evaluate children's work. I could no longer follow interesting spirals off into other realms.

*Fig. 28: Research Structure (c)*




These two, contrasting methods were determined by the nature of the research process within each Phase. The primary motivation behind the Exploratory phase was investigative. I wanted to find out how children used drawing to support design thinking by examining large numbers of design drawings from across the 5-9 years age range. The reading in which I was also engaged at this stage led to the development of a theory about the role of drawing in the design context which could be applied to teaching young children to use drawing to support design thinking.

The Exploratory Phase of the research was based on Inductive Reasoning (Fig.29) :

Observation → Pattern → Tentative Hypothesis → Theory

*Fig. 29: Research Structure (d)*

I then devised a Programme which would use this theory as the vehicle for explaining the nature of design drawing.

Thus the Structured Phase was based on the Deductive Reasoning (Fig. 30) which developed from the theoretical conclusions of the Exploratory Phase:

Theory → Hypothesis → Observation → Confirmation

*Fig. 30: Research Structure (e)*

I did not go back to the Exploratory Phase once I had moved into the Structured Phase. And although the development of my understanding involved the constant re-assessment and re-application of previous understandings, it was more like a snowball rolling downhill than a carousel. There came a time when the exploration had to stop because I had formulated a hypothesis and I needed to structure the research to prove it. The neck in the hour-glass represents that point. That the way I structured the account of my research should reflect this reality is something that I felt strongly.

To return to the hour-glass model to unite these two modes of working: although each of these phases were discrete, the emergence of theoretical understanding allowed the tentative hypotheses of the Exploratory Phase to cascade into the firmer working hypotheses of the Structured Phase, which in turn enabled me to make focused observations, to be analysed in a more rigorous way to provide confirmation of my theoretical understanding, which underpinned the hypotheses which the Programme was designed to test.

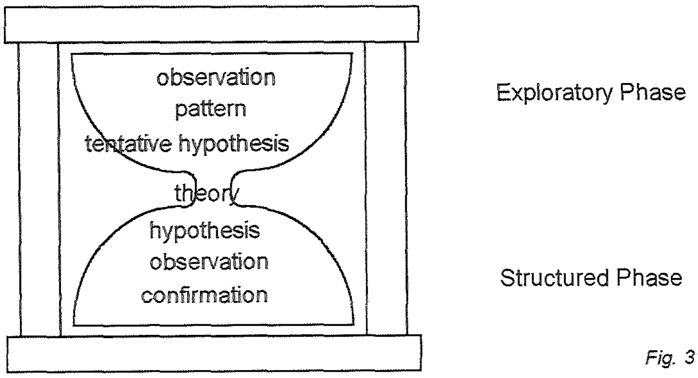



*Fig. 31: Research Structure (f)*

In his appropriately entitled paper "Self-doubt and Soft Data", Ball (1993) describes the development of theoretical sampling from the naturalistic:

> "Theoretical sampling involves the use of analytical insights derived from data collected up to a particular point in time in order to make decisions about the collection of further data"
>
> (op. cit.: 41)

which leads to data collecting focusing around these emergent categories, being part of a

> "secondary process of progressive focusing whereby other sorts of data are no longer collected...Choice indicates control and reflexivity." (ibid.)

This seems to describe the transition from the Exploratory Phase of my research to the Structured Phase. My understanding of the development of young children's design drawing capability emerged within the first phase, from analysing and reflecting upon the mass of data generated mainly from tasks conducted across the whole school, which enabled focusing on one age group and devising a programme by which to test my hypothesis in the second.

Despite not using positivist methodologies, I found some of Trochim's (2002) accompanying diagrams helpful in clarifying the kinds of experiments that I was conducting. This was not an attempt to dress up my endeavours as somehow more "scientific" but the utilisation of a useful technique to aid thinking.

The initial Exploratory Phase of my research, in which I was trying a range of ideas with a range of classes and observing the results, was of the Post-test Non-equivalent Groups Non-experiment type (Fig. 32) :

*(N = Non-equivalent groups; X = treatments; O = observations or measures)*

| | | |
|---|---|---|
| $N_1$ | $X_1$ | $O_1$ |
| $N_2$ | | $O_2$ |
| $N_3$ | $X_2$ | $O_3$ |
| $N_4$ | | $O_4$ |
| $N_5$ | $X_3$ | $O_5$ |
| $N_6$ | | $O_6$ |

*Fig. 32: Research Subjects (a)*

Note that some groups have "treatment" and some do not, some classes I had taught at some time in the past, and some I was teaching regularly whilst researching and some I met for the first time to carry out an experimental task.

The Structured Phase, on the other hand, in which I was delivering a Programme to one class (N1, the Focus Class) and comparing the results of Assessment Tasks conducted with both them and a non-participatory class (N2, the Comparison Class) was of the Pre-test/Post-test Non-equivalent Groups Quasi-experiment type, which, since I was conducting Assessment Tasks throughout the duration of the Programme, could be represented (Fig.33) as:

$$N_1 \qquad X \dashrightarrow$$

$$O_1 \quad O_2 \quad O_3 \quad O_4 \quad O_5 \quad O_6$$

$$N_2$$

*Fig. 33: Research Subjects (b)*

The two classes studied in the Structured Phase are Non-equivalent Groups since they were parallel classes within the same year group at the same time. Children were assigned to classes on entry to school in the Reception Year when little was known about their capability. By conducting an Assessment Task at the beginning of the Programme, I attempted to ascertain pre-programme differences in design capability between the classes and used the Key Stage 1 SATs test results as a proxy pre-test of academic attainment.

However, in adopting this way of considering my research subjects, the differences in the aims of my research and those of non-participant observers must be made clear. Those who employ such terms such as "predictive validity" assume that the phenomena that will be observed are phenomena in which they themselves have no part. In the Structured Phase I was making predictions about changes I believed would come about through a Programme I had designed and was to deliver. I predicted that it would be successful and I believe the data suggested that it was. However, as McNiff (1988) observed, teachers researching teaching and learning have a different agenda to those who are simply observing others doing their job.

## 2.5.2 My Research Data

The input to children was at group (whole class) level. The analysis, however, began at the level of individual drawing in response to input. This is in common with how teachers normally evaluate both children's achievement and their own effectiveness. However, as well as drawings being compared with each other and the cumulative achievement of children compared within their own class, whole class comparisons have been made. This has been true in both the Exploratory Phase, in which it was being established what children could do, and in the Structured Phase in which two classes were being compared more closely across the course of the Programme.

Thus there were three levels of analysis: the drawing, the child and the class:

Within each phase, each *drawing*, regardless of task, was subjected to the same analysis instrument. So that, although a better instrument was developed during the second phase of the research, there was internal consistency within each phase.

In both phases, the *child* was the basic record-keeping unit. In the Exploratory Phase I maintained records across three years of many children's time in school, which enabled me to form an impression of underlying skills that aided facility with design drawing. In the Structured Phase the quantified system enabled me to rank-order the children's work and examine their achievements in relation to each other on different kinds of tasks and different aspects of tasks.

At *class* level in the Exploratory Phase, I was aiming to find out if there were differences in response to different tasks, different ways of presenting the same task to children of different ages (reported in Section 3.3.2). In the Structured Phase, I was looking specifically to compare the achievements of the Focus Class, who received the Programme, and the Comparison Class, who did not (reported in Sections 5.5 - 5.9).

From these research activities, the *primary data* collected were predominately children's drawings produced during Design and Technology lessons, along with final products or photographs of them. This was turned into *secondary data* by quantifying the qualitative judgements made about the drawings. In the Exploratory Phase, the classification system based on these secondary data (which became more detailed and refined across time) were derived from observations made about the drawings. In the Structured Phase, the secondary data were based on a series of continua derived from a holistic view of children's design drawing capability that developed as a result of reflection on the analysis process during that phase (Section 5.4).

Qualitative data was used to support the quantified analysis (photographs, comments made by children about their work, etc.) in order to create as rounded a picture as possible of how the children were using drawing to support their design thinking. For both phases, databases and spreadsheets were used to collate and manipulate the data. My capability with these computer tools increased dramatically across the course of the research and contributed to the very different way in which the quantified data was handled in each phase.

### 2.5.3 Telling the Story

The realisation of the close parallels between research and design led me to consider the way in which knowledge is created and that the format in which such knowledge is disseminated should reflect the epistemology. Specifically, the way I presented my research should reflect the way the research proceeded and reflect my understanding of the way in which the two processes are parallel.

> "It may suffice to say that where we stand about research, how we see our place in that endeavour, translates to how we write and to the form we select in that writing."
>
> Ely (1997:158)

Consideration of how the story of my research would be told related to how this might reflect its content. In the tradition of the Bauhaus, form and function needed to be successfully wedded. If I was to tell the story "as it was" then the way in which the story was framed should enhance the telling and reflect the interplay between *hands-on* and *plan-ahead* which seems to characterise both research and design.

I had a problem with terminology. I wanted to reflect this two-stage research process in the way that I wrote the thesis, *"To tell it like it was."* but I needed a better pair of terms for these two phases. Hence they came to be called the Exploratory Phase and the Structured Phase. These seemed a reasonable choice. At first I was exploring the field: reading, thinking, trying things out in classrooms. Once I reached my watershed, then the work was structured by the Programme: its creation, delivery and analysis. That the analysis instrument was still evolving at this stage did not feel to me to be a problem. I was remaining reflective and not falling into one of the traps I had identified with too much planning ahead, i.e. sticking rigidly to a design when it clearly needs changing.

# 2.6 Reflections on Section 2

This brief summary reflects upon the applicability to my research of the issues raised in each of the preceding sections of Section 2, in preparation for Section 3, which begins the account of my research activity.

***Research Paradigms (Section2.2)***

In attempting to clarify issues related to the multiple paradigms of educational research, I discovered I was unable to find a niche in which I felt happy, mainly because (as I was to realise once the process was complete) I had effectively changed paradigms part-way through the research. The Exploratory Phase was dedicated to finding out *what is*; whereas in the Structured Phase I was committed to discovering *what I could improve.*

The hybrid nature of what I was doing, in terms of educational paradigms, meant that, although I did not fit in any one, I found myself using ways of understanding and methodologies from each tradition. Concerns that the interpretive tradition required the participant observer to be a non-participant remained, as did those regarding the way in which action research could be coupled to a deficit model of professional development and personal target setting. I needed a new category for people like me. "Practitioner researcher" sufficed.

***Epistemological Metaphors (Section2.3)***

As the teacher, I could not claim detachment from my subjects in the way that both classic empiricist and interpretive traditions required. Indeed, I was directly responsible for their learning. Even in the Exploratory Phase, when I was investigating what the children knew, with no attempt to change it, I was most often the person planning, delivering and assessing the results of the activity. In the Structured Phase there was the additional problem of comparing what I was doing with what someone else was doing, on the basis that I believed I knew something about children designing that others did not.

My understanding of issues of validity and reliability evolved over time. Initially my concern was for consistency so that I felt sure that I was comparing like with like in order to depict as accurately as possible what children could achieve at different ages and in response to different kinds of Design and Technology activities. As I moved into the Structured Phase, I was more aware of the need for the involvement of others in order to validate both the analysis instrument and the evaluation of children's work based on it.

***Choosing a Methodology(Section2.4)***

My awareness of the parallels between my own research processes and those of the children I was researching in design situations, led me to typify two approaches: hands-on or plan-ahead.

In the Exploratory Phase, I was frequently engaged in "hands on" activity. I would read about someone else's research or have reflected on an idea I had tried already and then go and try out something new. For example, on one occasion Richard Kimbell and I discussed a fan-making activity I had tried with a Year 3 class and, in response to his suggestions, I said "I'll go and try that next week." My constant access to potential research subjects enabled me to be reactive to new ideas and suggestions.

There was, however, a definite watershed at the time that I sat down and wrote the Programme for the Structured Phase, when I realised that I had to make all my decisions up-front and that once the Programme had started I could not go off and try other things. Having, therefore, identified these two distinct phases to the research, I wanted the way that the thesis was written to reflect that.

***Research Organisation (Section 2.5)***

I came close, at one point, to discarding the Exploratory Phase as a pre-amble to "real" research and had to personally reclaim it as part of my research process. As I moved into the Structured Phase, I felt that all I had was a hypothesis and that now I was setting out to conduct the research. I felt almost petulant in insisting that those early fumbling had value. And yet, the Structured Phase only came into being to "prove" the conclusions which I came to in the Exploratory Phase, from which the hypotheses were informed by observation, experimentation, reading and reflection. That the Structured Phase did considerably more than support my previous observations will be seen in Sections 5.5-5.10. New knowledge ensued from a new way of doing things. Both paradigms and methodologies were equally important.

I felt strongly that the thesis structure should reflect both halves, giving recognition to the Exploratory Phase as "real" research, despite the fumbling nature of my activity, and acknowledging too that, despite the planning ahead, the exploration and development of ideas was continuing throughout the Structured Phase.

# SECTION 3 : Exploratory Phase

# 3.1 Introduction to Section 3

Constructing a framework for understanding children's design drawings has been, for me, an evolving process with its earliest beginnings in 1996 with a small scale study conducted as part of my Master's Degree with the Open University. Joining Goldsmiths College to begin my M.Phil/Ph.D. in January 1998 was part of a seamless process, not just in terms of time, but also in the development of my understanding of children's use of drawing for designing.

Section 3 of the thesis comprises the account of the Exploratory Phase of the research:

- a review of the literature on children's design drawing (Section 3.2)
- personal observations of children's design drawings (Section 3.3)
- theoretical constructs resulting from reading and personal observations (Section 3.4)

***Literature review: Drawing as product or tool (Section 3.2)***

The greater part of this work was conducted during the Exploratory Phase of the research. Having continuous access to opportunities to try out ideas with children, this section of the thesis is not just a theoretical review of research conducted prior to my own, but a reflective, reflexive account of seeking answers in the literature for my classroom observations and seeking confirmation (or otherwise) in the classroom for things I had read in the literature. Thus my informal classroom observations are interwoven with my reflections on what I have read.

***Observational Constructs (Section 3.3)***

My early attempts to investigate how young children use drawing to support design thinking was essentially exploratory. I knew from the literature that this had not been researched deeply and so I had no model to guide me. I was convinced of the importance of *grounded research:* that theoretical constructs come from sorting and sifting the data to see what emerges, especially in the early stages of investigating a new field.

Therefore, I simply went and taught Design and Technology lessons and collated the results. I asked other teachers to conduct the same lessons and collected their results. I tried out different ways of presenting the same task to same age children; same presentation to different aged children; different presenter, same script; different presenter, same task, own way of presenting. I taught Design and Technology to a Year 3 class weekly for a year. I taught my own Year 1 classes continuously throughout the duration of the research. I collected evidence from Design and Technology happening anywhere and everywhere throughout the school. I even invaded the Year 4 Art Club. There was a constant to-ing and fro-ing between reading and observation and my continuous access to classes of children made this easy to do.

As a result of this work, I amassed a collection of design drawings from over 350 individuals across three years, many of whom contributed drawings at various stages in their school career. My analysis of these design drawings led to the development of a classification system which became called "Drawing Types" that moved on with me into the Structured Phase (see Section 3.3.5).

***Theoretical Constructs (Section 3.4)***

The theoretical constructs resulted from this reflective interaction between reading and observing during the Exploratory Phase and asking the questions :

- What is the role of drawing in designing and how does it work?
- What pre-requisite understandings / concepts are necessary for children to usefully access the genre?

I came to believe that if I could answer these two questions, I could perhaps devise a scheme of work or programme of lessons which would enable children to use drawing more effectively to model design ideas. Putting together a taxonomy of design drawing enabled me to identify key concepts for answering these questions.

***Transition from exploration to structured investigation***

The transition from this Exploratory Phase to the Structured Phase came as I began to feel that I had sufficient understanding of what was involved in drawing for designing and that I could explain this to young children with sufficient clarity to make a difference to their ability to use drawing for designing.

Part of this process was to identify of "Drawing Types" (which emerged as categories from my sorting and sifting of my collection of drawings), to give me the beginnings of a framework against which to evaluate success. The other part was the understandings created from reflective interaction with the literature, which enabled me to piece together a theoretical framework that became part of the underpinning of the more structured investigation that was to follow.

# 3.2 Literature Review: Drawing as Product or Tool

Since the major part of my literature search was conducted at the same time as the observations of children in classrooms, it was part of the ongoing weaving of my developing understanding with my observations of young children. I was questioning the literature and comparing it to observations, as well as making observations and looking in the literature for other people's answers. The way this literature review is written reflects that interactive, iterative process.

## 3.2.1 Using Drawing as a Tool for Thought

> "A tool... is an object which has first been chosen, then adapted to function as part of a skill"
>
> (Hodgkin, 1985: 39)

My first questions about the topic were simple ones:

- Why model ideas by drawing?
- Why plan on paper?

Put simply: *why draw anyway?*

In the normal course of their lives, adults do not always draw out what they are going to make, so why should it be seen as important to teach this to children?

Welch & Lim (1999) assert :

> "Sketching is a form of thinking and the fundamental language of design" (p. 136)

quoting Tipping (1983) as saying that sketching ability may be:

> "the single most important factor in developing any general design ability." (p. 45)

If this view is correct, then to teach this skill to children is of vital importance in developing their design capability. Welch & Lim (1999) list the role of sketching as: clarifying the task and understanding the design problem, encouraging the designer to play with ideas without the time-consuming and costly experimenting with real materials, facilitating evaluation of ideas and identifying and evaluating possible problems, and "because sketching is a language" enabling communication with the self and others. However, they appeared to discover that children rarely choose to draw their ideas ahead of engagement with materials.

The importance of developing pupils' metacognition is of importance far beyond the confines of the Design and Technology curriculum but the subject is ideally placed to develop these skills (Kimbell & Perry, 2001) . Straddling the arts and the sciences, using techniques, skills and knowledge from both sides of the traditional divide, Design and Technology can foster creativity, reflexive thinking and develop "thinking about thinking". Part of that process requires thoughts to become visible in order to be subject to appraisal by self and others. Drawing frequently performs this function.

It would follow from this, therefore, that children should be taught to record their ideas by drawing but as Smith (2001) said in his DATA lecture, more research and curriculum development is needed into children's design drawing The following review of the literature shows how little there has been, especially with regard to younger children.

A sensible place to start, therefore, seemed to be to look at the practice of adult design professionals and see how their practice might illuminate the process that might be taught to children.

Phrases used for the process of using drawing to support design thinking included "thinking with a pencil", "thinking through my fingers" (quoted by Kimbell, 1998) who also used the phrase "portfolio as mental print out" which represents the designer's train of thought as the project unfolds. Oxman (2000) calls this process "design emergence".

Goldschmidt (1994), observed that architects frequently use drawing, not just as a means of symbolic representation, but to actively generate ideas. This equates to my distinction between drawing as *product of* thought and drawing as *tool for* thought. Although many drawings, whether by designers or others, merely record thoughts already in the head but Goldschmidt was interested in visual thinking and tied this to "*fabrication* of visual displays" (her italics; p.162), via reference to Wittgenstein's concept of imaging as doing rather than receiving. This idea of *imaging as doing* also fitted into the concept that I was building of what I meant by *drawing as a tool for thought.*

The importance of distinguishing between *modelling for* and *modelling of* was stressed by Roberts (1992). A *model of* something, whether it be a flow diagram or a medieval castle made of wood, is a completed product. It is the end, not part, of the designing process. *Modelling for* is future orientated. Design drawing is a tool to support thinking about future action. To treat drawing as *modelling of* is to place closure on the procedure.

Likewise, Garner (1993) discussing the relationship between drawing and visual literacy, portrayed drawing as a tool for understanding, provoking responses and an important way of playing with and communicating ideas throughout the process of designing. However, his paper described the activities of adult design professionals and so this might not necessarily apply to young children.

We can only manipulate what we can name or compare and that our understanding of our environment is limited by our ability to name and make comparisons (Williams, 1985), who asks whether a thing be understood if un-named, let alone communicated, and if scientists missed potentials in their discoveries if they had no names for their observations and that the wider the vocabulary the better quality, more precise the communication and greater the understanding.

One could ask how far this would also apply to visual literacy. We cannot make what we cannot visualise, but it might also be true that we cannot design what we cannot model. The development of drawing has a role to play, therefore, in the development of design vocabulary:

> "Visualisation, as expressed through the use of drawings, is almost essential in designing physical things well ...And in design it is not until one backs it up with the visual mode that he can see whether he is fooling himself or not."
>
> (Adams 1974: 73)

Although Adams' discussion was of the practice of design professionals, my observations suggest that amongst young children, drawing ahead of task can appropriately support idea generation but not detailed construction techniques. Scrivener (1998) terms these first freehand externalisations a designer produces "idea sketches". Harrison (1978) applies the phrase "Letting the tool do the job" to the use of drawing as a tool and a springboard for future designing. Once the mental image is put on paper, the material image begins to do the job, as each objectification becomes the springboard for the next thought.

"More often than not" children are asked to "draw me one then make it." observed Constable (1994) but they do not see this drawing as "an essential vehicle for channelling thoughts" and the drawing appears to be more of a hindrance to the real task of making. It is this interaction between drawing and thinking which professional adult designers find so easy which is so hard-won for the child.

I wanted to know:

- to what extent young children could utilise their drawings as a *tool for* designing.

- whether there were essential skill(s) they need to have mastered in order to do this effectively.

However, I was aware that it is pointless to ask children to do something if it does not make “human sense” (Donaldson, 1978) in relation to the task in hand or to the children's perception of the task. Although drawing is part of the design repertoire, it is not a necessary part of something called "The Design Process" which is appropriate to every “Design and Make” task. Drawing should only be used where appropriate to the task and to the age/stage of the children, which might be different for different sorts of tasks, or even different sorts of children.

Therefore, I needed to clarify:

- what kind of tasks
- what age / stage / sorts of children

My informal observations of young children led me to believe that, below age 6, children do not generally understand that a drawing can be for planning a future activity but by age 8 or 9 they can. I wanted to know what happens in between, whether it is simply that they do not know that they could, or whether there is a barrier to understanding. If such a barrier exists (perhaps maturity or development of specific cognitive or manual skills), then I wanted to know what it was and whether it could be overcome by teaching.

If these issues could be answered, then those answers could enable teachers to help children to use drawing for designing more effectively (or, perhaps, at an earlier age) to develop design ideas and which might have knock-on effects in other areas of learning.

## 3.2.2 Children Drawing

That drawing is almost an intuitive act on the part of young children has been assumed by many writers, for example:

> "(Children) draw before they can write, and they associate their drawings with thought even before they can draw anything recognisable." (Silver 1978; 51)

Young children want to draw. Making marks on paper seems to be satisfying in its own right. However, to deduce from this that designing on paper is something they can do without specific teaching makes assumptions about children’s understanding of the potential of drawing for designing. Although ideas are flowing whilst a child is drawing a picture, the completion of the drawing concludes the event. Understanding that a drawing could be a plan to make something else or that drawing could be used to develop ideas about something that might be made, is not the same as drawing to portray either real or imaginary events or characters.

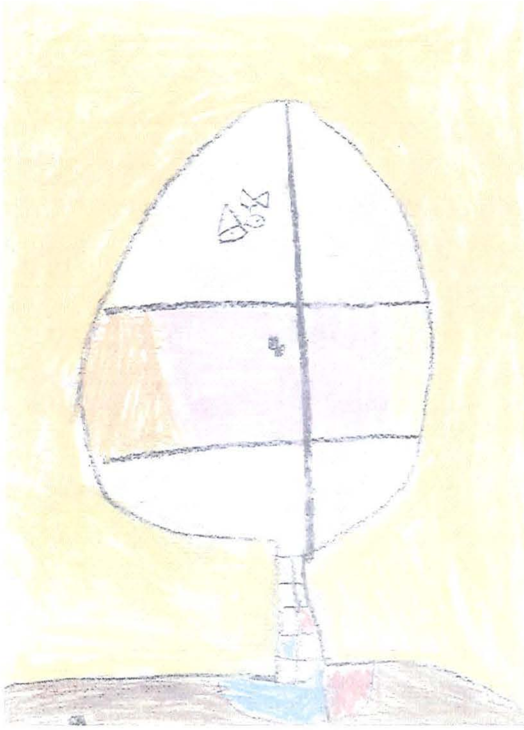
The literature on children's design drawings is, I discovered, slim. Historically speaking, the overwhelmingly greater part of research into children's drawings is into drawing as "finished product", rather than into drawing for intent to make. As Outterside's (1993) comments, of the three major forms of modelling (iconic, symbolic and analogue) identified by Baynes (1989), only the development of the first has been extensively documented.

### 3.2.2a Drawings as Maps of Development

Children's graphic development was assumed to be *teleological,* leading towards the accurate representation of reality as observed; Lowenfeld (1947) and Kellogg (1959) being influential in portraying children's drawings this way. Both were based on a stage-theory view of child development and of drawing as recording observation accurately on paper. Goodenough's (1926) Draw-a-man test had set the stage for the idea that children's artistic ability and intelligence could be measured by such "camera shots" of the world around them, which was assumed to be biologically determined and purposefully creative. Such plotting of graphic development seems highly dubious on three counts.

*Firstly,* this view of the nature of art discounted the non-representational adult artistic output within Western culture (some of the best known works of Picasso, Mondrian and Klee would all have failed the tests). The view of artist as recorder of visual observation that was applied to children's output, was not in tune with mid-twentieth century art theory, which viewed the artist as translator of an inner image into external form to communicate affectively to others, often relying on symbolism and suggestion. Klee's *A Young Lady's Adventure* (1921) uses lines, not to express observed reality, but to explore the dark and shadowy side of the "adventure" undertaken. Kandinsky combined conventional placement (for example, the triangular arrangement of many Renaissance Madonnas) with abstract shapes to express his view of the essence of art.

The mis-trust of non-representational art in society as a whole (which persisted throughout much of the twentieth century) and the continued preference given to representational art as a model to which children should aspire, has led to the marginalisation of other forms and uses of drawing that children might be encouraged to produce, some of which might have more potential for using drawing as a design tool than the "picture" (which was always seen as finished product). As shown by seven year old Glen's "Self portrait in the style of Paul Klee" (Ex.1), children express themselves in range of drawing genres.



*Ex. 1 : Yr. 3 : Glen's Klee*

Egan (1996) classified three styles of drawing produced by young children (representation, narrative and patterning) suggesting that narrative drawing contributes most to design capability. I too have observed many young children who can produce almost virtuoso drawings but cannot use drawing for design, perhaps because they see drawing only as a finished product, to be made as aesthetically pleasing as possible, rather than having potential for recording of changing, developing ideas, as the example below by a Year 1 girl (Ex. 2) shows. She could produce beautifully patterned pictures but did not become adept at design drawing, even by Year 4.

*Ex. 2 : Yr. 1 : Patterning*

*Secondly*, in the research setting, the child was frequently asked to draw a picture for which no contextual or stylistic cues were given, but the product was assumed to be typical of the child's artistic production. This showed little understanding of drawing in context. Children learn and utilise a whole range of genres (pattern making, cartoons, diagrams, sections, exploded diagrams, scientific diagrams) within both representational and non-representational art.

Assumptions were made about the development of children's drawings with little consultation with the children. It was assumed that the child implicitly understood the adult's agenda. The child produced what they believed the adult wanted, in a genre which might perhaps be called *drawing a picture to please an adult* : no rude bits, blood or guts. From my teacher's knowledge of young children, these abound, especially in boys' drawings (including Glen), from quite a young age and their absence reflects the power ratio of child to unknown adult.

*Finally*, the assumption that drawing *comes from the inner life of the child*, untainted by social pressure, became popular as early 20th century artists became enamoured with Primitivism and child art, which led to the paralleling of children's art with so-called "primitive cultures". This denied the social context in which children of all cultures develop their mark-making. Eng (1931) (for example) paralleled the development of child art with the development of primitive and folk art (Palaeolithic & Bushmen in alternate breaths).

Although to a more modern viewpoint this seems naively Eurocentric, the underlying assumptions of development towards attaining Western conventions of pictorial representation led to equating this skill with intelligence. Lowenfeld(1947) listed six stages of development in child art, which he saw as natural aspects of human development through which the child must pass, extrapolated from observations of American children striving to please the teacher and conform to their perceptions of the norms of their own society. Part of the problem lay in not understanding the cultural determination of children's drawings and artistic output.

Behind such schema are several unstated assumptions:

- that children's drawings are rooted in the nature of human cognition and not in the nature of society;
- that the social functions of drawings (and art in general) in western society is typical of all human societies and has not changed across time;
- that the attainment of point perspective was the pinnacle of artistic endeavour and the one towards which graphic education should aspire.

It is only recently, as a result of the National Curriculum for Art and Design, that young children have been shown examples of non-representational art as a regular part of their artistic experience in school and produce such work as Glen's Klee.

These issues remain un-addressed in more recent work on children's drawings. Matthews' (1999) detailed study of the artistic output of a small group of young children (focusing particularly on that of his son Ben) remains firmly within the confines of the genre of drawings as products. There are no plans-to-make drawings, design drawings, yet Ben, with his level of graphic competence must have produced design sketches, scientific diagrams, maps, flow-charts and a whole range of other drawing types that do not feature in the book at all. Matthews' viewpoint is of drawing as product. Even where it is a process towards resolution of inner image, the process stops with the completion of the drawing.

Wilson (1992) asserted that children from an Egyptian village with few outside influences had a very restricted visual vocabulary and showed far less diversity in their drawings than those of western culture, where the influence of television and especially cartoons influenced drawing style. Wilson did not, however, appear aware of Islamic disapproval of representions of humans and animals. Nor did he compare the Egyptian children's abstract pattern-making (a highly developed Islamic art form) with Western children's output in this genre.

For designing as well as picturing, due credence needs to be given to the cultural influences and expectations of children's drawings. Children function as part of a multi-layered socio-cultural system (Rogoff, 1996) as learners, peers and teachers; as transmitters of culture to each other as well as receivers of culture from older children and adults. They are actively seeking competence and identity within the overlapping and interacting cultural milieux they inhabit.

The booklet "Start Drawing" produced by The Campaign for Drawing (2002) demonstrates a greater diversity of uses for drawing (Perception, Communication and Manipulation) including a section on solving problems, which are predominantly Design and Technology, which comes close to my view of using drawing as thinking tool:

> " reflexive oscillation" between impulse, ideas and mark, receiving feedback from the marks appearing on the page, which prompt further thought and mark-making. Usually the drawing is one of a series, where ideas are explored, repeated, refined, practised, worked over, discarded, combined, where alternatives are sought and alternative possibilities explored." (op. cit.: 2)

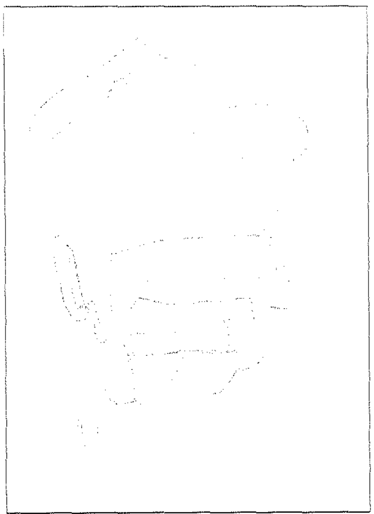
Children's drawing skills, like all aspects of child development, are far more fluid and adaptable than was once thought but if children are to access and utilise the genre of design drawing, then it needs to be demonstrated and taught along with other genres, otherwise we are relying on children's intuition to grasp the teacher's expectations heuristically.

Children's lack of experience or knowledge of a range of drawing genres may mean that their response to demands for a design drawing is a demonstration of their prowess in drawing rather than to produce a range of ideas sketches of something to fit the demands of the task. Children are less adept than adults at adjusting the level of specificity according to perceived purpose or context (Van Sommers, 1984). I have observed Year 4 girls drawing fashion details such as pockets and zips on designs for a puppet, which could not be made with the materials in the tray in front of them on the table.

## 3.2.2b Canonical Drawing of Objects

4-5 year olds often produce canonical drawings, i.e. they draw a cup with a handle even if shown a cup with its handle facing away from them. My observations of Year 1 children suggest that children want to produce the "best view" of the object: children sitting with a side view of a teddy turned it towards them so they got front view, to the howls of protest from the child seated with the best view of teddy's front. Drawing a teddy means a front view of teddy. Drawing his side view does not satisfy the child's idea of what constitutes a teddy.

There are two sorts of children who do not fall into this trap. The more sophisticated see it as a party trick - *Can you put this strange view onto paper?* and children who have conceptual difficulties. For example (Ex. 3), 6 year old Andy's back view of my rocking chair (below) . Andy had a delayed language development.



*Ex. 3 ; Yr.1 : Delayed Language Development (a)*

The accuracy of his drawing is probably due to the limitations of his verbal labelling skills. Such children record the shapes and angles of the scene that they see before them, without verbally labelling the objects. Nadia, studied by Selfe (1983) ceased to produce her exceptional drawings once she started to speak. Canonicality, I would argue, is not an aberration of children's drawings which they need to outgrow, but essential to designing and thinking: the inner visual image which accompanies a word label.

By Year 2 Andy was already losing his advantage to other more verbally competent children, although his class teacher tried to foster and encourage his artistic skills. By Year 3, he could no longer record his design ideas except in the most basic way: a single drawing of the object to be made. Perhaps he had reached the canonical stage, which other children achieved two years earlier and perhaps I had captured the progress of a child whose drawing ability enabled him to reveal the pre-canonical stage. When he left the school, aged 9, he was still a long way behind his peers with regard to literacy skills and had not become a good designer. This would suggest, perhaps, that internalisation and inner labelling, the connection between language and perception is vital for manipulating any symbol system, including drawing.

As part of their normal development, children come to understand that symbols are cut free from the concrete experience, that names of things are not part of the thing and can be used and manipulated in their own right. This must be true too with graphic thought, a time when children can begin to use drawing as a tool for thought, development and communication because the drawing has taken on an abstract reality of its own, no longer tied to the particular thought or object that inspired it, but can be changed, the symbols used, redrawn or crossed out because they are only a staging post towards an end. This involves conscious exploitation and manipulation of the symbol system; graphic metacognition.

Drawing made from observation shows the defects and idiosyncrasies of the particular whereas the canonical drawing reflects the generalised inner image and can be used as a basis for designing. Arnheim (1995), describes the process of creative designing as an interaction of arguments and moves. By making a sketch, the designer provides the mental image with an optical image that loses the disadvantages of the mental image whilst being still fluid enough to be re-interpreted by the eye and manipulated by the brain.

### 3.2.2c Analogue Drawing

Children's first graphic products are analogue: they look nothing like what they represent, although they have meaning for the child (Outterside, 1993). Analogue drawing is an abstract system of representation so, perhaps, children who produce such drawings are possibly more adept at using their drawings as a tool for modelling ideas than those who see drawing as a representation of observations.

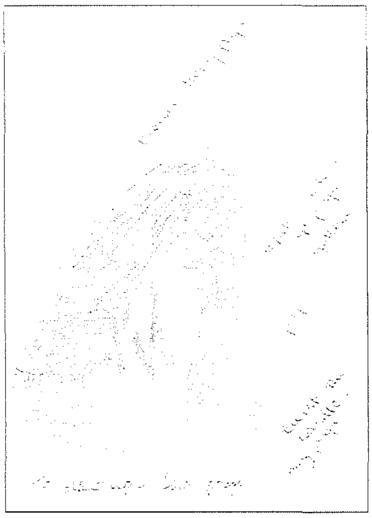
Andy produced the analogue drawing (Ex. 4) at 4 years old, soon after his entry to school. He told an incoherent story as he drew, concerning a day out at the beach with his parents and brother. It was stored as "evidence" in the Special Needs Co-ordinator's filing cabinet and given to him to take home some 18 months later . He became very excited and recounted to me the day on the beach and pointed out what the various parts of the drawing represented.

*Ex. 4 ; Yr.1 : Delayed Language Development (b)*

> *"It's a map. We went on a boat on it. There's big waves, like that big. I saw people writing with fingers on sand, saying "Liam" - and that.* (pointing to writing on right) *And a boat nearly sank.. And then we did, got fishing out. We got some worms and we catched some fish and got our fishing rods and put them in the sea and we fished."*

To me, there were three noteworthy aspects to this episode: firstly that he could read it so long afterwards (he was still unable to read print). Second that he called it a map; to an adult it looks like so much scribble, but his reading of it gives it total sense. Thirdly, Andy was one of the few children who could use drawing as a recording tool for his design thoughts by the end of Year 1.

Andy's design for "Wiggly Worm's House" (Ex. 5, overleaf, annotated by me) took account of materials and construction detail:



*Ex. 5 ; Yr.1 : Delayed Language Development (c)*

As a non-writer, Andy was still using picturing to place-mark stories by the end of Year 1 and this helped his designing since he thought visually as first choice. However, as indicated above, this prowess did not continue as he got older.

## 3.2.3 Children's Planning Drawings

> "Drawing is not habitually demonstrated [in the classroom] as a useful tool for organising and representing ideas.... our education system rarely offers examples of adults modelling drawing as a tool for thinking."
>
> (Anning, 1993; 38)

This is probably because most teachers don't! Teachers have had to use writing as the medium of expression in order to become teachers, even those whose main subject is art or design and who might naturally think more visually. Many teachers feel a sense of inadequacy about their drawing skills. This militate against the use of drawing to organise information or communicate ideas in classrooms.

### 3.2.3a Drawing for Developing Ideas

Matthews (1999) claims that children's repetition and reworking of images and themes over a period of days or weeks constitutes an editing and re-drafting of ideas. This might be harnessed to encourage children to maintain a planning note-book.

The spontaneous use of drawing to draft a picture becomes more common as children get older. At the start of Year 1, children draw an outline shape in colour and then fill it in but they soon begin to draw in lead pencil and then colour this. They have realised that the lead pencil gives them the freedom to rub out and change parts of the drawing with which they are unsatisfied. By Year 3 the pencil line drawing is perfected before painting commences.

I quickly discovered the need to give children a black biro so that I did not lose valuable evidence. The frequent occurrence of multiple drawings of the same object amongst Year 2-3 children was, I realised, due to their desire to improve their drawing. There was no progress of ideas, only adjustments of lines. They regard first attempts as "wrong" (i.e. wrongly drawn) rather than as stages towards a final outcome.

It would seem that the desire to get reality correctly onto paper inhibits designing at ages 7-9. Time and effort is wasted both on correcting unnecessary details and also on drawing to an inappropriate level of detail, even in collage work where it would be more sensible to cover the whole background first or simply copy the plan without drawing it on the background at all.

### 3.2.3b Sketch Books and Process Diaries

Robinson (1995) suggested that children should make their own sketch books to record their drawings which would then become a cumulative record of knowledge, thus encouraging children to mimic the practice of real artists. This could encourage children to see drawing as a developmental tool rather than the simpler "drawing as picture". This seemed a good idea so we tried it in Year 4 Art Club but many children did not bring them each week and had lost them by part-way through the year. Although my own observations during the Exploratory Phase indicated that children as young as 8 years could begin to use drawing as a developmental tool, it was not something they did spontaneously or would necessarily continue outside the classroom.

Children frequently are unaware that adults do not produce works of art at first attempt, whether written, visual or musical. Hammond (1997) comments on the importance of young children knowing that redrafting their writing is not just acceptable but vital. She speaks of the earliest attempts at conveying story on paper as "place-holding". The child can retell the story based on the marks made on the paper. This seemed to me to be a pre-design skill as well as a pre-writing skill. If they can place-mark for story-telling, I wondered, why not place-mark ideas for designing?

Vygotsky (1978) asserted that children's early drawing is a form of graphic speech, a precursor to written language. Harste, Woodward & Burke (1984) concluded that there exists a reciprocal relationship between young children's drawings and writing. At this early stage, graphics and emergent writing skills combine and support each other. When one ceases to be useful, the child moves to an alternative communication system to placehold meaning (Harste et al). As children become more competent writers, drawing takes a secondary role, from which it is difficult to resurrect it. But what makes them become recorders of frozen reality rather than fluid users of graphic expression? I think the answer is social pressure and a desire to copy the finished products they see around them. They so rarely see drawing being used to support thinking that they are unaware of the possibility.

The Process Diary (Rogers & Clare, 1994) , recorded in a variety of media: words, photographs as well as drawings, enabled children to record and think about the process of design through recording significant moments in the development of their project. They can then reflect on the decisions made at various stages. Rogers & Clare identified reflectiveness as the most important aspect of this work and making children metacognitively aware of their own thought processes to inform their future thinking.

## 3.2.4 Implications of the National Curriculum for Design and Technology

It came as a surprise to me, some 8 years after the publication of the first National Curriculum Orders for Design and Technology, to discover that there had been no research into young children's use of drawing for design purposes prior to its publication. Yet in 1992, 7 year olds were required to be tested in their competence in these uncharted skills. Any literature relating to drawing for design by children younger than 10 appeared to be an investigation into why the children seemed unable to fulfil the requirements.

### 3.2.4a "Extrapolation downwards"

My previous Headteacher read this phrase in one of the early circulars about the National Curriculum. It was nowhere more true than in the Design and Technology Order. Had no one heard of Piaget and that little children see the world differently from older ones? It was as if the whole body of child development understanding in which Infant teachers were grounded had been wiped away with one stroke. The serendipity of playing with materials which became something exciting in small hands had now been swept aside by identifying needs, generating ideas, recording possible solutions and making mock-ups of them to be evaluated before they fall apart before the next lesson. Medway (1992) called it the "academicization" of practical activities: the doing is only allowable within the overall context of the communicating, evaluating and other intellectual skills.

Articles and books that gave advice to teachers about how to develop designing skills frequently used the blanket word "children" with no indication of age. For example, Ritchie (1995) :

> "The ability of children to develop their ideas through drawing needs to be developed throughout the curriculum from an early age - so that "drawing an idea" becomes second nature"
>
> (op.cit.: 82)

with the warning that:

> "As children get older....they and their teachers can put too much emphasis on finished drawing quality." (ibid.)

What is this "early age"? Four? Ten? and when do these children "get older"? seven? eleven? or sixteen?

It has been assumed that the practices of design professionals were of educational application, and frequently the age of the children is unspecified, for example:

> "Graphic representations, in the forms of drawings, graphs and charts, are used to convey the design technology process and its results. The child grapples with the difficulty of transferring an idea to a two-dimensional format. Sketching freezes elusive ideas and provides a format for mental rehearsal as the child mulls over possibilities ... Just as a designer or engineer works with multiple drafts, so the child... the project will evolve, possibly through several drafts... a final two-dimensional rendering will capture the resulting changes in the original design."
>
> (Dunn & Larson, 1990: 34)

The "design" side of the Design and Technology Orders appeared to be heavily dominated by making explicit things that had previously either been assumed to happen inside children's heads, or had not been considered in relation to young children's craft work (as it was previously known) at all. The newness of the subject in the school curriculum, together with muddled thinking about the role of drawing for design and the capabilities of children at this age has produced mixed messages about both.

Teachers, let alone children, did not assume drawing to be a procedural tool prior to the National Curriculum. There could be none of Bruner's "scaffolding" since teachers had little perception of the intricacies of the structure. Neither, it would it seem, did the Curriculum writers. Yet this unfortunate document became a yardstick against which children's capability were now judged. There appeared to be mis-matches between what teachers knew about small children, the demands of the document and what researchers knew about designing.

McCormick et al (1993) considered the linear model of the design process promoted via the National Curriculum not only to be a poor model of how people solve problems but that its imposition on children leads to lack of ownership of the task.

Baynes (1998) criticised the effort expended in (and since) the National Curriculum on getting children to produce a design drawing and then carry it out. He feels that by giving drawing a role which it cannot fulfil, the National Curriculum has undermined the role of drawing in designing. He cites a bird house drawn by an 8 year old. The product is very different to the drawing, because she carried on designing as she made it "as adult designers do" (says Baynes). There is a mis-match between the National Curriculum model of the design process and the practice of real designers.

### 3.2.4b Observations of Young Children Drawing for Designing

Not surprisingly, many early papers and articles focused on what young children could not do, and whether or not what they could do was what the National Curriculum writers had in mind all along. The lack of research into young children's design skills prior to the publication of the document made its instructions a cause for anger or despair among teachers and frustration for the researchers who now entered the field. The following line by Constable (1994) :

> "Although there is nothing in the Order which states that children need to approach the ATs in a linear fashion - heaven forbid..." (op. cit.: 13)

prompted an instant reaction which I wrote in the margin: *"Why weren't we told?"*

She continues:

> "I would like to reassure KS1 teachers that this articulation of ideas need not necessarily be on paper..."
>
> (ibid.)

The reassurance did not reach us either, since:

> "Th(e) inappropriate use of drawing is partly due to the unfortunate linear approach to D&T which is encouraged by numbering the (old) attainment targets 1 to 4, thus suggesting that the complete design needs to be "generated" before making can take place."
>
> (op cit. p.10)

Constable also highlighted teachers' hazy perception of the role of evaluation, which, again due to the numbered list of Attainment Targets, was seen as the last lesson in the scheme of work. The iterative nature of designing had not been conveyed to teachers and hence was not being conveyed to children. Garvey and Quinlan (1997) observed that Year 2 children regarded their design drawings as "wrong" if the teacher suggested improvements.

The examples of children's work shown in papers and articles such as Samuel (1991) showed that Year 3 children could use drawing to record design ideas but, as the article makes clear, few teachers felt confident as to how to encourage children to do so. Chalkley & Shield (1996) reported Year 5 children being unclear how drawing could support designing.

In Key Stage 1, similar observations were made. Stables (1992) observed Year 1 children completely ignoring their drawings of a "home for a spider" once they began making them. Anning (1993) described two 6 year olds who thought they were giving their drawing to the hamster as a present; they did not see the drawing as a sketch of something they would make. My own observations as a teacher confirmed these. Children at this age appear to see a drawing as a product. Their agenda for the use of drawing is mastering the genre of conveying 3-dimensional objects in a 2-dimensional medium whilst also creating pictorial balance on the paper and aesthetic pleasure in the colours and lines.

I agreed with Egan's (1995) comment:

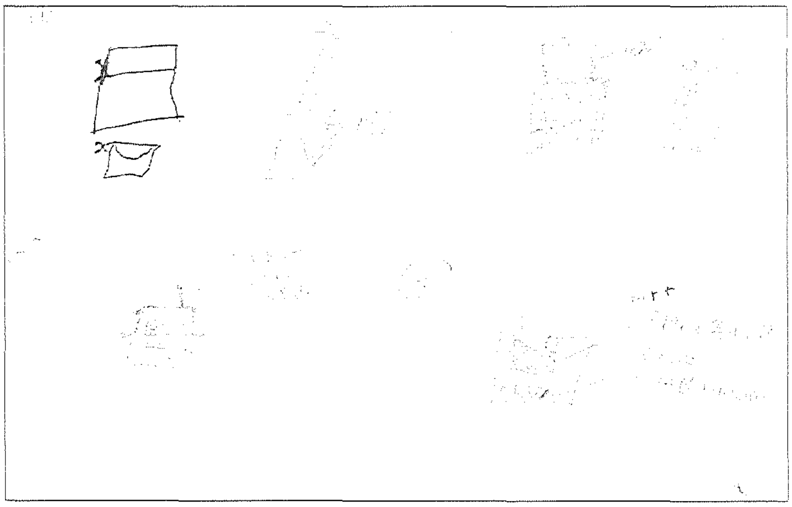
> "certain approaches or intentions while drawing would lead more naturally into design modelling than others." (op. cit.: 9)

But which, and how? She concludes:

> "Design drawing.. is drawing to explain rather than to depict, and as such has more links with the narrative.... It is possible that concentrating on the pictorial reinforces the concept of the drawing as an end in itself." (op. cit.: 14)

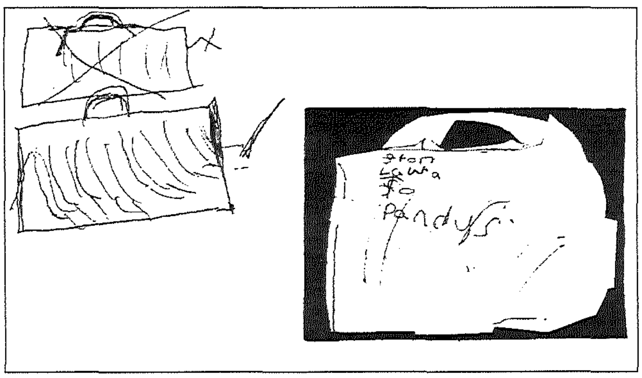
Constable (1994) described the design drawing as needing to be a simple line drawing, probably annotated, with views from different angles and smaller detailed parts drawn separately, but few Year 2 children chose to use the techniques even though they could do them. My observations in 1998 suggested that few children of this age could satisfy Constable's criteria, except in a very structured task, such as that shown in Ex. 6 in response to a mental manipulation task conducted with two classes from each of Years 1-4 (246 children in total) .

I showed the children a cardboard box and told them to imagine they were going to make it into a car. They were told to draw side, top, front and back views separately and indicate the extra materials they would need. The children were not asked to make the car and so the detailed plans may not have been perceived as blueprints for making.



*Ex. 6 ; Yr.2 : Role of Task Structuring (a)*

Shown below (Ex. 7) is the same child's design for making a suitcase for a toy panda, an unstructured task. Her "design" was typical of Year 2 children. The drawing (on the left) shows two attempts to perfect a simple outline drawing. rather than develop ideas about suitcases. The prototype (on the right, mounted on black) shows little continuity of thinking from the drawing.



*Ex. 7 ; Yr.2 : Role of Task Structuring (b)*

From observations of adults and children, Welch & Lim (1999) concluded that since neither opted to develop their ideas through drawing, that drawing was not a necessary part of the design process. However, drawing does improve design efficiency (consideration of options and possibilities prior to engaging with materials of construction) and that some of their subjects used drawing to clarify the terms of the task and to establish mutual understandings of a possible solution. As an educator, I would argue that what people do naturally is not necessarily the criteria on which decisions should be made about what children should be taught. With the hindsight of conducting my own research, I would query whether the isometric drawing techniques taught to Welch & Lim 's subjects imparted sufficient understanding of the *role* of drawing as a designing tool, or whether this was simply a learnt technique for which the subjects saw no application in the design task.

Mantell (1999) suggests using designing techniques familiar to teachers in other curriculum areas (mapping, listing and flowcharts), referring to the work of Wray and Lewis (1997), which could enable children to use graphics and text interactively. My results in the Structured Phase showed a much greater level of annotation of drawings than in the Exploratory Phase and I felt that the introduction of non-fiction texts in the National Literacy Strategy for Key Stage 1 had given children appropriate techniques to use in a Design and Technology situation.

Egan (2001) encouraged children to record their design ideas through drawing, so that the ideas could be viewed and discussed by others, thus enabling communication and clarification of ideas discussed in small groups. After some teacher-led practical tasks to provide knowledge and understanding of materials and processes, the children chose to re-image their ideas and produced more focused drawings of what they intended to make. Again these were older children than those whom I taught, as were those studied by Ching & Hulsbosch (2001).

The "Enriching Literacy through Design and Technology" project conducted in the education Action Zone in Middlesborough demonstrated enhancements in children's ability to record and develop design ideas. In a paper delivered to the Centre for Research into Primary Technology's Third Conference (2001), Rogers & Stables reported that Literacy and Design and Technology had proved to be mutually enhancing. The activity that they used for Year 2 post-input assessment was to become incorporated into my Structured Phase (see Section 4.3.2 & 5.3.1d). The findings of this study (improvements in generating and developing ideas, addressing the task and identifying user needs) were also to surface within my own results (Section 5.7).

Design drawing in the primary school, remains, however, an under-researched area. In his DATA lecture, John Smith raised the following questions:

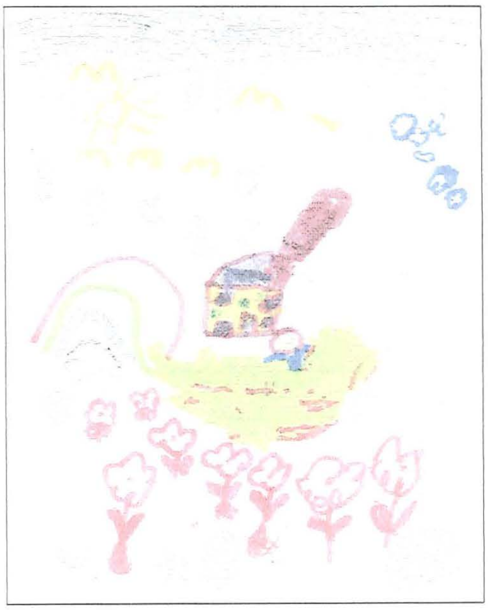
> If sketching is an important modelling aid for designing then surely more research and curriculum development should be undertaken in how to develop pupils' and students' sketching skills which provide opportunities for ambiguity and hence an opportunity for creating new ideas? What age should learning sketching techniques be started and to what depth? Do pupils understand that one reason for sketching when designing is to assist in the generation of more ideas through the ambiguity of the sketches and the juxtaposition of ideas?
>
> (Smith, 2001: 8-9)

He provided no answers and quoted no research into this area which might suggest appropriate answers. One assumes that he considered these questions still to be open and un-researched.

## 3.2.5 Design as internal process

Manual skills apart, my observations suggested that there appears to be a mental block on the idea of using a drawing as a blueprint for making which is not satisfactorily bridged at least until age 8. Before this age most children see a drawing as a product, a picture. It has no bearing on the making task for which they have been told that it is the plan. The potential of the analogy between drawing and making needs to become conscious in order to see that a particular drawing can equate a possible answer, and only one among many.

But little children do not play with their drawings in this way. They do not want to have several tries on one sheet. They want to produce a picture, including what the weather was like behind. Ex. 8 shows another Yr. 1 "Wiggly Worm's House" from the same class as Andy, cited in Section 3.2.2b & c.



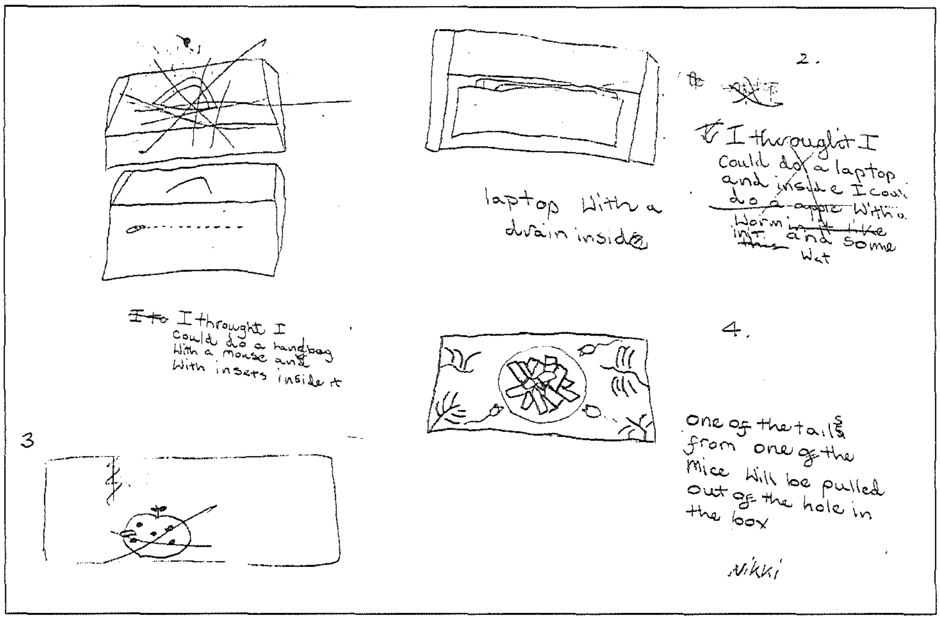
*Ex. 8: Yr. 1 Narrative genre*

This left me with a list of questions for which the literature on children's drawing and designing provided few answers:

- Is children's drawing ability too rudimentary, insufficiently developed to record what they want to make, particularly when combined with their lack of fluency in the medium in which they are going to make the final product?
- Or is it a lack of awareness of the potential uses of drawing?
- Or is it due to the children not having realised the symbolic nature of drawing?

The problem appeared not to be whether they could do the drawing but whether they could model in one medium (the drawing) and then make a product in a different medium which matches, in its essential characteristics, the drawn model.

Year 4 children appeared to be able to use the drawing to support thinking about what to make. Ex. 9 is a Year 4 girl's development of a "Surprise Box".




*Ex. 9 : Yr. 4 Design genre*

The initial idea was a handbag with mice and insects inside. The word "mouse" made her think of a laptop carrycase, but what would go inside? Still on insects, she thought "worm in an apple" and partway through writing the word "water" she broke off to think "drain". I noticed that she was sitting staring into space and sat down next to her. She drew picture 3 as we talked - she was linking insects to bugs - computer bugs. What else had a double meaning? apple/Applemac, mouse, chips. She thought for only a few moments and confidently drew her final design - a plate of chips with a bug sitting on top and mice attacking from all sides. She made it from a shoe box. It was a computer on the outside with a plate of chips, bug and mouse on the inside.

Children in Key Stage 1 frequently do not understand that there can be a connection between what they can draw and what they can make with some other material. They see no analogy between the drawing and the future product. They will conform to the teacher's instructions - make a drawing, make a model - but the drawing does not inform their making unless they are constantly supervised and kept on task. The children may be able to draw, they may be able to see that someone else's drawing is a plan for action, but the conceptual difficulty is seeing that *their* drawing could become a blueprint for *their own* actions.

If a child has not grasped the idea that drawing is symbolic and can become context-free, then they are unlikely to be able to use drawing as a design tool. They may be able to make realistic models and even be good at drawing (in the usual representational sense) but until they see that ideas can be developed by drawing, or from the drawing, then this mode of designing is closed to them. This is part of a larger issue concerning the development of symbolic manipulation. Piaget & Inhelder (1969) saw the emergence of symbolic thought at age three in the development of symbolic play: the "as-if" quality of play emerges and children pretend the materials are something which they are not (Craft, 1997)

Donaldson (1992) reported finding that 6 year olds did not appear to accept the limits imposed by the problem or the information she had provided, adding other characters to the situation ad hoc. She observed that:

> "They did not have a clear conception of *this problem* - this one and no other - which they could hold on to and use in deciding when the problem had been successfully dealt with, so that thinking about it should cease." (p.135)

Perhaps this is one reason why, for young children, the drawing does not necessarily relate to future action. They do not perceive the drawing as in any way providing *the* design solution. It is *one* design solution, the model which they make later is another.

The ability to handle both aspects of designing (addressing the problem whilst imaging possibilities) were to become emergent themes in the Structured Phase of the research.

### 3.2.6 Making for play

In his discussion of modelling, Archer (1992) observed that :

> "...the human mind is predisposed to seek similarities within and between its accumulating conceptions, and to assign these to categories... (plus) the predisposition assign symbols to represent conceptions, categories and relations. The use of symbols permits abstraction in inner thought, and the externalisation of thought for recording or communication purposes."
>
> (op. cit.: 5)

This predisposition towards use of analogy and symbolism emerges early in life. The symbolism which accompanies the fantasy role playing of small children is vital to the abilities which underlie design as manipulation of symbols. Those children who have rich imaginative play are better at visualisation and hence design tasks. Those who do not play so imaginatively do not manipulate symbols, make one thing stand for another, and so cannot image solutions. This might imply that there is a strong link between design capability and the use of found objects in play.

A baby picks up a plastic bottle, for example, to *explore its properties*, the pre-schooler will make it *be* something, the infant school child might make it *into* something and finally, in middle childhood, the bottle will be a *component chosen for its physical properties*. This goes beyond, Bruner's (1978) enactive, iconic and symbolic representation in play into the "making for play" activities in which children of school age engage, e.g. making clothes for dolls, constructing hides and dens, which are closer to the activities of Design and Technology.

In this "making for play" children are prepared to do a fair amount of pretending. A cardboard box become a den one day and a train the next. Total realism is not the aim, but enough to satisfy the requirements of the play. These are tools for play, part of the tool box for a game - a fantasy world which mirrors reality but occupies a different plane of existence. When the game ends, the tools are discarded. For adults, design is needs driven, whereas children are playing. The object forms part of fantasy world and the solution does not need to fulfil the criteria in a realistic way. A hat for teddy to go home in the rain can be made from ordinary paper. Properties can be re-assigning as a part of play.

Winnicott (1971) concluded that human play arises from the capacity to make bridges imaginatively between our own inner reality and the external. Children combine objects from outer reality with ideas from inner reality to create a "dream potential". This seems to me to be the same skill as designers use. Even something as simple as a concertina-ed strip of paper with a string attached and called an Inch-worm can become a spring-board for play for small children and stimulate the imagination further. Bailey (1971) closely allied to the child's scientific search, seen first in an infant's grasping at objects, feelings of pleasure in exchanges with significant adults and the need to explore :

> "....the basis of creativity is need, a need to know and express feeling, a need to come to terms with what is already known and what is only partly known." (p. cit.: 118)

Aided by the acquisition of language, this leads to planning, comparing, categorising, which in turn become the foundations of creativity. Craft (1997) perceives "possibility thinking" as the core element in creativity; involving play, asking questions and motivation.

Language-mediated play, as the culmination of representational play, is essential for school success. Schomburg (1999) conjectures that one of the reasons that children with good representational skills do so well in school is that their opportunities for play are not cut off. These continuing inner fantasies are crucial to taking designerly playing into a more mature form of designing. This would accord with my observations of Andy (cited in Section 3.2.2) who had not achieved Schomburg's language-mediated play until at least two years after his peers.

The relationship between children's play and the adult trait of playfulness was explored by Lieberman (1977), who compared the results of a set of "Divergent Thinking Tasks" to a "playfulness" scale for teacher assessment, on which she found correlation both for small children and adolescents, concluding that playfulness continues beyond childhood to become an adult personality trait. One of her "Divergent Thinking Tasks" (product improvement) was a classically Design and Technology task: "How could you make this doll/toy dog more interesting to play with?"

Coghill (1989) also observed making and playing to be early indicators of design capability. Like playing, designing involves the use of cognitive maps, ideas and representations to consider the means towards a "not yet fully perceived end, making meaning through action or imagined action." Like Bailey (1971), Coghill perceived curiosity as a spur to meaning-making, often embedded in, or projected into, aspects of physical reality which act as holders for thought and action, so they can be worked on or changed.

Yet drawings seem to have no such function in young children's minds. The children in my Year 1 class did not use their drawings as a tool for planning what might be made with other materials. Once a drawing was finished, the thinking had finished. It was not a springboard for something else. Kress (1994) described the way a drawing changed its function once a child had cut it out, to become an object for play, something I observed often in my Year 1 classroom. For example, one day a boy brought in a "ghost" he had made with his childminder. It was a piece of tissue paper, draped over a second piece rolled into a ball, tied round with a piece of thread to make a neck, dangling from another length of thread attached to the top of the head. By 10 o'clock half the class had one and were playing with them and conducting conversations through them.

In their playing and their making such young children use their perceptions of the similarities between things, the analogies which they perceive all around them, sometimes by serendipity, sometimes by intent, using and combining them playfully and creatively to design a self-propelling, shared world. In this, they are acting in exactly the same way as adult designers. Hence the term employed by Baynes (1989): designerly play.

Smith (1992) asserts that pattern-recognition prevents the imagination running out of control and confusing reality and fantasy. He sees this as the mechanism as the brake on fantasy running out of control. This pattern-recognition is socially learnt and practised in play. Children with a rich fantasy life are often the most adept at creative and design tasks. They have learnt to exploit mental fluidity, yet they have a strong sense of what would really work.

## 3.2.7 Reflections on Section 3.2

By the end of the Exploratory Phase, I had searched the literature on children drawing and made connections with my informal observation of children. I was also reading in related areas: problem-solving, creativity, language development. I was becoming interested in generic cognitive functions which expressed themselves in the capacity to model ideas and record these in drawings. Observations that I made in classrooms gave me a perspective on my reading, and vice versa. For example, trying out the canonical cups with about 100 children for whom I had design drawings gave me a good feel for this measure of inner imaging among 5-6 year olds.

There seemed to be few studies of consequence of children's drawing for any purpose other than picturing or of children using drawing for planning to make. What was required was a longitudinal study of a convincingly large cohort of children, so that an audit of skills at different ages could be compiled. My own explorations (detailed in the following Section 3.3) seemed to be among the only ones being conducted.

I was becoming convinced, via my colleague Sue Hammond's M.A. study on emergent writing, that the place-holding of ideas through a mixture of graphics and text-symbols, which appeared as a staging-post towards literacy, had potential for recording of design ideas. If children just past their fifth birthday (as was Shelley who produced Ex. 10) could use drawing and text so interactively to tell me about playing in her garden, then surely, I reasoned, this skill can be harnessed for developing design ideas at quite a young age. However, most research into children's drawings continues to be from the viewpoint of drawing as art, as the finished product and not as a plan for future action. It was to be the literature on cognitive development, language and emergent literacy that would give me the most useful insights into how young children might be enabled to access the genre of design drawing and use it as a tool for thought.

*Ex. 10: Yr. R Place-holding meaning*

## 3.3 Observational Constructs

From January 1996 to July 2000 I was exploring and trying out ideas with different groups of children across the school as well as collecting drawings from other teachers' lessons. Those activities were to form the basis of my understanding of how young children's use of design drawing evolved over time. For my findings to be reliable, it was important that the drawings I considered were not just from lessons conducted by myself or that were presented in just one particular way. I wanted to know what children across the 5-9 age range could actually do, in terms of using drawing to support designing in a range of contexts. I developed a classification system, which was to be carried forward into the Structured Phase as part of my analysis instrument (Section 3.3.5).

As Design and Technology Co-ordinator, my role was to act as subject leader, to write the subject policy documents and the long-term and medium term plans and liaise with colleagues from other local schools and with Paul Shallcross, Kent County Advisory Teacher for Design and Technology. As part of the school's quality assurance procedures, I was required to work alongside colleagues in a supportive role and to observe their Design and Technology lessons, from which I gained insights into children's capabilities at different ages. Some of my colleagues' lesson ideas became part of my Structured Phase Programme. An initial survey was conducted in Summer 1997: a Punch & Judy Theatre as a series of three lessons, to develop colleagues' confidence in teaching Design and Technology whilst, at the same time, enabling me to observe children designing.

Throughout my research, observations, feedback and discussion with colleagues were important in developing my understanding of what young children could do. Sue Hammond, the Literacy Co-ordinator, was conducting research into children's emergent literacy skills and Mrs. R., the Art Co-ordinator, began a Masters Degree in Expressive Arts. This meant that we were constantly sharing ideas, discussing issues of methodology or cognitive theory and suggesting useful texts to read. The Special Needs Co-ordinator was often part of these discussions, with her expert knowledge of children's cognitive development.

The Kent model for teacher appraisal was by peer review and so, for example, the Deputy Headteacher observed one of the Stan96 lessons as part of this process. Her transcript of my introduction of the activity became the basis of my script for introducing the activity across the school in 1998. Throughout the Exploratory Phase, therefore, my activities were under constant peer review and scrutiny. This not only enhanced the validity and reliability of the research but gave me confidence in the evaluative judgements that I was making.

## 3.3.1 Mapping the Field

My understanding of methodological issues at this stage was rudimentary. I knew that for the sake of validity, I needed to keep as many variables as possible the same in each task presentation. Yet, for the sake of reliability, it would be better to have several colleagues involved. However, in order to maintain a measure of consistency, all activities were introduced by me, even though, once working, many children were supervised by teaching colleagues or other adults.

I believed that it was unlikely that children would use drawing in a very different way during a single lesson that I was delivering to that to which they were accustomed with their own teacher. This was borne out across the three years period of the Exploratory Phase, as I began to identify varying levels of understanding of designing among my teaching colleagues through taking their classes for these occasional sessions.

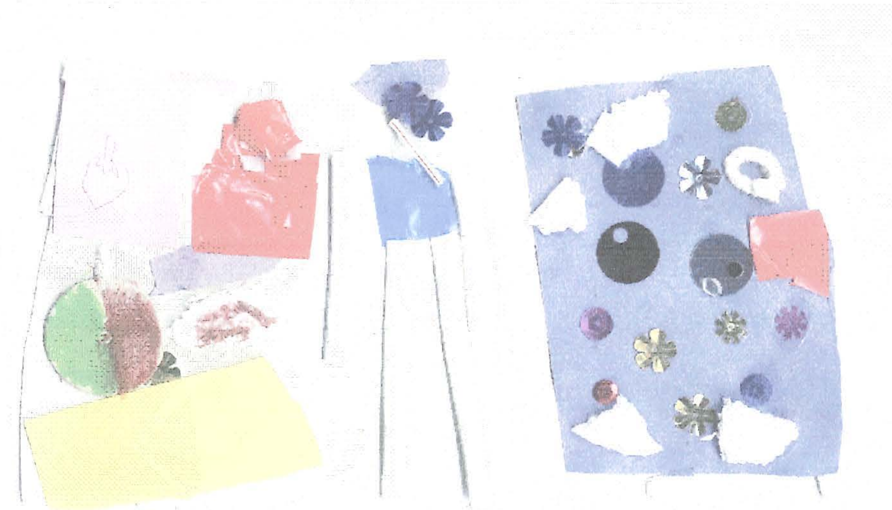
For all activities the children were provided with sheets of white "kitchen paper" for drawing ideas, throughout both Exploratory and Structured Phases. In the Exploratory Phase, I wanted to discover how children used drawing to support designing and felt that providing a pre-printed worksheet might guide them in a particular direction and that I would not get a true sense of what they would choose to do unaided.

### *"Stan96"*

Mrs.R., the Art Co-ordinator, had read "Flat Stanley" by Jeff Brown to Year 1 and suggested that children working in pairs to design and make a puppet to go in an A5 envelope as a suitable task for the small-scale research project which was part of my M.A. course. I conducted the activity with all children in Year 1 (96 children), some of whom worked independently in peer pairs, some helped by an older child (Yr.4), some by teenagers and some by parent volunteer helpers . All pairings with older helpers were audio recorded, as were an equal number of peer pairs. In general, the Year 1 children relied on the older partner to tell them what to do. The parents allowed the children least lee-way in making their own independent design decisions. whereas my daughter became extremely skilled *("Do you want this group guided or unguided, Mum?").*

The Year 1 children had little idea why they were planning on paper before making the puppet. *"Why are we doing this twice?"* became a question which, for me, would not go away. With hindsight, they should, perhaps, each have made their own puppet, even if they had collaborated on the planning. Some pairs solved the problem by one child decorating the design sheet (Ex. 11 ) whilst the other made the puppet.

They paid scant attention to the construction materials whilst drawing their plans. Some children took a selection of materials to their table and then chose from amongst this selection once they had drawn the figure on the card and some drew the figure onto card first and then went back to the resource table and chose their materials. Whatever they were doing on the design sheet, it was not planning construction. Feedback from my teenage helpers suggested that guiding the Year 1 children towards using drawing for planning what they would make was difficult since the children had no concept of what was being asked of them. One of my Year 1 colleagues, Miss S., who had previously taught in Year 4, felt that even these older children had limited understanding of design drawing.



*Ex. 11 : Yr. 1 : Flat Stan (1996)*

### *"Insects97"*

As a result of Stan96, I believed that I had established that Year 1s did not have much understanding of planning and designing, but what about Year 4? I began with the expectation that Year 4s would be more likely to articulate their understanding of design when they were in an organisational role. Sue Hammond selected some "good designers" from her Year 4 class to each work with two Yr.1 children.

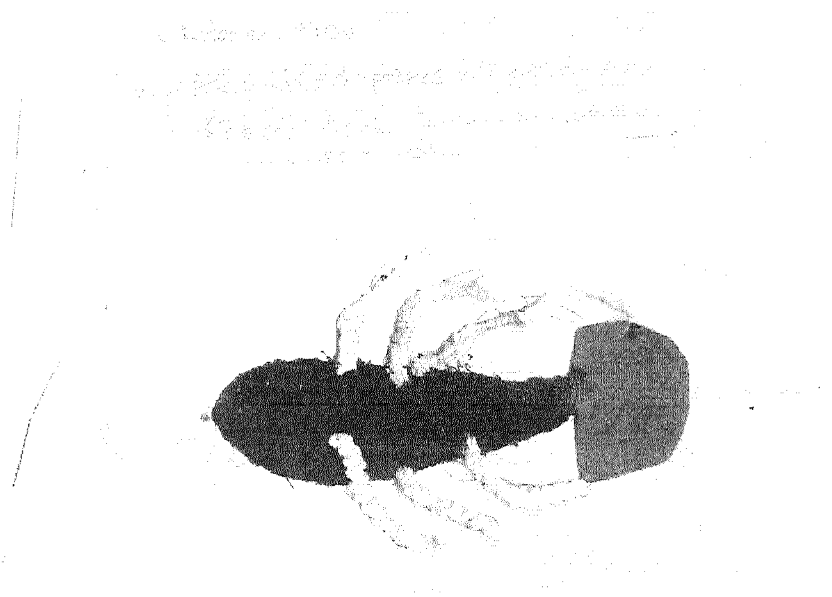
In order to study the design aspect separate from the making, a task was needed for which this separation would not be too contrived: putting together a kit for a younger child to complete unaided later. Thus although the input of the Year 4 children terminated at the planning stage, they had to think ahead to what the Year 1 child would need for task completion. Working with the Year 1s who would be assembling the kit would, hopefully, enable the Year 4s to realise what was needed.

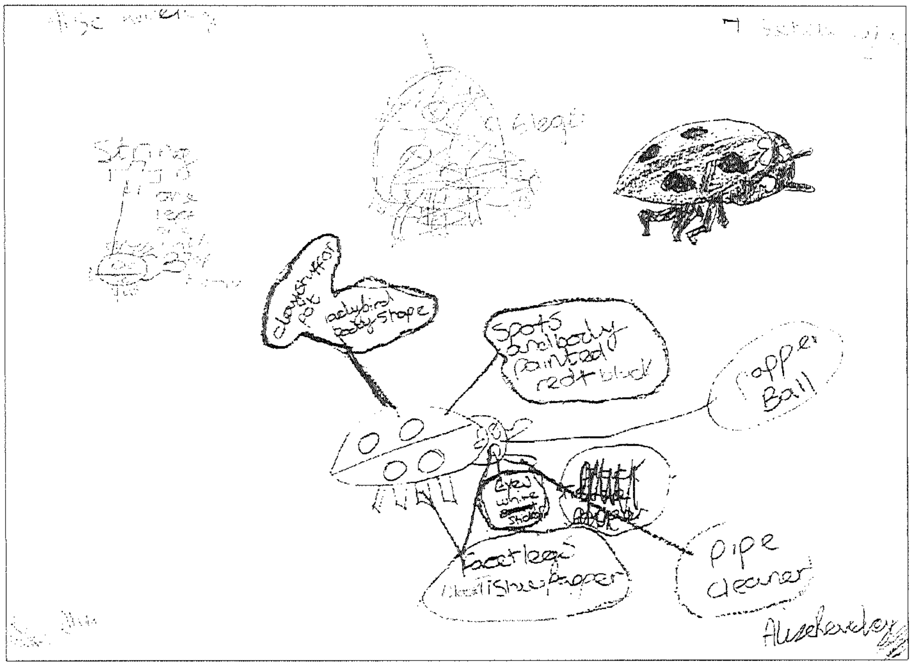
The children showed no inclination to use drawing as a tool for thinking and seemed unaware of drawing as a way of developing understanding of the problem, exploring or communicating ideas, or supporting their, frequently rich, discussions. They were relying on developing shared meanings with their Year 1 clients through talk. This also appeared to get in the way of the production of a template for creating a model based on the design. They did not see either the drawing or the template as stages towards final product that the Year 1 children would make but as discrete products in themselves to be produced because they were on the instructions. The template was frequently treated by the Year 1s as a base to decorate, not a pattern to draw round, as also were some initial drawings.

The following year (1998), I repeated the task but kept the children apart once they had decided on the insect to be made. The Year 4s developed the kits in their own classroom, coming to me each day for feedback and collecting materials. The results seemed remarkably similar to the previous year's and so the presence of Year 1s for the entire process had not hampered the Year 4s in 1997. Since the Year 4s were not present for the making, they were not aware and, therefore, unable to trouble-shoot problems with the kit that they provided. We had one Year 1 boy in tears because he could not make the ladybird because he could not find the red cloth. He found it hard to accept that older children could have made such a simple mistake as forgetting to put it in the envelope.

In hindsight, I think that part of the problem was that in 1996-7 Design and Technology was still a relatively undeveloped subject area in school. I was feeling my way and design drawing was not being taught consistently in school. Some teachers gave their classes sketch books to record ideas, but most did not, including the class used for the Insects97 task. Over the years, I have noticed that design skills generally across the school have improved as teachers' understanding of Design and Technology has increased and children's capabilities have been developed as they pass through the school. The examples overleaf (Ex.12) show the difference between the use of drawing for designing between the Year 4 children involved in Insects97 and the Year 4 Art Club 2000 children, who were involved as Year 1s in Stan96. Both are representative of average capability. The 2000 example shows clearly that this girl was thinking of a 3-dinemsional product as she drew, the 1997 girl simply drew an insect and the way she used the drawing led the Year 1 child to treat it as a flat shape to decorate.

*Ex. 12 : Yr. 4 : Insects (1997 & 2000):*





## 3.3.2 Distinguishing Drawing Types

I began my investigations for my M.Phil./Ph.D. by building on the small scale studies and the understandings I had gleaned from them, together with the associated reading from the M.A. course. These materials were heavily weighted towards Secondary Schools and my own endeavours had led to finding only a handful of texts, even in 1997. No wonder teachers lacked expertise. Therefore, as well as reading as widely as possible around the subject, I began to conduct my own experiments within school. These were to lead to the identification and naming of different types of drawing used by children in response to design tasks.

### 3.3.2a Through "Stan98"

The aim of Stan98 was to try Flat Stan again and add a follow-on task "Round Stan" in as many ways as possible across as many classes as possible to find out what worked best and what commonalties existed regardless of presentation. 279 children made Flat Stan, of whom 197 also made Round Stan (Table 1).

| | Flat Stan | | | | Round Stan | | | |
|---|---|---|---|---|---|---|---|---|
| Year Group | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 |
| No. of Classes | 2 | 3 | 3 | 2 | 2 | 1 | 3 | 2 |
| No. of Children | 39 | 83 | 94 | 43 | 28 | 28 | 83 | 58 |

*Table 1: Research Subjects : Stan98*

I wanted to try as many formats and ways of presenting the task as possible in order to find out what worked best, as well as how well the children understood the role of drawing for designing. I did not question children closely about their intentions since I was looking quite specifically at what children recorded on paper. I attempted to devise ways of handling quantitative data using databases that evolved as I looked at an ever-increasing number of factors as my ideas about how young children use drawing for designing developed.

Initially, beginning with the Flat Stan task, I looked at:

- Satisfying task criteria (Was Flat Stan flat? Did he fit in the envelope?)
- The use made of the drawing (Did they pre-draw? Was there more than one attempt at drawing?)
- Recording materials (Did they draw the puppet as if made from the materials supplied?)
- Relationship of product to the drawing (Did it look like what they had drawn? Had they used the materials provided or had they simply coloured a cardboard cut-out?)

Inclusion of the Round Stan task, and the desire to compare the two, led to extensions and refinement of some of these categories:

- The use of the drawing (For children who did more than one drawing, was there a range of ideas or had they simply tried to improve the drawing of a single idea?)
- Recording materials (Had they indicated intended colours? Had they indicated intended materials?)
- Appropriate level of detail (too much was a bad as not enough!)
- Labelling (arrows or lines linking words with drawing)

Throughout the analysis process I used a simple 1=Yes, 0=No for the database field entries with summation fields for more global skills (satisfying task criteria, use of drawing, recording o materials and relating making to drawing) which attempted to answer the question "To what extent?" with regard to capability in each skill area.

These skills summation fields were then summed to make a Total Score for the task. Table 2 shows the Form view of the Flat Stan section of the database by which all these early trials were analysed (see Appendix N: AN1.1 & AN1.2).

| | | | | |
|---|---|---|---|---|
| FLAT STAN: 7 | | | | |
| F.CRITERIA: 1 | F FITS: 1 | FLAT: 0 | | |
| F.DRAW SCORE: 3 | F PRE-DR: 1 | F MULT DR: 1 | F MULT DES: 1 | F DR DET: 0 |
| | F VIEWPOINTS: | F EXPANDED: | F LABEL: | |
| F.RECORD MATS: 1 | F COLOURS: 0 | F DRAW MATS: 0 | F WRITE MATS: 1 | |
| | F INSTRUCTS: | F EQUIP: | | |
| F.MAKE SCORE: 2 | F MATS: 1 | F RESEMB: 0 | F EXACTLY: 0 | F MK DETAIL: 1 |

*Table 2 : Database, Form view (the "F" Prefix indicates that this is the Flat Stan section)*

This Year 2 child has a total score for Flat Stan of 7, composed of:

- Criteria score of 1 : the puppet fitted the envelope but was not flat.
- Draw score of 3 : they pre-drew their idea on scrap paper; there was more than one item on the paper; these represented different ideas.
- Recording materials score of 1: they had written the intended materials to be used.
- Make score : they used the same materials as indicated on the drawing; the level of detail in the finished puppet was appropriate to the materials provided (i.e. they did not make a detailed drawing to the card and then cover over the drawing with fabric or sticky paper, which was common amongst Year 2 children)

What this child did not do that other (probably older) children did:

- Draw in sufficient detail to convey design intentions.
- Indicate colour or draw the puppet as if made from the materials provided.
- The puppet did not resemble the drawing.

This scoring technique was, admittedly, crude. However, the findings fed into my growing understanding of children's design capabilities. Appendices N includes the full form view of the database and spreadsheet for all these early whole school activities. The Total Scores for all the Stan tasks (Chart 1) produced an approximation of a normal distribution curve, which felt reassuring, since this data represented the work of children across the 5-9 age range, exposed to a variety of task presentation methods, and supervised by different adults.

*Chart 1: Stan98 (a) Stan tasks: all children*

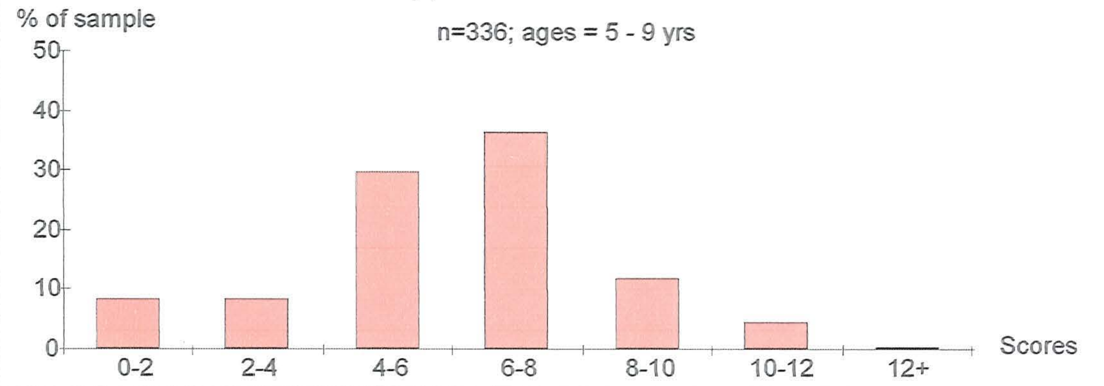
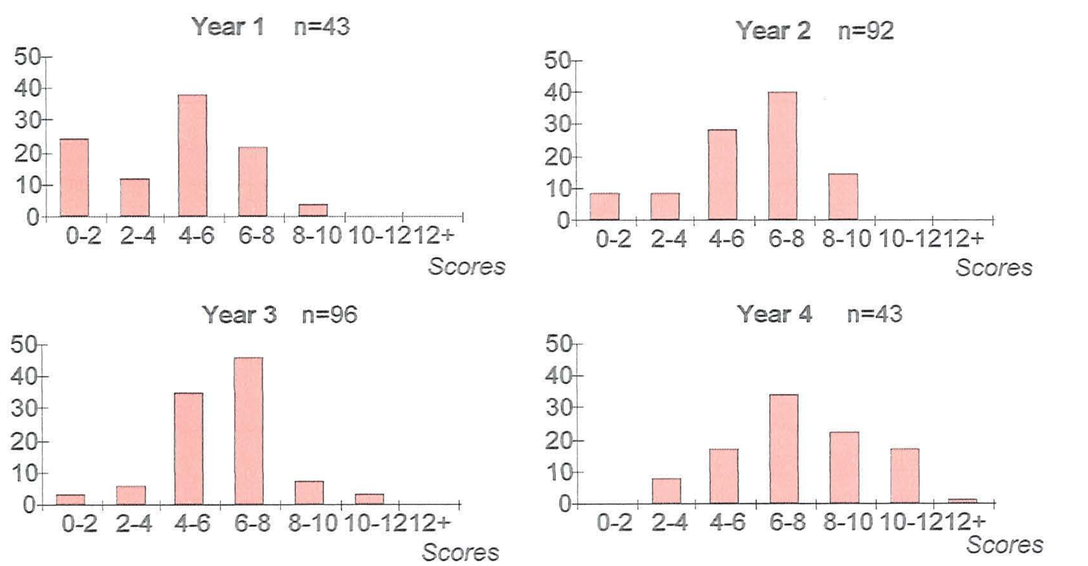


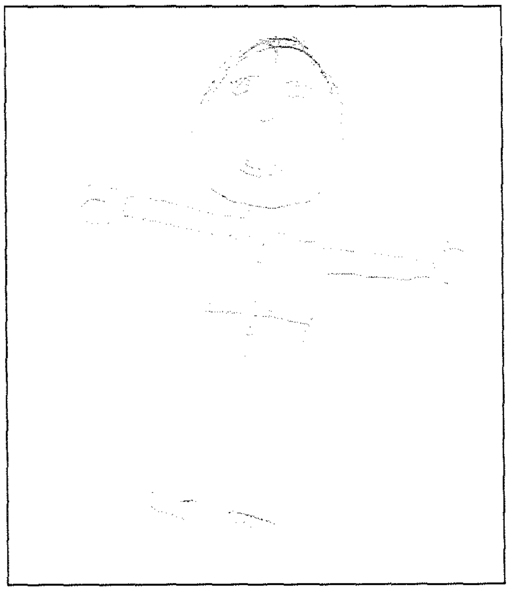

Chart 2 shows the results for each year group for Flat Stan only, since there were less children involved in Round Stan and a greater variation of task presentation. The Stan96 children were the Year 3 cohort in this study in 1998.

*Chart 2 : Stan98 (b): Flat Stan acoss whole school*



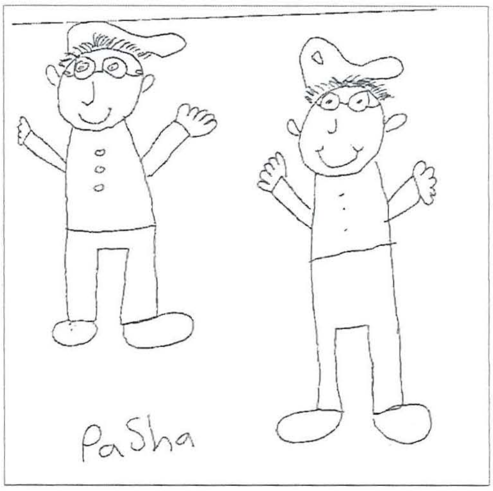
By distinguishing between the number and types of drawn items on the paper, I began to get a sense of different uses of drawing to support designing. At this stage, I was considering this to be a linear progression, since findings such as those represented by Chart 2 seemed to suggest a growth in understanding with age. This over-simplification was not to be resolved until the Structured Phase (Section 5.4)

Key Stage 1 children (and less able older ones) tended to produce a *single drawing* quite quickly of what they wanted to make (Ex. 13). If they were thinking about the realities of making the product as they drew, these were not indicated in the drawing. The conversations between children centred on clarifying the task more often than on developing ideas about a product. Some children cut out their drawing and stuck it onto a lolly stick "handle", despite the unsuitability of the flimsy kitchen paper for a final product. I tried hard to convey the message that this was scrap paper for playing with ideas.



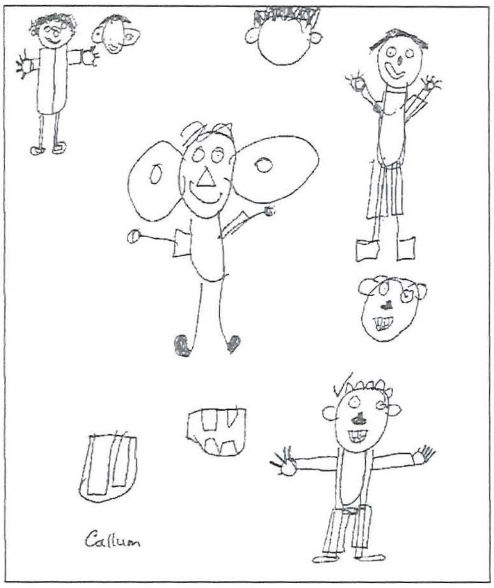
*Ex.13 : Yr.2 : Flat Stan (a)*

There was a distinction between *Multiple Drawings* and *Multiple Designs* (Exx.14 & 15 overleaf). Some children re-drew their one idea more neatly whereas others recorded several different ideas. This also seemed to be age and ability related. A schematic of the finished puppet demonstrating its parts and / or materials appeared to be a distinguishing characteristic between drawing a picture and designing a product.




***Multi-drawing***

*Ex.14 : Yr.2 : Flat Stan (b)*



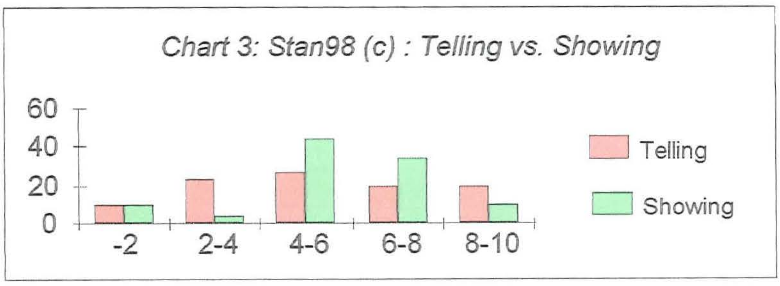

***Multi-design***

*Ex.15 : Yr.2 : Flat Stan (c)*

More Year 3 children drew their Round Stan figure as if made from the materials or wrote down the materials than for Flat Stan. I was unsure whether this was because Flat Stan was seen as a decorated card copy of the drawing and so they had not thought about materials until "decorating" stage or whether it was due to practice effect. Older children, especially Year 4 girls, put in too much detail e.g. zip and pocket details, indicating that they had not understood the drawing as planning to make *with the materials provided*. Some re-drew their Flat Stan figure onto card in great detail and then pasted fabric on top.

Drawing as a means of designing appeared generally to be beyond the capability of Year 1, even if supported by an adult, although several ways were tried. They were successful planners if they told an adult or a tape recorder what they were going to make, but they could not *draw* and make. They were not using drawing to image ideas to be made in another medium.

The importance of seeing as well as hearing was re-inforced through comparing the responses of two parallel Year 2 classes for whom the only difference in experience was in seeing the illustrations in the Flat Stanley book rather than simply having the story read to them (Chart 3).



This was sparked by fellow researcher saying to me, "If I was a six year old and you showed me the pictures in the book, I would just copy them." This proved not to be the case. Children who saw the pictures produced a greater range of ideas for their puppet than those who did not, possibly because seeing the pictures enabled them to understand that the puppet had to be flat and so they used drawing to play with ideas for making a flat figure. Those who did not see the pictures tended to produce single stereotypical human figure drawings.

The importance of seeing as well as hearing was re-inforced through considering the drawings of the third Yr.2 class, who were shown preliminary drawings done by two teenagers (who were able to be compared with a Yr.4 class who had the same Round Stan introduction). Both classes produced clearer, more designerly drawings than their respective peers, leading me to conclude that it was important to show children what I meant by a design drawing. This Yr.2 class also made a "Stan Buggy" in which I asked them to choose the main components from the recycled materials box before starting to draw. They produced a single, well-focused drawing and then made what they had drawn, implying that providing the major components might limit the range of ideas but that this aids thinking towards construction.

Although making a puppet is a common D&T task, a host of questions arose:

- How truly "Design and Technology" was it?
- There was no client or user to consider. Did it matter?
- Did the children view it as D&T or Art? Did that matter? Is the design process the same?
- Did the fact that the product was a human figure make a difference? Would there have been more varied ideas for a different product, less likely to produce a stereotypical response? How many children just drew their current representation of a person?
- For Flat Stan, was there a problem with it being flat and made of card? Many children were simply copying their drawing onto card and then decorating it.

I had purposely chosen something simple to make so I could concentrate on the drawing but I worried that there was not enough scope in the task, not enough of a problem for the children to tussle with. I wanted to do a trial run with something else, which had a client, could not be confused with art, not prompt stereotypical responses and have some constructional issues with which to grapple.

I had identified three kinds of drawing that children produced in response to design tasks: *Single Draw, Multi-draw* and *Multi-design*, which implied: a single quick sketch, more than one drawing but subsequent drawings are simply neater versions of the first, and recording of several different responses to the task requirements.

### 3.3.2b Through "Pandy98-9"

In July 98 I tried another idea with my own Year 1 class and a Year 4 class - Pandy's suitcase. The children were to design and make a suitcase for my toy panda to take on holiday. The handle of the suitcase must fit over his arm, and not be too big that he could not carry it nor too small that he could not get his belongings inside. The modelling (working out with the paper) was to include making sure that what they made fitted by trying it on the toy panda. This concept seemed even harder for Year 1 to understand than "draw before you make".

Year 1 mostly drew the suitcase and items of clothing, sunglasses, bucket and spade etc. on one piece of paper and then cut them all out. Many first attempts were drawings of suitcases, with little regard to the size of the panda, which were cut out, and declared finished, even after other children who had a better idea of what to do had made considerable progress towards success. What seemed to be stumping them was the idea that I wanted a real suitcase that Pandy could put things in, not a picture of a suitcase. *"That's the suitcase"* they kept saying, showing me their cut out drawing. *"How do you get the clothes in?"* I kept asking. *"In there"* they replied, pointing at the suitcase. Some of them folded up the edges of the suitcase, and I demonstrated the cut out clothes falling off of it. They were sent to look at my handbag and school bag. The overall solution was to cut out two flat, suitcase shaped pieces and staple them together. Those who still did not understand what they were doing put the staples through the middle rather than round the sides.

For example, Avril cut out two suitcase shapes, complete with handles, stapled them together and cut large holes in the body of the suitcase:

> *Me to Avril: "Why's it got a hole in it?"*
> *Avril: "So he can hold it"*
> *Me: "Won't his things fall out?"*
> *Avril: "No"*
> *Me: "Have you ever seen a suitcase with a large hole in the middle?"*
> *Avril: "Mmm" (uncertain).*

What came across was that they had not thought in terms of making a real thing that worked (suitcase) or that they were planning real things to go in it (holiday items). They were making things that could be pretended to be the real thing. *"Does it fit over his arm?"* could be managed; they tried it on. *"Does it hold things?"* could not because they had not realised it was meant to. Cutting out pictures of the holiday items that were minuscule in comparison to the size of the panda, were flat and made of paper did not bother them at all. They were willing to pretend that the panda could wear them. My protestations that it could not was greeted with amusement, puzzlement, confusion, even dismay that I was not as delighted with their results as they were.

This experience led, inevitably, to more questions:

- At what age do children start to make real things for their dolls and action figures?
- Why do they not do it earlier?

And some tentative answers:

- It is not to do with motor skill.
- It appears to be to do with their pre-occupation with play and fantasy. Their imagination would make up the shortfall on reality of the items they had made.
- This would appear to stand on its head the idea of children progressing towards symbolic representation. What they had made were symbolic representations of suitcases, *rather than* suitcases.

In contrast, Year 4 had little difficulty with the task. Making it fit the panda was solved by measuring. They were engaged in the reality of solving the task. No one cut out pictures as final products, although some appeared to be drawing what they wanted to make in order to clarify their ideas about how it would look. Some appeared to be engaging in the ritual of draw and write instructions. They did not exhibit the spontaneous *"I know how to do this"* that had been in evidence in Year 1 (although such confidence was largely mis-placed).

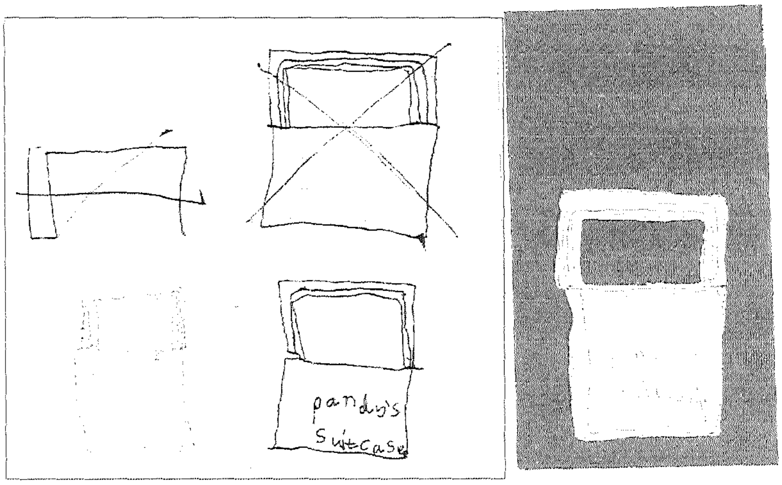
Secondly, they showed much greater flexibility in choice of technique, looked at and assessed each others progress and made subsequent adjustments to their own. They were confident in finding materials they needed (e.g. sellotape, treasury tags) without asking me. They also asked for more paper as and when they needed it. They were less inhibited about starting again if it went wrong.

The task appeared to be sufficiently challenging whilst being within their capability. I had wondered about its suitability, especially for Year 4 boys. However, no one quibbled about making such an item. Perhaps this was aided by the initial discussion about keeping such toys from early childhood (the toy panda is genuinely mine). I was pleased with the results. It was a step closer to producing a real artefact than Stan had been. So Pandy's suitcase was conducted across whole age range, 2 classes per year group in the following Spring term.

I knew that we were into the grey area between fantasy and reality. I was asking the children to design a real suitcase to fit a real toy panda in which he could put a real plastic mac but pretend he could go on holiday. I decided that I would resist telling them it needed two sides but would prompt them to think about it with the question *"How will he put the mac inside?"* or *"Can he put his mac inside?"* I did not want them failing the design task simply because they had misperceived the reality/fantasy divide inherent in the task. I would, therefore, positively intervene where a child told me they had finished when they had only a cut out picture of a suitcase and not allow them to pretend that they could put the mac inside. If this made no sense to them I would leave it, but I thought it unfair to discriminate against those who had consulted me (or had even been sent to ask) while others gleaned the information from observing successful peers.

***Observations in process:***

Year 2 - No rulers in evidence here, except to rule straight lines. Quite a lot of *"How will he put his mac inside the suitcase?"* prompts needed.



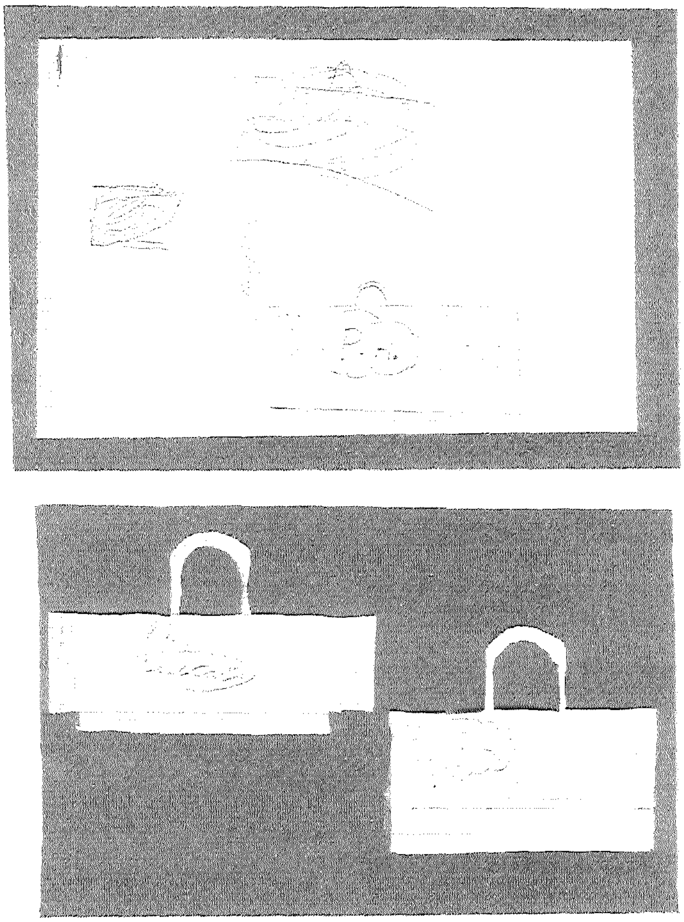

*Ex.16 : Yr.2 : Pandy's Suitcase (a)*

The design sheet in Ex.16 has become rather crumpled and smudged due to lying on the table whilst the suitcase (right) was made. The suitcase was made in pale yellow card (hence mounting on black) but was single-sided. Effectively, the child had perfected their drawing on the design sheet, copied this to yellow card and cut it out, without realising that a real suitcase to hold Pandy's mac was required. Imaging of real suitcase had ceased once perfecting the drawing had taken over as the priority in the child's mind.

Year 3 - Many spontaneously got rulers and passed the mac around to measure it. Their design drawings were done to these measurements. I told those who had done this to put the measurements on the drawings so that I would know they had done so. Some children, however, put more effort into designing different pictures and logos for the outside of the suitcase than how it would be made.

Year 4 - Comparable level of sophistication to pilot study class : for example, *"Can I draw a net for the suitcase as my design?"* but also, as with Year 4 girls on the Stan task, their interest in fashion details often overrode the reality of the materials provided for making the item.

Despite drawing just one idea (after a couple of false starts) the child whose work is shown in Ex. 17 made an exact copy of the shape and logo as drawn on the design sheet. Construction was not recorded in the drawing. The suitcase has been taken apart so that each half can be seen separately.



*Ex.17 : Yr.4 : Pandy's Suitcase (b)*

***Reflections:***

- More sophisticated drawing techniques (multiple viewpoints, labelled diagrams and expansion to show small detail) were used by Year 3 and Year 4 children than had been in evidence in the Stan task. Pandy had triggered more designerly thinking.
- These older children were grappling with the reality of the task (e.g. spontaneous use of a ruler) whereas younger (Key Stage 1) children were sincerely pretending.

Appendix N: AN1.3 & 1.4 show the database through which evaluations of the children's drawings were quantified. As a result of this analysis, I needed a new label (beyond ***Multi-design***) to describe the work of children who had used their drawings to develop a design solution: ***Progressive***. They had begun with a basic idea (or a range of ideas), sketched this and then used drawing to record how they would make it, perhaps through one or more labelled diagrams or by drawing it from several viewpoints. This appeared to me to be a major stage in their understanding of drawing for designing. They were imaging a real object they wished to make and using drawing to work out how to make it.

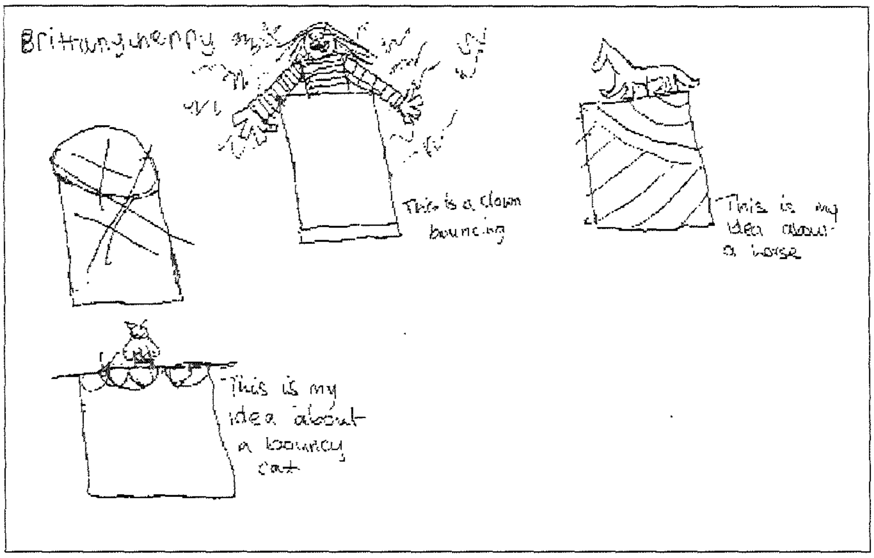
## 3.3.4 The Outliers

***Interactive Drawings***

Among the many smaller samples of children's drawings collected across a range of less structured settings, the experience of helping to run an after-school Art Club with Year 4 children added most to my understanding.

One of the projects was a "Surprise Box" for which the children had to make the inside of a box into a surprising interpretation of the theme of the outside of the box. The children's use of drawing as they grappled with this play of ideas and double meanings led to identification of a new Drawing Type: ***Interactive***. A few of the children were evaluating and combining several drawings to create new solutions to the design problem. These Interactive drawings had several drawings on a page, a clear thread of thinking could be determined across them and they combined features of previous drawings in new ones. The children were becoming genuinely evaluative about what they had drawn. An example of one of these is shown in Section 3.2.5 as Ex.9.

The following year, we did a "Surprise Tube" for which the children had to make a card tube into an object whose contents were surprising, a sort of Jack-in-the-box (Ex.18, overleaf). This time there were more children who were beginning to use drawing in an interactive way, suggesting that the standards across the school were going up.




*Ex.18 : Yr.4 : Surprise Tube*

***Non-designers***

There were, however, children from every age group, regardless of task or its means of presentation, who did not use the planning sheet for planning. They either cut out the drawing of Flat Stan and pasted it onto card or stuck the puppet's stick directly onto the cut-out drawing. There were some who used the planning sheet to draw Pandy going on holiday carrying his suitcase. They were oblivious to the different working methods of other children around them.

Providing all children with paper for planning at the start of the session, obliged them to record something before making and I labelled these as ***Picture***. The difficulty in knowing if a single simple drawing of a human figure was a picture or if it was intended as a design for a puppet led me to realise that puppets (and specifically Stan) were not suitable as an assessment task.

## 3.3.5 Classification of Children's Design Drawings into "Drawing Types"

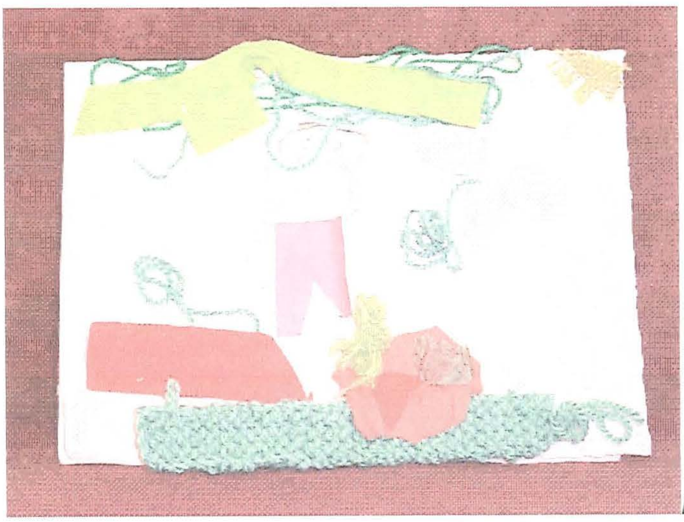
Throughout the Exploratory Phase, the features of the children's design drawings were recorded on databases, which enabled the classification of the drawings into the following "Drawing Types". All examples are taken from Stan activities.

***The Picture***

The child sees the drawing as an end in itself, rather than future-planning. The child may includes features of narrative or representational drawing which are inappropriate to the genre of design drawing.

*Ex. 19 : Drawing Type : Picture (a)*

The child is not addressing design problems and client needs, they are drawing a picture which relates to the subject or problem. The drawing is perceived as a product, a completed activity, which does not cascade into the making process. Therefore, the drawing may either be abandoned completely and something entirely different be made, or the picture is decorated to make a collage of the subject instead of making a product.

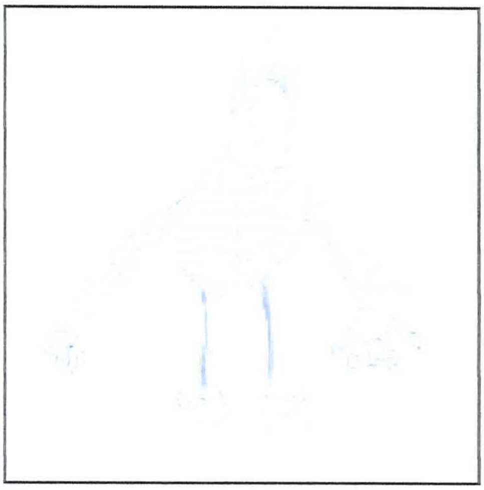


*Ex. 20 : Drawing Type : Picture (b)*

***Single-draw***

The drawing is seen as a record of an idea which might be made, to show the teacher before going and making it or something like it. The genre of design drawing, an object disembedded from its background or context, has been grasped but the drawing is not used to develop design ideas. Once allowed to handle the materials, the drawing is frequently forgotten, although copying it exactly without any subsequent development or modification is equally common. There is no record of constructional issues having been considered.

*Ex. 21 : Drawing Type : Single-draw*

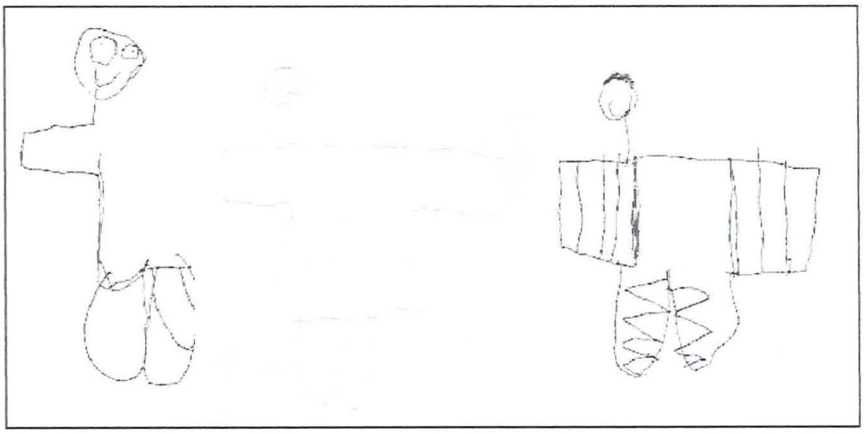


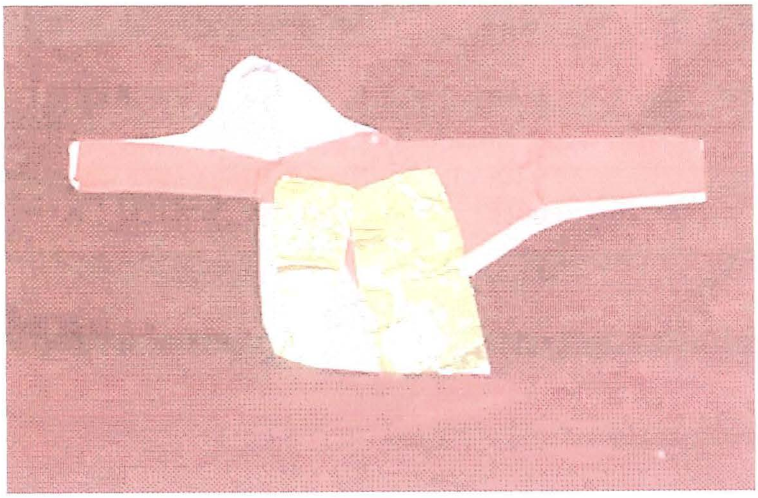
Progress in understanding of the purpose of drawing for design then seemed to take one of two alternative paths, which I called Multi-draw and Multi-design.

At this stage of the research I was uncertain as to the relationship between Multi-draw, Multi-design and Progressive. Multi-draw appeared to be more closely related to Single-draw and I wondered if the children were simply re-drawing their idea more neatly, so that it looked better; improving the drawing rather than enhancing the idea. I was uncertain whether to classify drawings that were essentially the same except for surface decorations as Multi-draw or Multi-design, or how much different a second drawing needed to be to count as progressive.

***Multi-draw*** - The child seeks to perfect their drawing of a single idea by redrawing several times rather than using drawing to develop and explore design ideas. There is evidence of understanding of the needs of the client, but only one real solution to the problem is recorded. Drawing is not used to explore and develop a range of design ideas. Evaluation relates to the appearance of the drawing rather than to the practicalities of construction or alternative design solutions. Surprisingly, after spending time perfecting the drawing, it does not necessarily inform the making since the child has not really seen the role of the drawing as a way of modelling real outcomes.

*Ex. 22 : Drawing Type : Multi-draw*



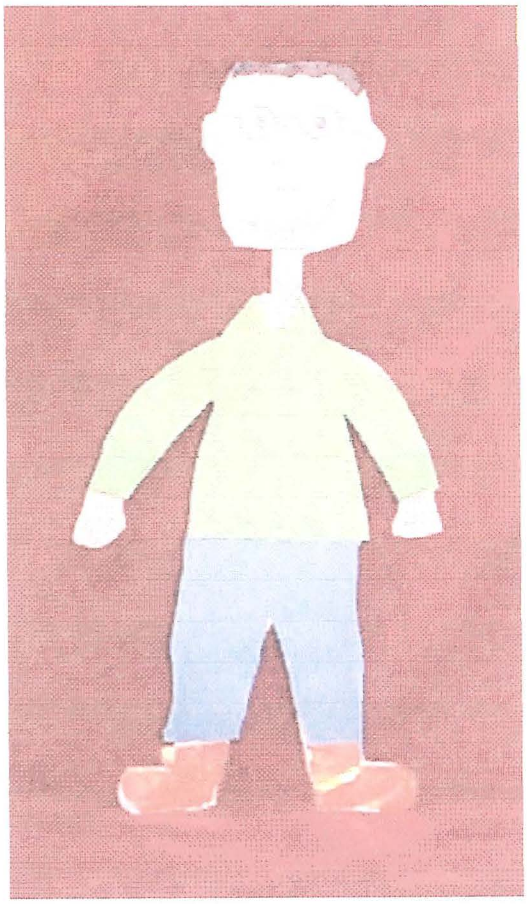


## *Multi-design*

The child sees the role of the drawing in designing as a means of brainstorming ideas. The design sheet will be filled with different ideas, some related more closely than others. The object made may even be yet another different idea. The child has grasped the idea that the paper can be used to try out lots of ideas related to client needs and to working out solutions to the design problem, but without thinking too much about constructional issues or evaluating how any of the ideas would work out in practice. The product to be made may well be selected on the basis of "best drawing", even though it may not represent the most fruitful or practical idea.

Ex. 23 is quite a sophisticated Multi-design by a Year 4 boy, in which body parts have been drawn, almost as a mix-and-match selection. Possibly, he was planning to make the puppet fully articulated. In the final product, only the head slides up and down.

*Ex. 23 : Drawing Type : Multi-design*

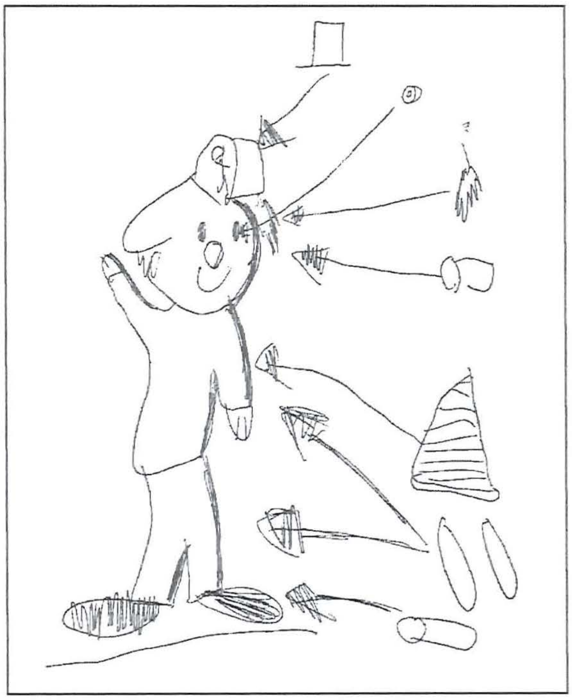


## *Progressive*

Although they may arrive by differing routes, all children need to reach this phase in their understanding of design drawing. This is the point at which they realise that they can use drawing to develop an idea and work out how the object will be made or fit together. Labels, verbal descriptions, expanded drawings to show small or separate details, diagrams which attempt to show different viewpoints or results of movement. The product is a realisation of the final drawing. It should be appreciated that this phase does not necessarily "follow on" from Multi-design. Children more frequently opt for one good idea and develop it into an action plan.

Progressive drawings frequently show a combination of words and graphics but the example shown here is by a dyslexic Year 3 boy, who drew the figure and then used drawing to record his ideas about how he would then make the figure. A clear design path, including the figure's pose, can be seen between the drawing and the product. It remains my all-time favourite Round Stan puppet and hung from its string in my room for a long time.

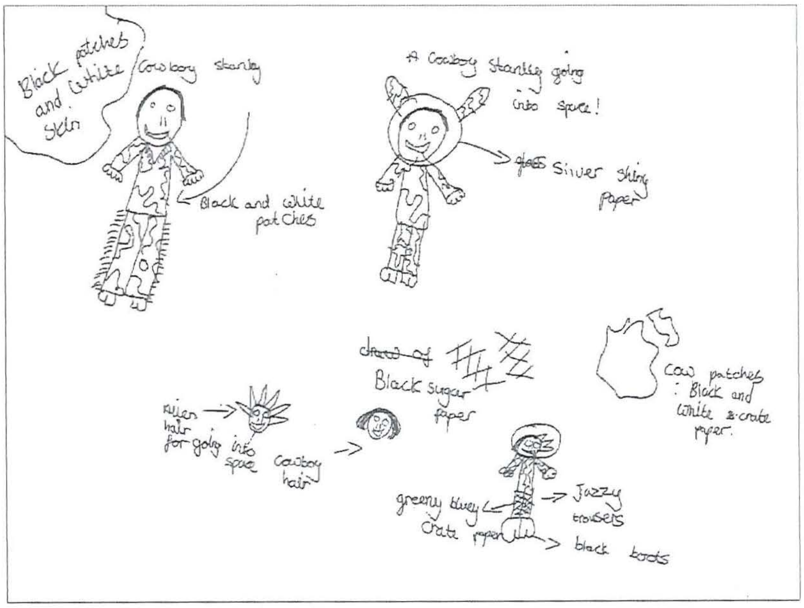
*Ex. 24 : Drawing Type : Progressive*

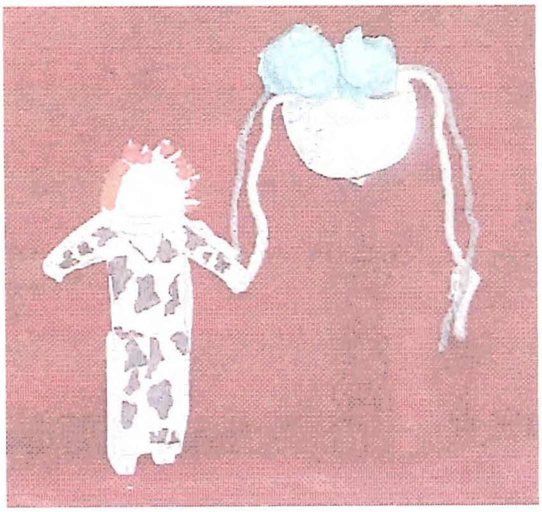


***Interactive***

At this point the child begins to have a conversation with the drawing. The child sees the drawing as a means to work out what will be made and how to make it. This phase can almost be seen as a combination of Multi-design and Progressive. More than one design idea is recorded, which are then thoughtfully evaluated and discarded or developed through more drawings, combining and discarding elements of several drawings. Several related ideas, styles or construction methods are considered and combined to develop a product based on this process. Evaluation occurs as part of the total process. Further ideas about previously drawn solutions may be recorded after other solutions have been developed as the child begins to combine ideas (in the example below, the comment at the top left was added last)

*Ex. 25 : Drawing Type : Interactive*

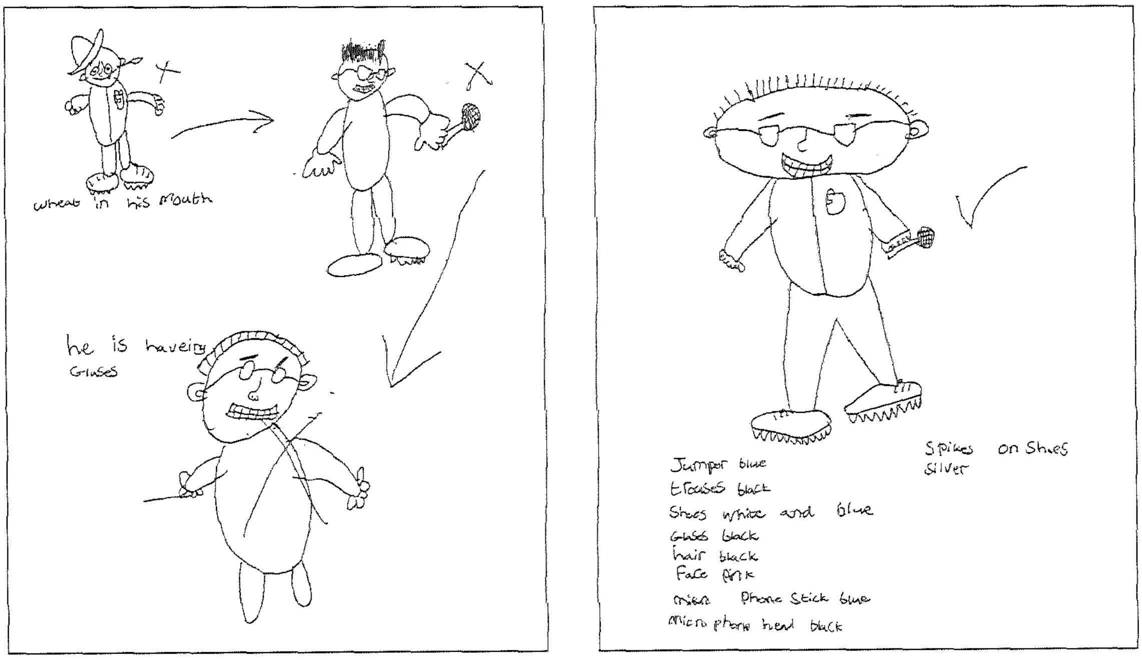


***Comment***

Although generally speaking progress is age-related, the examples used here are chosen to illustrate that this is not necessarily the case. The *Picture* example is by a Year 2 girl with receptive language difficulties. The *Single-draw* is by a S.E.N. Year 3 boy. The *Multi-draw* is by a precocious Year 1 boy. The *Multi-design* is by a Year 4 boy who demonstrated a high level of design capability from Year 2 onwards. The *Progressive* drawing shown (Year 3 boy) is without text but during the Exploratory Phase, this was often one of the distinguishing features between Multi-design and Progressive. The *Interactive* drawing is by Avril (the girl with whom I had the conversation about Pandy's suitcase when she was Year 1) but here she is three years later in Year 4.

Finally, Ex.26 is by a Year 4 boy in 2000 whose work shows a clear progression of ideas, with combinations of ideas from earlier drawings into the final design, expansion (of the head) to work out small details and sensible use of words (recording a design decision *"he is having glasses"*) and the colour scheme as a list. This is a long way from my comments on the 1996 Year 4s who seemed to have no more idea than the Year 1s as to why they should use drawing to develop their design ideas. The standards of design capability had risen considerably across the school in the intervening three years.




*Ex. 26 : Drawing Type : Interactive: Flat Stan : Yr.4 (2000)*

# 3.4 Theoretical Constructs

As a result of my reading and observations of children at work in Design and Technology lessons, I began to create personal theories about what was happening inside children's heads in design contexts and to pull these together into a more coherent picture. This led to the creation of two taxonomies of design drawing: one of external assessable evidence and the other of internal cognitive skills. From this process developed the major theoretical underpinning of the Structured Phase of the research: the analogical reasoning inherent in design drawing.

## 3.4.1 Modelling Concept Relationships

My readings and reflections were catalogued under various subject headings stored as "Thoughts files" (database with related text documents). I began to think through how these topics related to each other by creating a series of concept webs, placing different areas of interest at the apex and re-arranging the other elements in relation to each new "key word." I found this a very powerful yet simple way to develop my understanding of the way the various aspects of design cognition related to one another. There was nothing propositional about these concept webs and I was not trying to define precisely what the elements meant or how they related to each other. At this stage, I was merely playing with ideas. One of these concept webs is shown in Section 1.2.1 as Fig.7.

There are many ways that the elements could have been arranged, even with the same choice of "key word." The concept webs were a tool for thought, stimulating and generating new ideas and understandings. However, this way of representing concepts that were emerging as being important for children's designing skills enabled me to see not only the relationships between them, but also which were of more central importance. Put simply, some concepts turned up in almost all the webs whereas others hardly featured at all.

As a route to further clarifying what I already knew about young children's designing through drawing, both from reading and from personal observations within the Exploratory Phase, I attempted to construct a taxonomy of design drawing. The methodology was simple: I highlighted every statement in the "Thoughts files" directly related to children's design drawing skills and collated it. The Taxonomy headings are to be found overleaf (Table 3) and the full Taxonomy, showing sources for the headings is in Appendix A.

*Table 3 : Taxonomy of Design Drawing :*

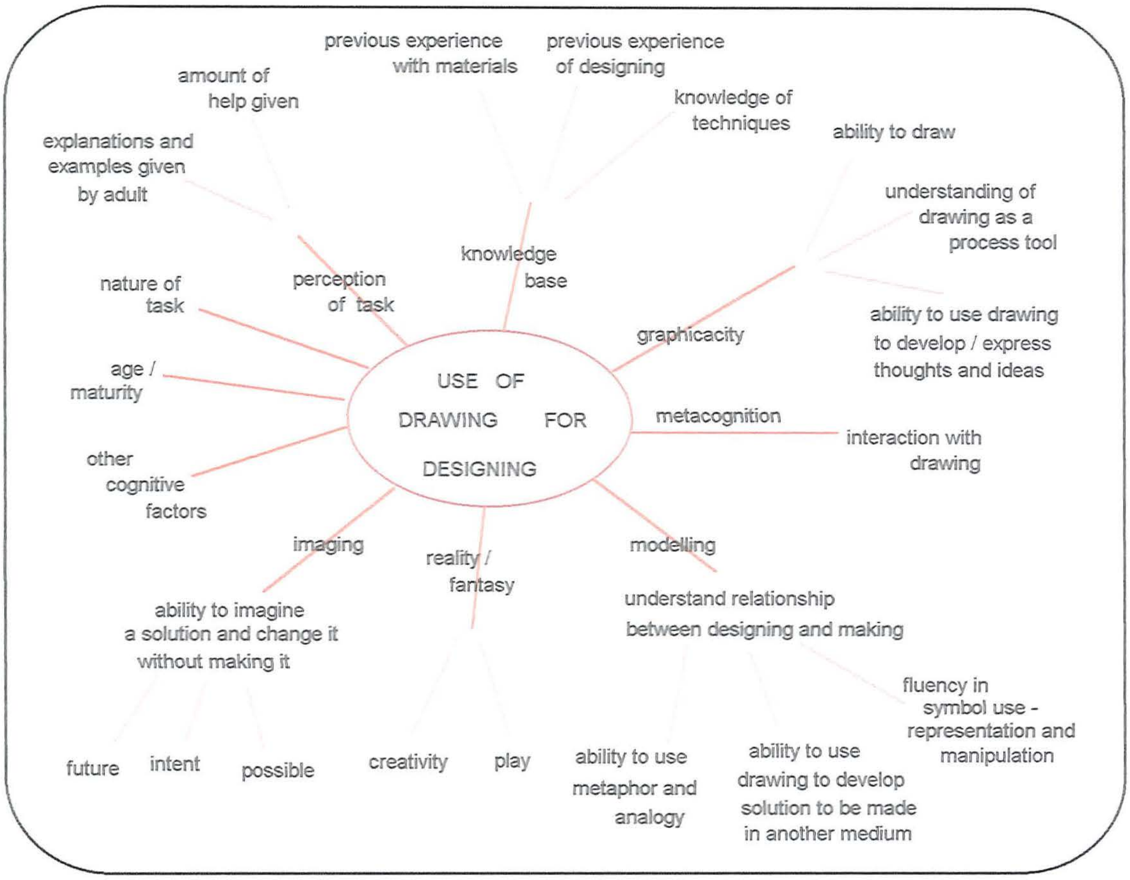
| | |
|---|---|
| PURPOSE<br>drawing as "finished product"<br>communicate to others/aide memoire for child<br><br>INVESTIGATING NEED<br>perspective taking<br>simple prediction<br>forward planning<br><br>CONCEPT DESIGN<br>brainstorming<br>generation of ideas<br>deciding what to make<br>recording of the design stage<br><br>DETAIL DESIGN<br>investigating production method<br>deciding on production method<br>recording production method<br>sequencing production<br>drawing with respect to materials<br>produce product specification<br><br>TYPES OF DRAWING<br>analogue/iconic/symbolic<br>symbolic (stereotypical)<br>manip of inner image<br>drawing in the style of..<br>labelled diagram<br>canonical drawing<br>2D & 3D<br>plan drawing/viewpoints<br>appropriate level of detail<br><br>DRAWING & MAKING<br>make what they draw<br>pattern development<br>recording of finished product | COGNITIVE DEVELOPMENT<br>Age/maturity<br>Other cognitive factors<br><br>ADULT INPUT<br>Nature of tasks<br>Explanation given<br>Amount of help given<br><br>KNOWLEDGE BASE<br>Previous experience with materials<br>Previous experience of designing<br>Knowledge of techniques<br>Visual literacy<br><br>GRAPHICACITY<br>Ability to draw<br>Understand drawing as process tool<br>Use drawing to develop thoughts & ideas<br>Partial occlusion<br><br>MODELLING<br>Understand relationship between draw & make<br>Fluency in symbolic manipulation<br>Use drawing for solution in other medium<br>Use metaphor & analogy<br>Reality/fantasy<br>Interact with the drawing<br><br>IMAGING<br>Make changes from drawing<br>Imagine/record future state<br>Imagine/record future intentions<br>Imagine & record the possible<br><br>REL TO OTHER WAYS OF THINKING<br>Linguistic/narrative<br>Creativity/imagination<br>Play<br>Conation |

Two things became immediately apparent from this work :

- the taxonomy needed separating into external, observable skills and inner, cognitive processes
- I had far more instances from my own observations than the literature search had yielded. The field of children's design drawing had not been previously explored in any depth.

Whilst I was working on the almost mundane cataloguing task of highlighting and filling in the Taxonomy, I was simultaneously creating a Concept Web (Fig. 34) on a separate piece of paper on the table beside the computer. This was not a mechanical *"this fits here and that fits there"* process as I worked through the Thoughts files but a creative event that recorded the leaps of understanding and realisations of connections, which occurred in parallel to the task in which I was engaged. At one point I completely suspended compiling the taxonomy in order to give complete attention to the web.

*Fig.34 : Design Drawing Concept Web*




This was the most important result of the taxonomies in terms of moving my understanding forward. In creating the taxonomies I realised that I was more interested in what was going on in the children's heads and asking why they could or could not produce different kinds of drawing for different purposes rather than simply cataloguing the kinds of drawings used. It seemed to me that if the cognitive processes involved in using drawing for designing could be identified, then it would be possible to determine whether or not, or at what age or stage in their development, young children could access and use the genre. Before this was done (and it appeared to me not to have been) I could not see how anyone could make recommendations about what young children should be taught to do.

This concept web enabled me to identify the factors which I considered to be the most important. The relationship between drawing and making seemed paramount. By this time I had a considerable collection of children's drawings from a range of Design and Technology lessons and this seemed to be the key issue: Did they understand that they were using drawing to *plan* what they were going to make?

Many children, even in Year 1, could make a drawing of something they wanted to make or had been asked to make, but the drawing was being used simply as a recording device, as if the child was using it as a ticket to gain permission to make. It was a statement of *"I want to make one of these"* a cursory drawing which contained little real meaning in terms of representing design thinking.

The web also enabled me to place, in relation to everything else, the central questions of
*"What is a design drawing?"*
*"What function does it serve for design practitioners?"* and
*"Is this relevant to teaching small children?"*

It was at this point that I began to consider the metaphorical or analogical nature of drawing, in the way that it acts as a go-between, negotiating the gap between the inner image and the outer world of materials and products. Drawing is viewed and discussed as if it is the real thing, whereas it is more like a mirage on paper.

From the start of my research I had been aware that the ability to manipulate symbols was highly pertinent. In Jan.1998, Mrs. S., our Special Needs Co-ordinator, and I were discussing this and she wondered if the ability to use drawing for designing was linked cognitively or developmentally to the ability to read beyond the words and make inferences about a text, which she used as an informal marker for "really reading" rather than simply decoding text. Her observations were that the average child achieved this during Year 2.

Was she right? Was there a second order symbolic manipulation skill that was the key to using drawing for designing that was akin to reading for meaning?

Related to the ability to appreciate analogies is the juxtaposition of the incongruous which is basic to humour, art, literature and design. Koestler (1974) coined the word "bisociation" - the ability to put two things together to create something original. Thus the question might be asked: "Does the age at which humour and ability to understand and tell jokes emerge also match the age/stage at which children can start to create designs as opposed to the serendipitous playing with materials?" This ability would then parallel the analysis/synthesis aspects of designing. My observations of 5-6 year olds would lead me to speculate that those children with a lively, flexible mind, who appreciate humour and can "read between the lines" of a story, are able to begin to record their planning for a making task by the end of Year 1 whereas those whose world is more literalistic have far greater difficulty.

These thoughts had been there right from the start, gone underground and resurfaced several times. I now thought that I knew what this skill was: the ability to use symbols metaphorically, to use the symbol as if it were the real thing. The *analogical nature of drawing* was to become the central tenet of my understanding of what design drawing was, how it functioned and, ultimately, how the skill could be taught to children at the point at which they develop Mrs.S.'s "really reading" ability, i.e. in Year 2.

All I needed to do now was prove it!

## 3.4.2 The Role of Metaphor and Analogy in the Construction of Meaning

The perception of drawing for designing as involving metaphorical or analogical understanding placed me in unfamiliar territory. I began with an internet search of American university materials on-line which gave me an overview and the names of the major players in the field. The insights gained from these writers on semantics meshed with understandings gained from writers on child development, creativity and cognition, and of course, Design and Technology. This interweaving of ideas from apparently disparate fields can be seen in this account of my developing understanding of the analogical nature of design drawing and led, eventually, to what was for me a major conceptual breakthrough.

> "Invention can only be done deliberately if the inventor can discern similarities between the particular result which he is ensivaging and some other results which he has seen and stored in his memory...An inventor's power to invent depends on his ability to see analogies between results..."
>
> (Pye, 1964: 27)

Gick & Holyoak (1985) demonstrated the importance of analogy in problem solving and concluded that successful transfer of learning involves overcoming contextual barriers, perhaps by focusing attention on the abstract character of potential solutions. This insight seemed useful to me in that the ability to use drawing as a design tool hinges not just on seeing the analogy between the designing medium and the making medium and being able to transfer seamlessly from one to the other, but on being able to manipulate one symbol system to develop ideas about something to be created in another. Perhaps I could find a way of getting children to perceive the spatial similarity between the mental image, the drawing and a real object to be made.

In his discussion of the difference between the way the brain and the computer solve analogical problems, Arnheim (1969) asserts that the brain is geared to perceiving topological features which "inform the organism of the typical character of things" (p.77), which suggests a predisposition towards the abstraction necessary for successful transfer between 2 and 3 dimensions inherent in design drawing. Arnheim concludes that analogical perception is basic to intelligent behaviour and that the topological skill which enables similarities and analogies to be made is what makes productive thinking possible.

Researching the role of analogy in the development of scientific concepts, Gentner (1982) sees models as "structure mappings" from one domain to another. But she struggles to find a suitable ordinary word which does not have other connotations and does not lead into theoretical arguments over semantics and thereby distract from the real issues:

> "There is no good term for "non-literal similarity comparison". The term "metaphor" conveys an artistic or expressive non-literal comparison of a certain form; the term "model" conveys an explanatory-predictive non-literal comparison, often mathematically stated."
>
> (op. cit.: 107)

Thus Gentner chose the term "analogy". I wanted to use the word "mapping" to indicate that we are talking relationship not semantics, then the word "structural", "analogical" or "metaphorical" could be used as a prefix to describe what kind of relationship is currently being discussed. I think that "structural mapping", "metaphorical mapping" or "analogical mapping" (depending on the precise context) sound quite good but smack of esoteric tautology. Perhaps Gentner was sensible to just use "analogy".

Gentner discusses scientific "explanatory analogies" and compares them to "expressive analogies", which are the province of the semanticist. I wanted to know if there are not also such things an *exploratory analogies* (like drawing) which are used to explore ideas, which would also, perhaps include allegory and paracosm and even day-dreaming.

Her term "structural mapping" seems to be parallel to Veale's (1999) "conceptual scaffolding" which he describes as

> "an architectural guide, or blueprint, for the assembly process, but may not constitute an element in the final edifice. That is to say, conceptual scaffolding possesses a transient existence to serve as a temporary representational purpose."
>
> http:/www.compappdcu.ie/~tonyv/papers/CogSci.ps,gz; accessed Jan.2002

Tourangeau in Miall (1982) speaks of "creating a parallel system" (p.25) which also seems to describe the process of being able to think completely in one system and come to logical conclusions about the parallel target system; to think in it, manipulate it, make parallels and juxtapositions and jump back and forth from one to the other. What Wittgenstein (1969) simply called "seeing as".

Parallel to Wittenstein's "language games" (which, in conjunction with his "seeing as", is what metaphors allow us to play) is Booth's (1978) suggestion that instead of attempting a formal definition of metaphor, "family resemblances" should be sought. I attempted to plot parallels between each of Booth's family resemblances (Table 4) and design drawing and felt that the family resemblance between the two are sufficiently strong to be persuasive:

| ***Table 4:*** ***Booth's list of family resemblances*** | ***Applicability to design drawing*** |
|---|---|
| Intentionality | Design drawing begin from the intention to find a solution to a problem or opportunity |
| Context-dependent | Design is always rooted in a specific context |
| Persuasive purpose | If the client is to be shown this stage |
| One of many ways of expressing same idea | Other media could be used |
| Can be paraphrased using another metaphor | Other drawings could be made of same idea |
| 2 things, not 2 words, are being compared | The drawing relates to other real or imagined objects |
| Stable: "once understood, no further act of interpretation is required." | Equally true of drawings |
| Local & finite: tied to this situation | The design context is frequently specific and particular |
| More is communicated than the words say | Design drawings frequently suggest lifestyle and marketing niche |
| A change in perception of the situation takes place | Design drawings objectify inner images of the intended product. Changes in understanding of the problem and its solution frequently occur as a result of drawing. |

Weldon's distinction between difficulties, puzzles and problems (cited by Bruner, 1962) refers to the way a problem is solved or a discovery made when we impose a puzzle form on a difficulty to convert it into one with which we can deal. Discovery consists of knowing how to impose a workable "puzzle form" on various difficulties. Dufresne et al.(1995) observed that novices cannot use analogies to solve problems due to difficulties identifying which of the problems that they have already solved are conceptually similar to the one they are currently trying to solve.

Because the links between concepts and problem situations are bi-directional, analogies are an extremely useful problem-solving tool for experts, who, by classifying problems according to the same umbrella concepts, can translate problem situations into appropriate procedures. It would seem, therefore, that a central skill in problem-solving is to be able to link the appropriate strategy knowledge to the specific domain knowledge, which, I would assert, is by analogy with previously encountered problems. For the experts, with rich previous experience in solving like problems, the analogies are not far away. For novices, learners and children, the search is too wide to provide useful links.

For drawing for designing, it is necessary to see that

| | | |
|---|---|---|
| the analogy exists<br>it can be exploited | knowledge that | using drawing as<br>a design strategy |
| know how to | knowledge how | |

*Fig. 35 : Strategy Knowledge for Design Drawing*
*(see Fig. 24)*

> "I think intelligence cannot develop without content. Making new connections depends on knowing enough about something in the first place to be able to think of other things to do."
>
> (Duckworth 1987: 14)

Knowing that by drawing it, a design problem can be solved, is an imposition of a known puzzle form in Weldon's sense. However, realising that the task is bigger or more complex than can be visualised mentally and that external support is needed, whether by doing a drawing, making a list or other place-holding device, involves a level of self-awareness or metacognition which Key Stage 1 children lack.

> "If the mind cannot solve a problem by terms dictated by the situation, then it will do so in terms of some other but similar situation. Thus invention is the emergence in the mind of novelty under the control of system."
>
> (Blanshard, 1964: 148)

Children are unaware of the limits of their visualisation skills. They think they have the answer and start to make something, leave it half done because it does not work or change it completely at a whim. By teaching children to objectify and record their mental images, visualise onto paper, we are teaching methodological efficiency for use in a whole range of contexts.

The ability to use drawing as a design tool hinges on seeing the analogy between the designing medium and the making medium, on being able to transfer seamlessly from one to the other and on being able to manipulate one symbol system to develop ideas about something to be created in another.

Arnheim (1969) called these "pictorial analogies" which

> "fulfil a mediating position between the world of sensory experience and the disembodied forces underlying the objects and events of that experience."
>
> (op cit.: 148)

In speaking of the adolescent "having discovered that art may be consciously manipulated as metaphor," Matthews (1999: 144) limits metaphor to the psychological, objectifying inner perceptions of mental states and abstract concepts. However, I believe that this is only one form which graphic metaphor takes. Design drawing requires the same skill, seeing one thing as another, but the metaphor is of a concrete reality to be constructed in another medium. Interestingly, Matthews links this stage in his son's artistic development to his playing of fantasy "Dungeons and Dragons" type games, making parallels with the emergence of infant art and the role-playing of young children.

The metaphorical (or, perhaps, more accurately, metonymical) nature of drawing for designing, as a way of *seeing as* in Wittgenstein's sense means that we view the drawing as if it were the real object and discuss and adapt our ideas about a mental image of a real object in the light of the drawing of that mental image. Seeing the similarities and patterns in things enables us to make the leap from one area of knowledge to another or from one symbol system to another. Analogical fluency allows us to construct in one symbol system a pattern for construction in another: to draw what we will make.

### 3.4.3 The Container / Journey Metaphor

Lakoff and Johnson (1980) believe that all human thought is based on metaphor and the central tenet of their position is that new ideas and concepts are not just built from previously stored ones, but from the metaphors in which prior concepts are couched. These newly constructed concepts they call *metaphorical entailments*. Their examples are taken from language use and their main example throughout the text is the concept ARGUMENT (I have followed their convention of capitalisation of examples here) for which they produce the diagram shown as Fig.36.

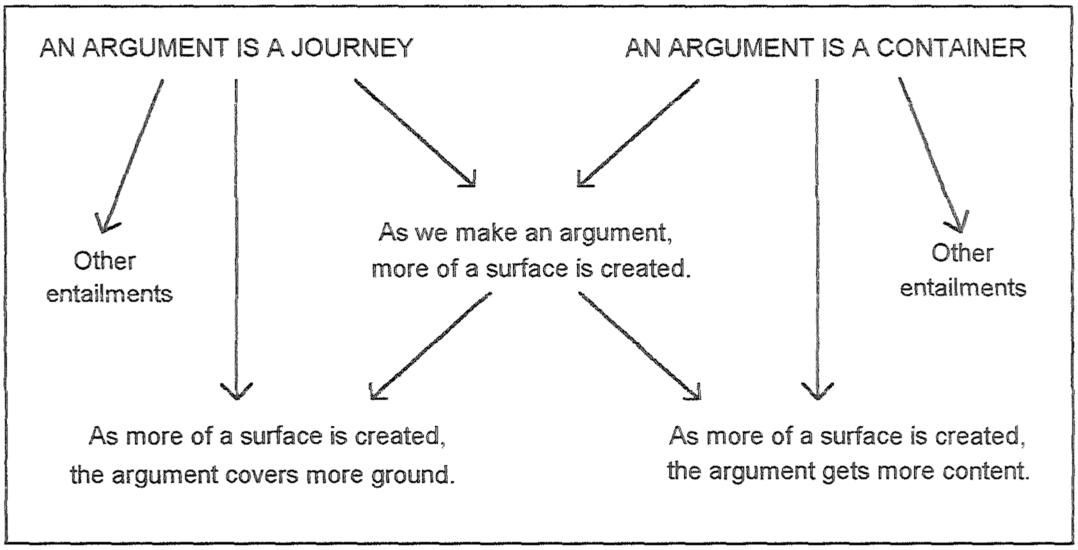



*Fig. 36 : Extrapolation of Lakoff & Johnson (1980: 96) (a)*

My prior *seeing drawing as metaphor* enabled me to realise that this model, with its specific metaphors of JOURNEY and CONTAINER can be generalised to include all *process verb / product noun* pairs, e.g. trust, work, plan, design, etc. (as shown in the Fig.37). Some of these verb / noun pairs do not share exactly the same word, but the metaphorical connection remains. For example, the verb "make" has no directly attached noun, but the process of making and the object that is made have the same JOURNEY and CONTAINER metaphors entailed in them. In making an object, we undertake a *journey* of thinking and planning and doing. The object we create *contains* all those thoughts and plans and actions.

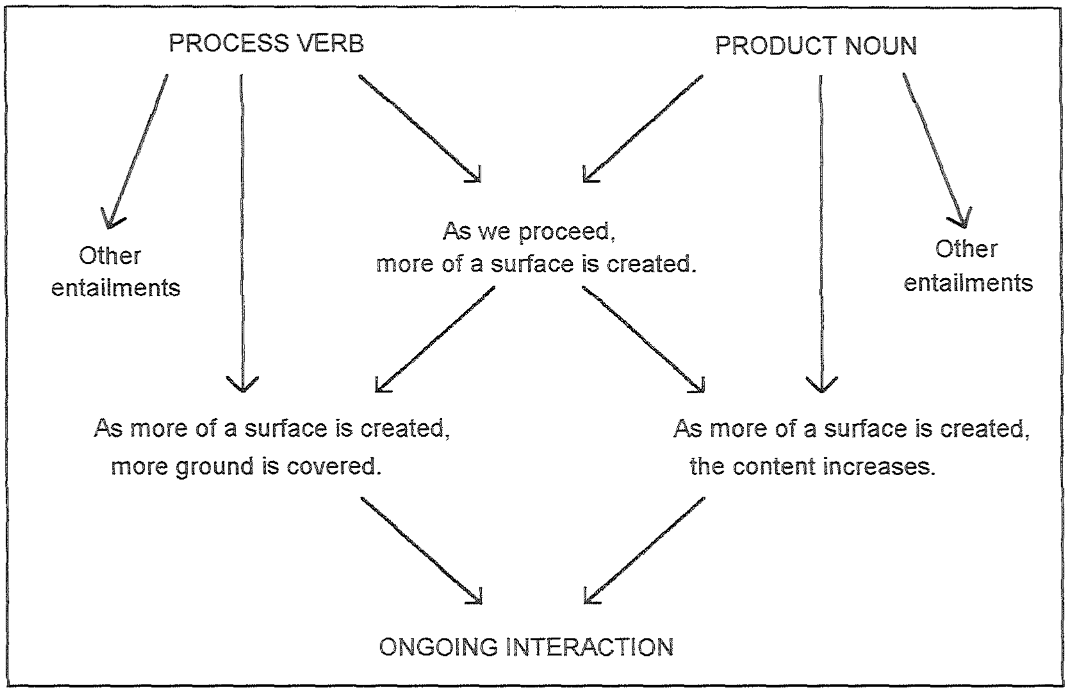



*Fig. 37 : Extrapolation of Lakoff & Johnson (1980: 96) (b)*

The word "design" fits neatly into the pattern. "To design" is a process which is creative and intellectual *journey* which we undertake. "The design" is the thing that *contains* our thoughts and plans. Likewise, "drawing". Thus drawing for designing also fits the pattern. When we use drawing for designing we take our thoughts, along with our pencil, on a *journey* and produce "a drawing" which is then the *container* for those ideas. Applied to the specifics of design drawing:

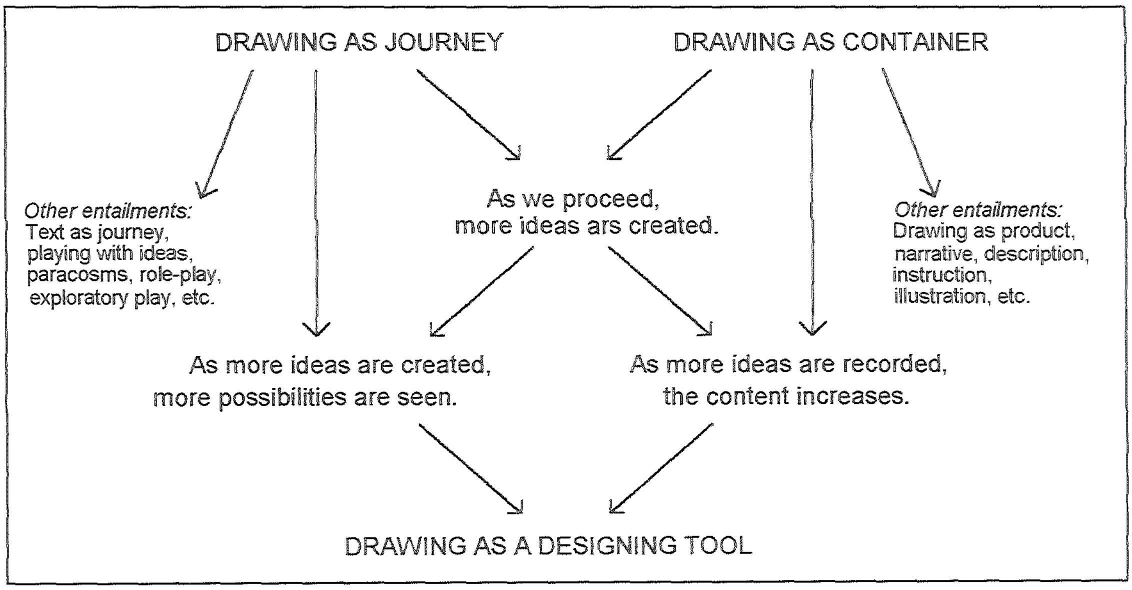



*Fig. 38 : Extrapolation of Lakoff & Johnson (1980: 96) (c)*

I further simplified the diagram to the following form (Fig. 39) for use with children (using colour as metonymic to suggest interaction and merging) and, because it is conventional to read from left to right, it seemed more logical to put the CONTAINER metaphor on the left, as being the static starting-place for the JOURNEY:

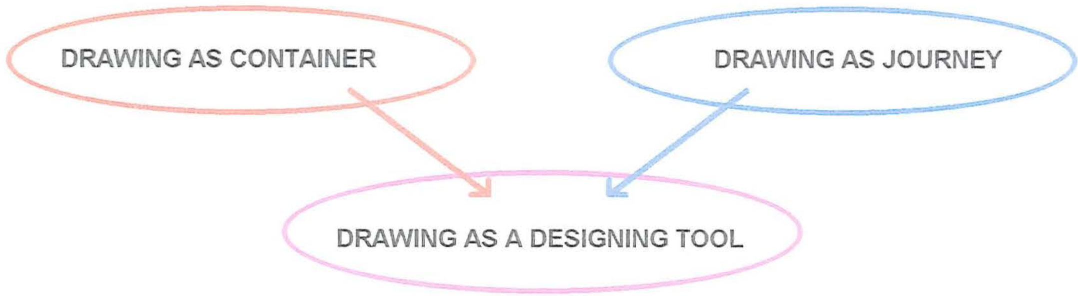



*Fig.39 : Container / Journey Metaphor of Design Drawing*

This model not only transformed my understanding of the role of drawing for designing but also gave me a narrative, a story, in which to embed an explanation of the process to Year 2 children: It's like going on a journey with a carrier bag full of ideas and every now and then you stop, take your ideas out of the bag, look at them, re-arrange them, pick up something else interesting lying around, put them back in the bag and off you go...

## 3.4.4 The Story behind Designing

The whole issue of the development of early design skills seems interwoven with the issues of play and fantasy and the ability to manipulate inner mental images, not as simple discrete constructs, but as complex free-flowing, changing, kaleidoscoping, transforming and interconnecting with fuzzy boundaries which can collide, combine, spark off the new and the novel and create a whole new world of meaning and seeing.

Piaget made a seminal contribution to the understanding of child development but where he was less successful was due to his view of the child as scientist, whereas the child was looking for the story and expecting the story to make sense. Although I believe his central tenet of assimilation and accommodation to be correct, I believe that he mistook the motivation and the mechanism, due to his own background as a scientist in an age and culture in which rationalistic science was considered to lead the perception of reality, rather than being one of many ways of making sense of the world around us.

The child's motivation is story: making sense of the world as narrative. Small children love stories and the more stories they are told, the better their ability to construct abstract concepts.

Children from story-rich homes, generally speaking, seem to do better in school. They know that meanings slide. They know that words can be used in several ways and can be interpreted at different levels. They know about metaphor and can extrapolate from the literal to the figurative. Their heuristic knowledge of the way we can use and interpret language enables them to access and utilise the symbol systems of the classroom, mathematical as well as linguistic.

The mechanism is analogy and extrapolation: fitting new percepts into the inner story already created and stretching and extending those inner constructs to assimilate new ones where possible or to rearrange or even discard those constructs to accommodate new ideas which will not comfortably fit. Experience and knowledge provide the base ground for assessment of new percepts which are added to knowledge base by finding an analogy to already stored perceptions, which the brain stores as like/non-like. Language or visual labels shortcut the process and enable storage and classification by label. Perception or recollection of a label may trigger or bring out a whole raft of concepts.

I wondered how far is this manipulation of mental schema from the understanding of allegory or the construction of paracosms and whether children who can create a whole fantasy world in their head are generally better at designing. I knew of children for whom both abilities existed and wondered if they were related. The ability to create and think completely in a system and come to logical conclusions in that system, whilst fully aware that it is a created system which parallels another system, seems common to both fantasy role playing and designing. Whether using drawing as a design tool or living out a role in an imaginary world, the player can think in it, manipulate it and make logical domain-appropriate decisions within it by juxtaposition with a domain-parallel system and mentally switching back and forth from one to the other.

People are meaning-makers (Wells, 1986) and the primary vehicle of making-meaning is language. That the richness of metaphor could be used to convey understanding of an abstract idea such as the use of drawing to model design ideas seemed to me highly likely and one which I was prepared to try. The theoretical underpinning of the Structured Phase was an extrapolation from these thoughts.

# 3.5 Reflections on Section 3

Following the framework of Section 3, these Reflections are sub-divided according to the Sections of this part of the thesis: the literature, my observations and the creation of the taxonomies.

***Literature review: Drawing as product or tool (Section 3.2)***

My reading around the subject of drawing and of young children designing revealed that little had previously been researched with respect of drawing for designing, mainly due to the newness of Design and Technology as a primary school subject. The most useful insights came from writers on play, creativity and other contributory skills towards design capability. I found I was casting the net widely, looking for strands which would be applicable to young children's design skills, in fields as diverse as cognitive modelling and artificial intelligence to the development of language and pre-literacy.

***Observational Constructs (Section 3.3)***

Between Jan.96 and July99 I had looked at the work of 371 individuals across the 5 - 9 age range, 96 of whom had been in the original Stan 96 study and had been tracked across their whole time in the school. Some of these older children, especially those with whom I had considerable contact, were using their drawings to develop a design solution. I also had an intuitive feeling that standards were going up across the school and I doubted that my comments about the Year 4 helpers for Stan96 (that they did not understand why I wanted plans on paper any more than Year 1) would be true of the 1999/2000 Year 4s. As a result of all this work, I had devised a classification system (Drawing Types) which could be used to determine capability in design drawing.

***Theoretical Constructs (Section 3.4)***

The construction of the Taxonomies and the Concept Web finally crystallised my thinking. This meshed with my reading on language development to look for parallels with the development of visual literacy, mean that I encountered the idea of the role of metaphor in the construction and transmission of meaning, which was to become central to my understanding of the drawing as metaphor. I also became convinced that children who were more able to access metaphorical language were likely to be able to use drawing to model design ideas, because of the parallels between the two processes.

Extrapolating from Lakoff and Johnson's (1980) metaphorical entailments diagram enabled me to construct a model for explaining the role of drawing in designing to Year 2 children: the

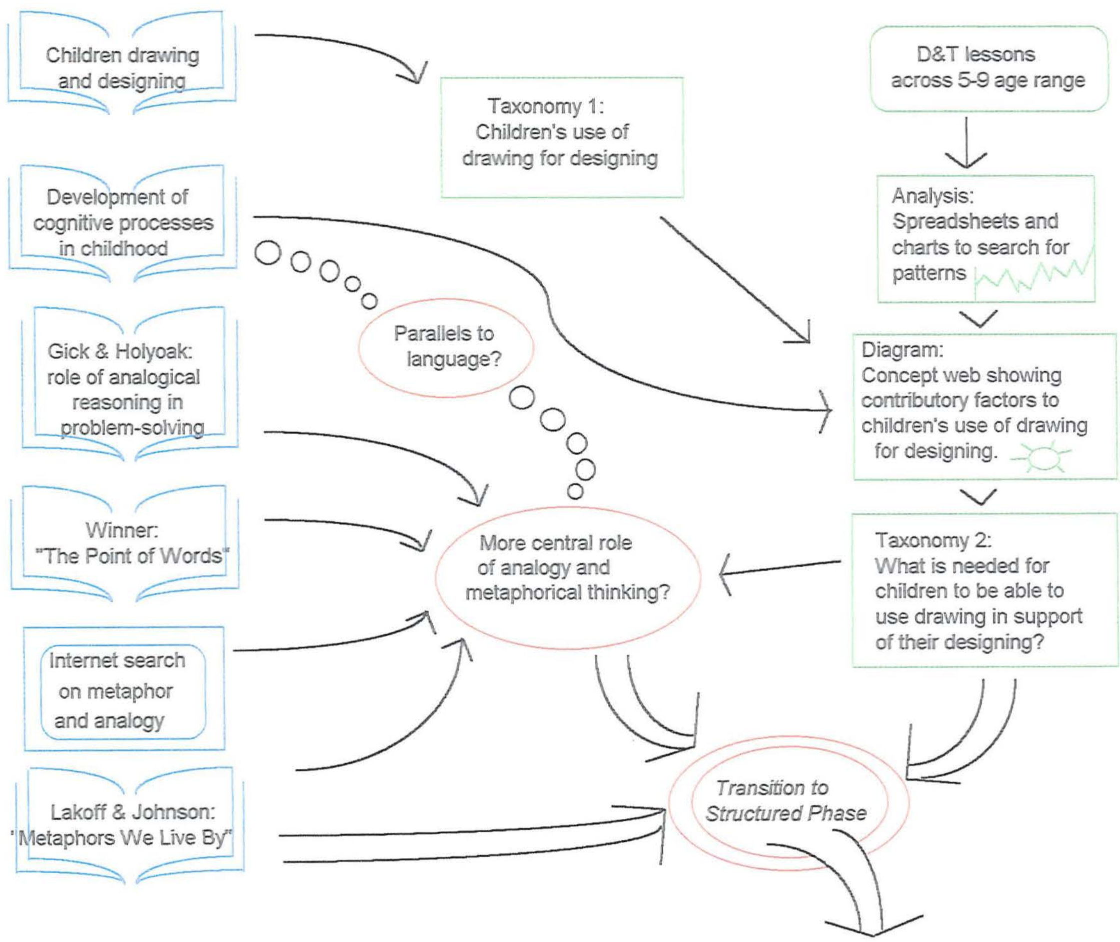
Container / Journey metaphor. It was this understanding that was to be enshrined in my Programme of lessons in the Structured Phase of the research.

***Transition from Exploration to Structured Investigation***

I felt that to push Year 3 children over the brink into using their drawings to progress design ideas would be easy. I had managed this with many of the children in a Year 3 class I had taught weekly in 1998/9, whilst I was still trying to identify what children were doing. The year group for whom I had least data, for purely practical reasons, were Year 2. I knew that it would be conceptually impossible for Year 1s to understand what I meant; I had been trying with every class since 1996 to no avail. But I thought I now had sufficient understanding of what I was looking for and also what I meant by using drawing as a tool for thought to attempt to improve Year 2 children's design understanding, although both the literature and my previous personal observations suggested that this would not be easy.

This transition can best be represented diagrammatically:

*Fig. 40 : Transition to Structured Phase*



# SECTION 4 - Structured Phase

# 4.1 Introduction to Section 4

The transition from the Exploratory to the Structured Phase was not an easy time. I had an idea about the metaphorical nature of design drawing and a belief that new knowledge is constructed by analogy and that this inherently human skill is invoked constantly in teaching, but initially I had little idea how I might demonstrate this. I also believed that I had a specific metaphor (Container / Journey) that could be used to explain the use of drawing for designing to children, possibly as young as Year 2. I came to the pragmatic conclusion that if I wrote a Programme in which such a pedagogy was embedded, then its success might prove the hypothesis.

***Planning for the Structured Phase (Section 4.2)***

As discussed in Section 2.3, changes in methodology affect issues relating to the generation and validation of data and these need to be made explicit. Delivering a pre-planned Programme rather than mapping the field meant that there were issues of validity and reliability (addressed in Section 4.2.3) that pertain specifically to this phase of the research. Section 4.2.4 details the range of data generated as a result of the Programme and how both qualitative and quantitative data were used in the multi-method analysis.

***Programme Delivery (Section 4.3)***

Section 4.3 details the structure of the Programme, and provides an outline of the Teaching Input and Assessment Tasks. More detailed lesson plans can be found in Appendix B. The embedding of the Container / Journey metaphor (Fig.39) within the Programme is explained in Section 4.3.3. The Comparison Class' experience of Design and Technology is outlined in Section 4.3.4. Events that occurred within the 15 month duration of the Programme, external to the Programme itself, that affected its delivery are detailed in Section 4.3.5.

***Evaluation and Reflections on the Teaching Input (Sections 4.4 - 5)***

It was decided, for the sake of clarity, to locate the evaluation of Teaching Input to the Focus Class separately from the outline and also from the analysis and discussion of the Assessment Tasks found in Section 5. Section 4.4 provides an evaluative commentary on the delivery of the Programme and Section 4.5 reflects on the learning: both mine as researcher and that of the children.

# 4.2 Planning for the Structured Phase

In planning the Programme to be delivered in the Structured Phase of my research, I was much more fully aware of the practical issues which impinge on research activities. I was no longer "trying things out in classrooms" as I had been during the Exploratory Phase but was seeking to implement a Programme of four school terms' duration which had a specific overall aim: that of improving Year 2 children's capability in design drawing.

The choice of year group was based on the Exploratory Phase analysis. Year 2 appeared to be the youngest age group with whom the Programme might have success, as Year 1 classes consistently showed little understanding of recording design ideas through drawing. Year 3 children, on the other hand, employed drawing for recording design ideas and were beginning to use drawing for developing their ideas. I taught Year 3 children for nine years prior to becoming Year 1 Co-ordinator, and had continued to teach Design and Technology to a Year 3 class until 1999, so as well as having a large collection of drawings from this age group, I also had a heuristic "feel" for their capability. So, although I felt that I wanted to test the Container / Journey metaphor with the youngest children possible, I also wanted to continue the Programme into Year 3, so as to be able to make comparisons with my observations of children of this age. Also, from a practical point of view, I had activities that I had used with Key Stage 2 children, which could be incorporated into the Programme if I continued it into Year 3. I especially wanted to incorporate kit-making (the idea behind Insects 97,98 & 2000).

## 4.2.1 Aims and Objectives of Structured Research Programme

- To improve young children's ability to use drawing as a design tool through the use of a specific understanding of designing as a Journey and drawing as place-holder (Container) for ideas along the way.
- To attempt to establish a link between ability to use drawing for designing with more general cognitive skills relating to analogical understanding
- To limit the scope of the research to *drawings* within the wider context of designing, and, therefore, to consider annotation of a sketch as part of the whole but to exclude text for which the drawing is merely illustrative.

From previous observations of children's design drawings, I knew that before Year 2 very few children can begin use drawing as a tool for thought but by age 8-9 many of them do. Therefore I wanted to focus on Year 2 children and the development of their designing skills. I believed that understanding and being able to exploit the analogy between the drawing and the making processes is the key to being able to utilise drawing as a design tool.

In describing the difference between the way that novices and experts solve problems, Kahney (1993) uses the terms declarative and procedural knowledge. Declarative knowledge is at the level of verbal knowledge, following instructions. But:

> "In order to achieve skilled performance you need to be able to translate declarative knowledge into actions. A new form of representation, known as procedural knowledge must be established...The expert learns to respond to whole patterns rather than to individual components of a situation."
>
> (Kahney, 1993:.91)

Although aiming to develop the children's ability to use drawing as a design tool, specific drawing techniques (such as perspective) were not taught, neither did every lesson feature drawing. The aim was to impart understanding of design and the part that drawing can play in supporting the design process. I needed to ensure that the difference in experience was the *understanding* of using drawing to support design thinking which was being developed rather than simply inducting the children into a formulaic way of "how to do D&T".

Therefore, I devised a Programme of Lessons which would form a coherent teaching package to last 15 months, from October 2000 to December 2001 to be delivered within the context of Design and Technology lessons to one class of Year 2 children (from the beginning of Year 2 to the end of their first term in Year 3) to extend their understanding of design by making explicit the analogical nature of design drawing. This I would do through utilising the Container / Journey metaphor (Fig.39) to explain the design process. This class is referred to as the Focus Class throughout.

In conjunction with this I devised a series of Assessment Tasks to be conducted termly, concluding in January 2002, which were single lesson Design and Make tasks, most of which I had previously conducted with other classes across the 5-9 age range during the Exploratory Phase of the research. These Assessment Tasks were also conducted with another parallel class (the Comparison Class) to determine whether any gains were made by the Focus Class as a result of the Programme.

## 4.2.2 Research Subjects for Structured Programme

Two parallel classes with the 2000-1 Year 2 cohort were chosen, one as the Focus Class and one as the Comparison Class:

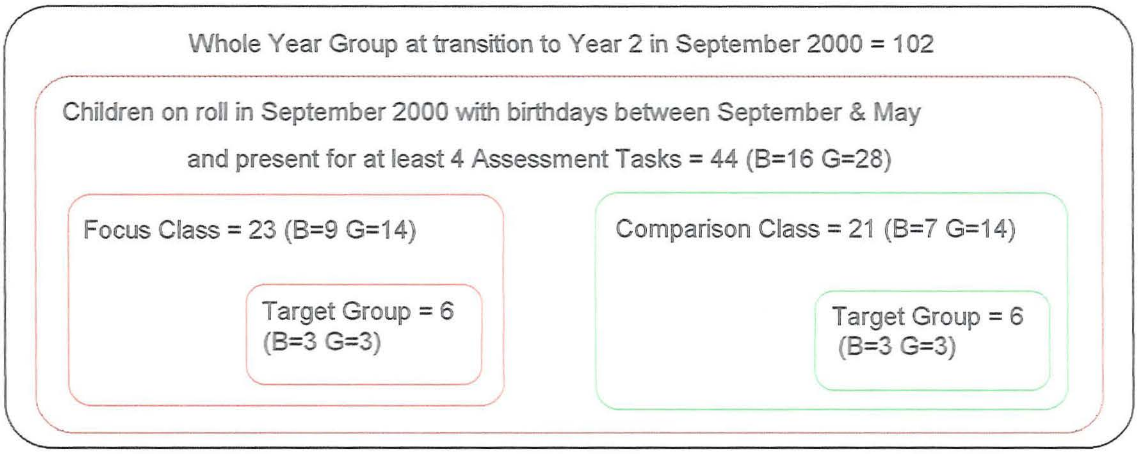



*Fig. 41 : Research Subjects (Structured Phase)*

The children were heterogeneous parallel groups (representing a range of academic abilities and yet being within a narrow age band) which helped to address both internal and external validity. The history of both groups was known, in that they had similar experiences of Design and Technology activities in Year 1 since I had overview of planning and delivery in my joint roles as both Year 1 and D&T Co-ordinator. The setting in which they were studied was naturalistic, since the Programme formed part of their school curriculum, they were studied working in their own classrooms and they knew me well. There were 24 children in each class group at the beginning of the Programme, but numbers shrank due to placements in other schools and families moving away, which also affected the gender balance. Thus, although threats to internal and external validity were kept to a minimum through the choice of subjects, the loss of subjects during the study could not be controlled.

*Focus Class*: with whom I conducted the Programme of lessons, delivered weekly during four consecutive school terms, during which the dual nature of design drawing as Container and Journey was made explicit. These were children from a Year 1 class parallel to my own in 1999-2000. My previous contact with them was only in my role as Year Co-ordinator.

*Comparison Class*: with whom I would conduct the Assessment Tasks only, at intervals throughout the Programme (also conducted with the Focus Class). These children were my 1999-2000 Year 1 class, plus a new girl who joined the school in Sept.2000.

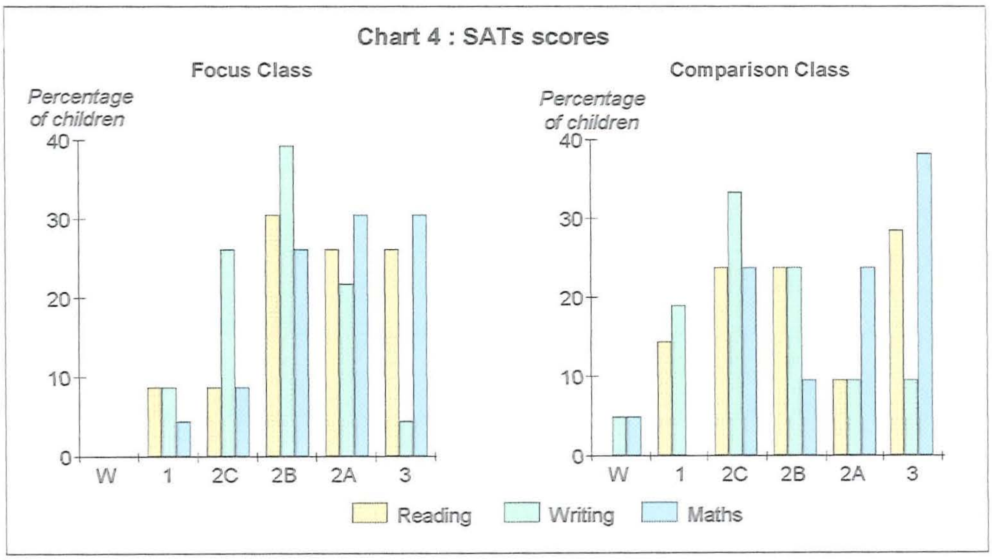
*Target Groups:* Six children from each class who would demonstrate a range of approaches and understanding and who would not be camera-shy or react adversely to being questioned about their work, whose drawings would be submitted to my moderating panel for blind-marking. The choice was based on my heuristic knowledge of the children at the beginning of Year 2. The Comparison Class Target Group were chosen whilst they were still my Year 1 class, and the Focus Class Target Group were chosen in discussion with colleagues during the first few weeks of the Programme (Autumn term 2000) to mirror the Comparison Class Target Group.

***Gender balance***

There were more girls than boys in both classes (14:10 at the start of the Programme) and the three children who left the Comparison Class during the year were all boys. One boy in the Focus Class was absent for two Assessment Tasks and so was excluded from the analysis in order to even up the numbers. Section 5.9 contains the evaluation of the differences between the boys' and girls' performance.

***Academic attainment***

School Records Data on the children's academic performance was limited to the results of the SATs tests taken by the children in May 2001 and used as proxy pre-test data to indicate the academic performance of the children. I was unable to obtain detailed records of the Baseline Entry profiles which were conducted at the start of the children's Reception Year but know that this cohort scored several points lower than the county average (37 : 45). As can be seen by the SATs scores (Chart 4, below), the children involved in this study are of below average attainment for their age (7.0 to 7.6 years in May 2001, the older half of the SATs cohort) but fairly comparable to each other. The Focus Class appear better at writing; the Comparison Class seem to be better mathematicians.



### 4.2.3 Validation of Structured Phase Analysis

I began the Structured Phase of the research with greater awareness of the issues of validity and reliability. It was important that, as far as possible, I was able to demonstrate that systems were in place to address these issues. Since I was using a multi-method approach, using both qualitative and quantified data, I was concerned that the terminology and assumptions of one methodological tradition did not become the lens through which both aspects of my methodology were viewed and also that validity checks that were appropriate to large-scale quantitative studies would not be inappropriately applied to my small population. Section 4.2.2 has already indicated the minimising of threats to validity through the selection of research subjects.

Section 2.2.3 outlined the importance of multiple perspectives for addressing issues of validity and reliability of research procedures and findings, whilst also limiting the extraneous variables through maintaining consistency of approach and analysis methodology. At the beginning of the Structured Phase, I was far more aware of these issues than I had been during the Exploratory Phase and I attempted to deal with these issues in the following ways:

***Assessment Tasks***

The Assessment Tasks were all activities of the type that would form a normal part of a Year 2 Design and Technology curriculum and (with the exception of the Maze Task) had been trialled my myself and others prior to the Programme. Although each task had its own characteristics, the materials of construction could be cut by the children using scissors and the task could be completed within one session. The Assessment Tasks were conducted at intervals throughout the duration of the Programme, thus giving a longitudinal aspect to the study, as shown in Fig. 47 in Section 4.3.1. I was careful that the Assessment Tasks were conducted in the same way in each class and that the same Teaching or Learning Support Assistant was present for both sessions for each Assessment Task.

Trochim (2000) discusses the reliability issues that relate to Test-Retest scenarios, observing that the longer the time gap between the re-tests, the less similar the factors that contribute to error. In my Programme, the tests were spaced unevenly across a period of 15 months. However, the aim was not to compare before-and-after as much as between two populations at each assessment point. The assessment situations were not of the type usually associated with large-scale quantitative studies, they were intended to be the kinds of activities in which Year 2 children would normally be engaged in Design and Technology lessons and, as such, each Assessment Task had its own characteristics that affected the results. This I did not see as a disadvantage, for although it might have affected the mathematical reliability of a statistically based analysis, it fitted more appropriately with the reality of the classroom which I was attempting to capture.

Although the Assessment Tasks were of broadly of the same type, differences between the tasks to give a range of opportunities for children to display their design capabilities. Issues surrounding the variations between Assessment Tasks not realised at the start of the Programme are discussed in Section 5.2. The extent to which these variations would affect the internal validity of the research was minimised by using comparison between the classes as measure of Programme success rather than relying purely on criteria referencing. Trochim (2002) defines parallel-forms reliability as relating to the consistency of the results of two tests constructed in the same way from the same content domain. The content domain for my Assessment Tasks was Design and Technology lessons appropriate for the age of the children. However, the richness and diversity of variables within that domain was far greater than that to which I could be easily mathematical modelling, even if such were considered valid, given the low number of research subjects.

On reflection, I feel that such variations added to the validity of the study, since it demonstrated another perspective: the way in which children use drawing in different design circumstances. If each Assessment Task had been identical in its demands and required the same range of thinking skills, a much narrower perspective on children's design skills would have emerged. In order to establish parity across Assessment Tasks, I introduced each task to the whole class at the start of the lesson and the children were then asked to develop their ideas on paper before engaging with the materials and making the product. To give a different perspective on the children's design capability, one of the researchers from the "Enriching Literacy; the Design and Technology Evaluation Project" conducted the Surprise Card assessment activity from that study.

***Analysis Methodology*** - both qualitative and quantitative approaches were used in order to give as full a picture of the children's capability as possible. Section 4.2.4 details the range and type of data collected, summarised in Table 5 :

| Qualitative | Quantitative |
|---|---|
| Log book entries - Programme Log (Focus Class) & Child Response Log (both classes) | Assessment Task drawings & photographs (both classes) |
| Audio & Video recordings - children working (Target Group, Focus Class) & de-briefing interviews (Target Groups, both classes) | School records data - register details & SAT results (both classes) |
| Drawings and/or photographs from most non-assessed lessons with Focus Class | |

*Table 5 : Qualitative & Quantitative Data*

Within the quantitative analysis, the same marking criteria and recording format was used on every piece of work produced for an Assessment Task. Moderation by others was an integral part of the validation process, both in the development of the quantitative analysis instrument and in establishing a consensus on what constituted a specific allocation to points on a continuum (discussed in Section 5.4.3b) to avoid halo effects, generosity and contrast errors, which, as Judd et al. (1991) point out, can easily lead to biased judgements. Trochim (2002) considers that "inter-rater reliability is one of the best ways to estimate reliability when your measure is an observation." (http://trochim.cornell.edu/kb/reltyypes.htm). My sample was not large enough to support statistical techniques suggested by Trochim, such as Cronbach's Alpha, but the principle remains the same: multiple raters would lead to greater assurance of reliability of analysis findings.

Within school, two colleagues were involved in testing the analysis instrument at several points in its development (detailed in Section 5.4.2). Miss N. (the Comparison Class teacher) was involved in the early stages of developing the analysis instrument and, as a mathematics specialist, gave useful advice on modelling the results. However, since I was anticipating a difference between the two classes to become apparent, it seemed unwise to ask her to become involved with marking. Miss S., the Year 2 Co-ordinator, and Mrs. R, the Art Co-ordinator (now also Year 3 Co-ordinator) took on this role. Both colleagues had many years experience in teaching across the Primary age range and had maintained an interest in my research since Stan96, They blind-marked all the Target Groups' work for each Assessment Task, including re-marking where changes to the analysis instrument had impact on classification.

A member of the Design and Technology Bridging Group, who taught Year 2 in a neighbouring school also offered advice on the wording on the analysis instrument and became the third member of my moderating panel who blind-marked Target Group work for each Assessment Task. Holding meetings with her at the same time as my in-school colleagues were available was sometimes difficult to arrange, since all of us held posts of responsibility within our schools as well as running after-school clubs.

Since two of my moderators were colleagues within my school (especially since Miss S. was Year 2 Co-ordinator) the moderation panel were given photocopies of the children's work with names obliterated so that they did not know which were Focus Class and which were Comparison Class children. I was anticipating differences emerging between the two classes and I did not want any comparisons being made between Miss N. (Comparison Class teacher) and myself, since I was expecting the results to be better than I had achieved previously with children (hopefully comparable to the Year 3 class that I taught weekly in 1998-9) If differences emerged it would be due to the Programme content, not my teaching style and I did not want comparisons being made about our teaching skills based on Programme outcomes.

Our procedure was for each of us to have copies of the Target Groups' drawings, photographs of finished products, copy of video, audio tape or Log Book notes, which we would then assess by the analysis instrument criteria (Appendix N). On meeting we would compare, discuss and come to an agreed position about each drawing. This agreed evaluation would become the quantified data entered into the spreadsheets on which the quantitative analysis reported in Sections 5.5 - 5.9 was based. This process was complicated by the evolution of the analysis instrument (see Sections 5.4.1 - 2) and there were several occasions when we needed to revise our previous judgements based on revisions of the analysis instrument. Once the analysis instrument metamorphosed into its final form (Section 5.4.3), Miss S. and I jointly reviewed the evaluation of all drawings (not just those of the Target Groups).

An in-school workshop that I conducted in June 2001 on developing young children's design drawing skills provided an opportunity to ask the whole teaching staff to blind-mark the Easter Assessment Task work using the quantitative analysis instrument as it was at that stage. Colleagues worked in pairs with a selection of Target Group drawings. In July 2001, I repeated the design drawing workshop at the Design and Technology Association conference, again using the Target Groups' drawings and asked those attending to evaluate them by the criteria on the developing analysis instrument. It was apparent, however, as I circulated the room, that the shared meanings that had been established with my moderating panel and the heuristic knowledge that my in-school colleagues brought to the evaluation of First School children's drawings, was not shared by this more varied group of people.

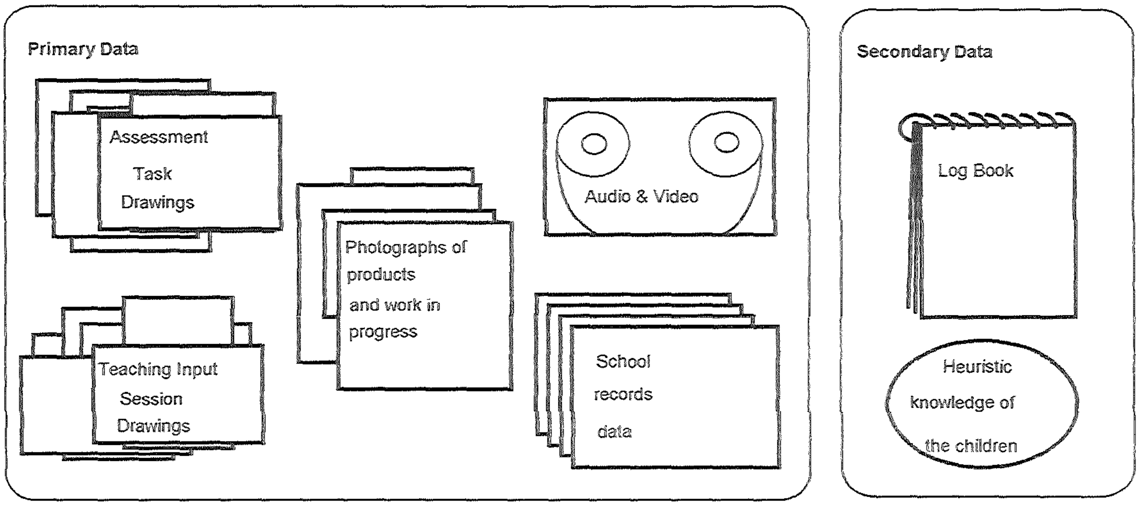
Neither of these workshop groups had the benefit of viewing or listening to the video and audio recordings, reading my Log Book notes or of seeing the completed products. My moderating panel agreed that it was difficult to place the drawings without the other data, since the child often revealed their intentions in a comment during de-briefing, or that it became apparent that design ideas were being developed when the product was viewed in conjunction with the drawing. It would seem that there was an inherent danger in assessing drawings, that were intended to support a design journey, as if they were journey's end.

The evolution of the analysis instrument, as well as the assessment of children's work was subjected to discussion over many months with my research supervisor and the research group at Goldsmiths College (Section 5.4.2b). This research group comprised research students of the Design Department at Goldsmiths College, who met termly for mutual support and discussion of progress, chaired and advised by Professor Richard Kimbell.

## 4.2.4 The Choice of Data to Collect

It was important to make the correct decisions about the data to be generated for analysis: wide ranging enough to give as full a picture as possible, without giving myself an impossible task as regards analysis time and complexity. Spreadsheets and databases were constructed to manage the task of recording and analysing all data, whether evaluations of products or transcripts of video recordings.

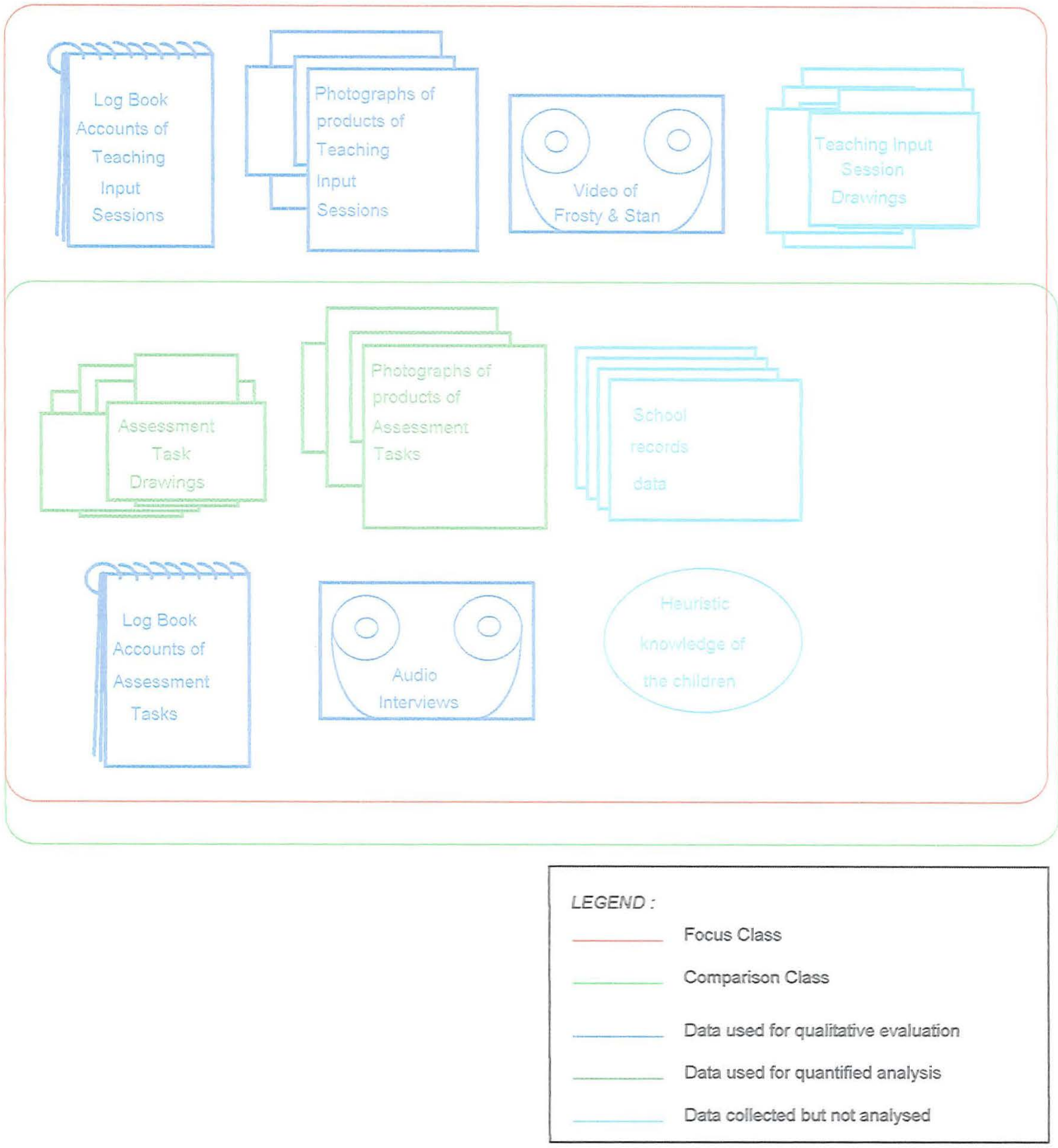
*Fig. 42 : Primary & Secondary Data*




***Primary Data***: All drawings produced during the Programme were kept. Photographs were taken of products of Assessment Tasks and of children working both during Assessment Tasks and some of the Teaching Input sessions. Video recordings were made of children working (Focus Class Frosty and Flat Stan) and discussing their work after completion (Stan Series). The school records data were the children's SATs results.

***Secondary Data***: I maintained a Log Book throughout the Programme, which included all field notes made during contact time with children. Heuristic knowledge of the children included my knowledge of family circumstances, acquaintances with other family members, relationships built through teaching them or their close relatives.

*Fig. 43 : Distribution of Data Collected*




Drawings produced by Focus Class children during Teaching Input would not be subject to quantified analysed, although observations would form part of the evaluation of the Teaching Input. Despite enabling me to be informed about the work that the Comparison Class were doing, photographs of this class' work outside of Assessment Tasks were not analysed. The school records data was not as extensive as I had hoped, so that conclusions about relationships between design capability and achievement in other curriculum areas were not able to be drawn. My heuristic knowledge of the children informed my choice of the Target

Groups and being well-known to parents enabled permission to be granted to use children's work for publication.

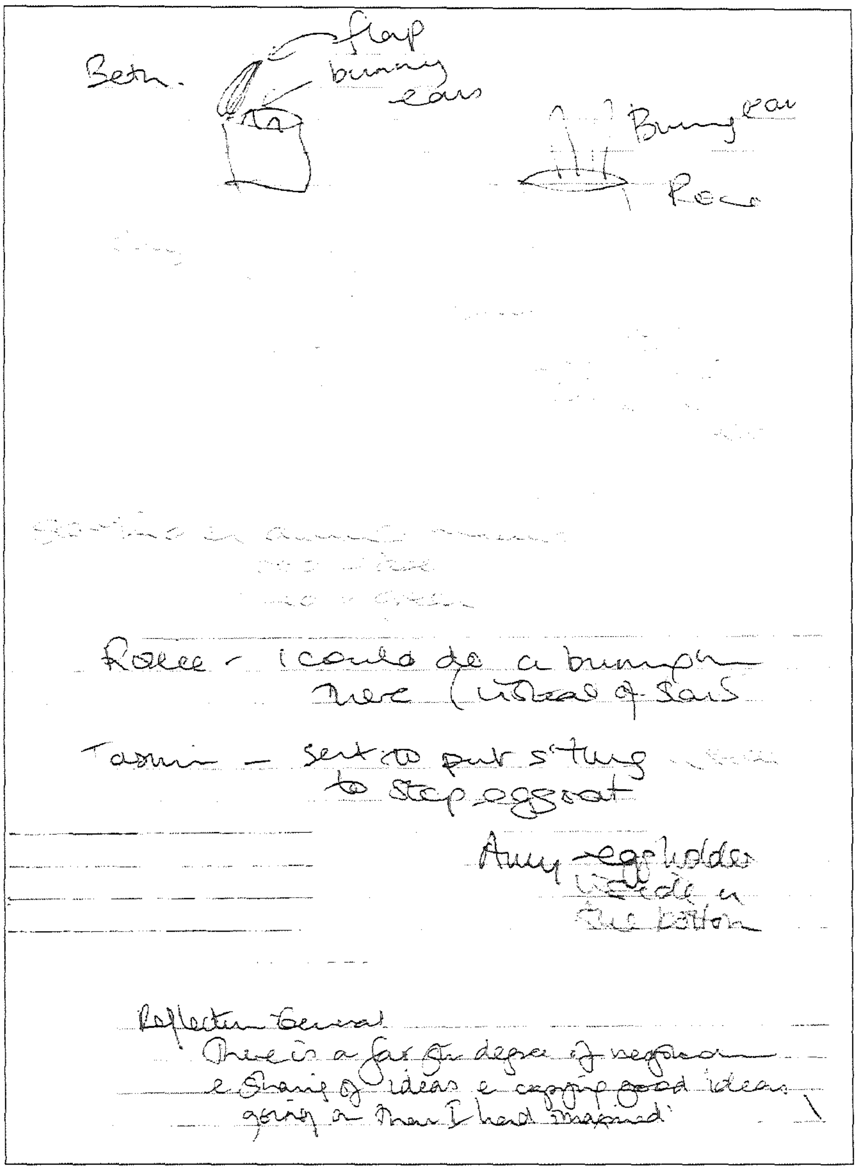
My intention was to video-record the Target Groups at work on each Assessment Task. However, attempts to use the rarely-used school video camera led to frustration over missing parts and flat batteries. Previous experience of transcribing audio recordings of classroom work did not encourage me to substitute audio for video. This media was used successfully for de-briefing interviews with the Target Groups immediately after the Assessment Task sessions. My Log Book, became the main vehicle for recording in-context observations, combined with digital photography to capture critical moments and to record all finished products, became the most efficient and effective means of recording both teaching and assessment sessions.

The advantages of the Log Book were its:

- *spontaneity* - it moved with me to the hot-spots in the classroom; it was not trained on children doing not much whilst something more note-worthy was happening elsewhere.
- *adaptability* - I could record verbatim speech, personal reflections, make sketches of work in progress (as excerpt shown in Fig.45), write in columns or divide up the page for recording several children's work and add notes to each child's square when I returned later, colour-code, write sideways or across previous recordings, draw circles and arrows to connect themes.
- *familiarity* - it was the system I ordinarily used in the course of teaching to record observations and evaluations of children's learning across the curriculum.

Fig. 45 (overleaf) shows a page from this Log Book. The "Reflective General" comment (just off the scan) reads : *There is a far greater degree of negotiation and sharing of ideas and copying good ideas going on than I had imagined*, which is borne out by my sketches of the work of the main girls' group at the top of the page.

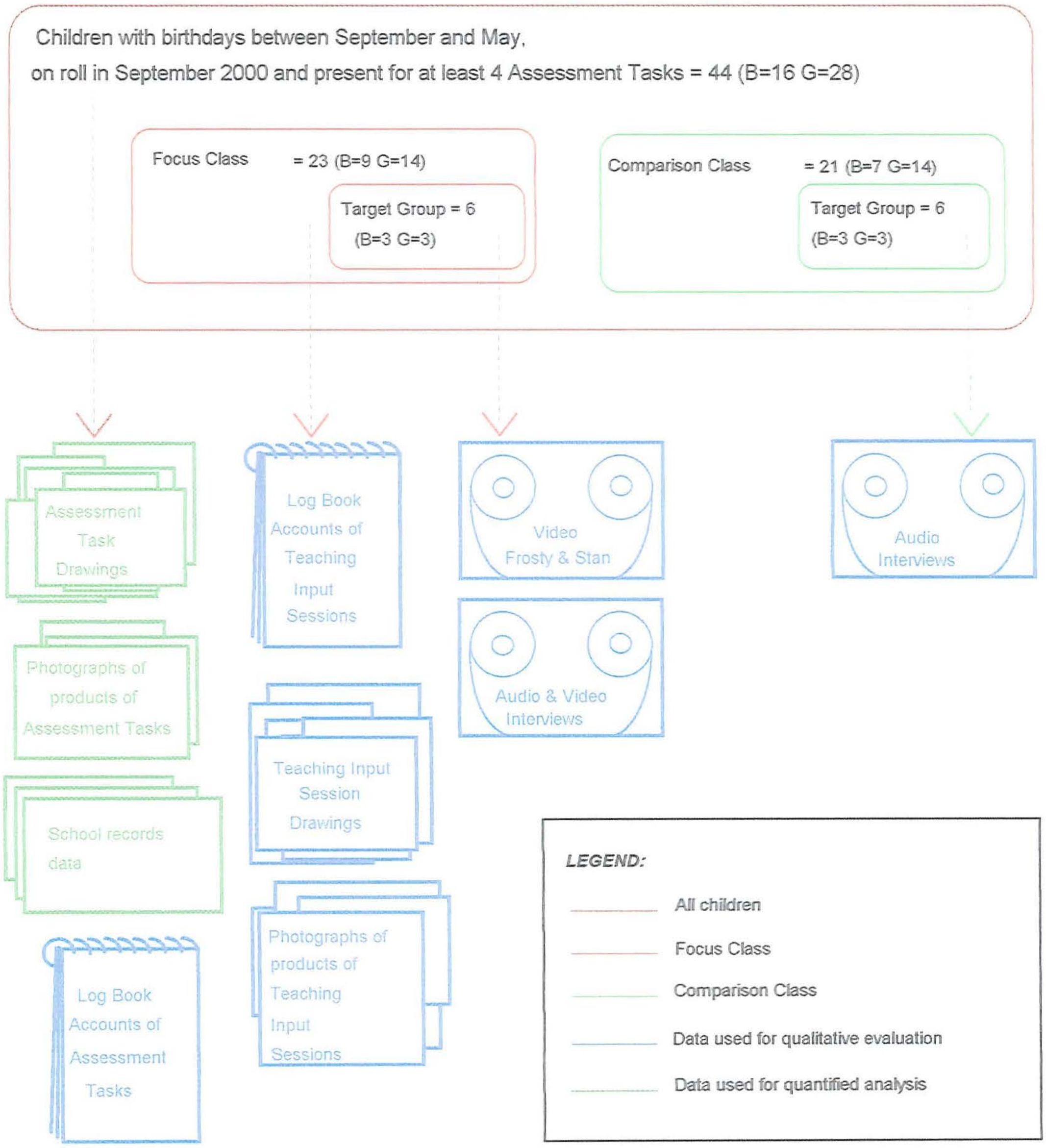
*Fig. 44 : Excerpt from Log Book:*




These Log Book notes, combined with digital photographs, proved to be the most efficient and effective means of recording children working and capturing the important moments, as I could circulate, photograph, sketch and note comments made by children while they worked. I found that sitting down and making quick sketches of the children's work prompted them to tell me about what they were doing and I would annotate my drawing appropriately and note their comments verbatim. I was thus able to get a cameo of each child at some point during each Assessment Task session, which became vital for interpreting their drawings. Holding a "photo-shoot" at the end of each session was the easiest way to record the finished products.

I had used the Log Book in this way during all the teaching sessions with the Focus Class from the beginning of the Programme and the children would frequently come to me to tell me what they wanted me to write down. I created a Log Book Index database (Appendix M) to enable classification of the comments and sketches. My original intention here was to use the filter function to trace themes and the development of individual children across time. When I attempted this, however, I realised that the context was lost. It was in the reading of all the comments relating to each activity that the richness of the situation could be seen, as well as difference between the two classes.

*Fig. 45 : Distribution of Data Sets used for Analysis*




The qualitative data was to form the basis of the evaluation of the Teaching Input to the Focus Class (Section 4.4) as well as contributing to the evaluation of the children's performance on the Assessment Tasks (Section 5.3). The quantified data originated from evaluation of the children's drawings, which could then be manipulated more easily in numerical format. This is reported in Sections 5. 5 - 9.

Fig. 46 shows the data that I had collected by the end of the Programme and how it was managed for analysis of the Structured Phase:

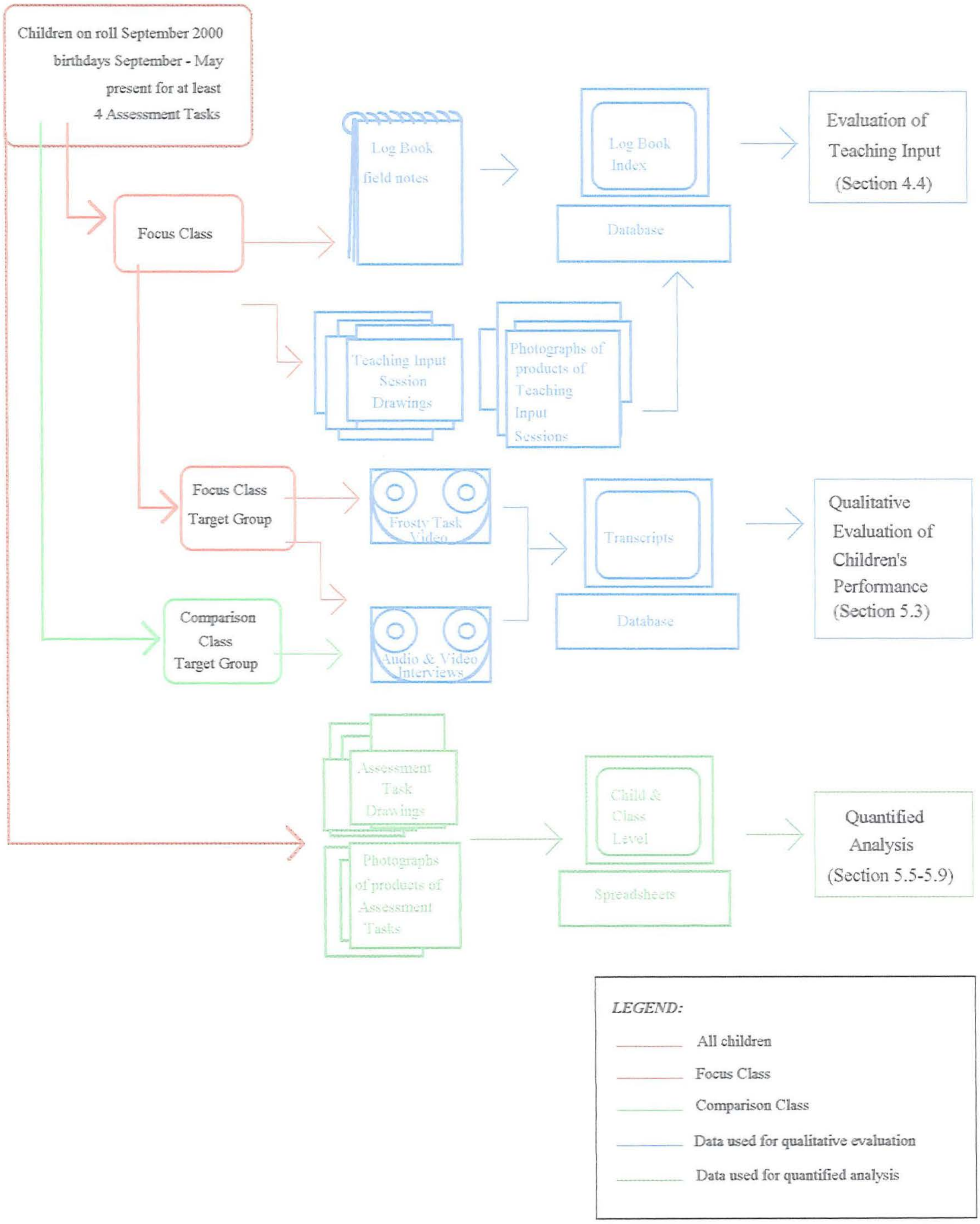



*Fig. 46 : Management of Data in Structured Phase*

# 4.3. Programme Delivery

Unlike those of the Exploratory Phase, the Structured Phase activities were planned as a complete Programme across fifteen months (October 2000 - January 2002) to be delivered to a specific group of children who entered Year 2 in September 2000 in the school in which I worked. The Programme was devised in February 2000. This section outlines the Programme, indicates the changes made and gives account of the reasons behind these changes. The full lesson plans can be found in Appendix B. The Programme Outline (Section 4.3.2) briefly describes the projects within the Programme.

## 4.3.1 The Structure of the Programme

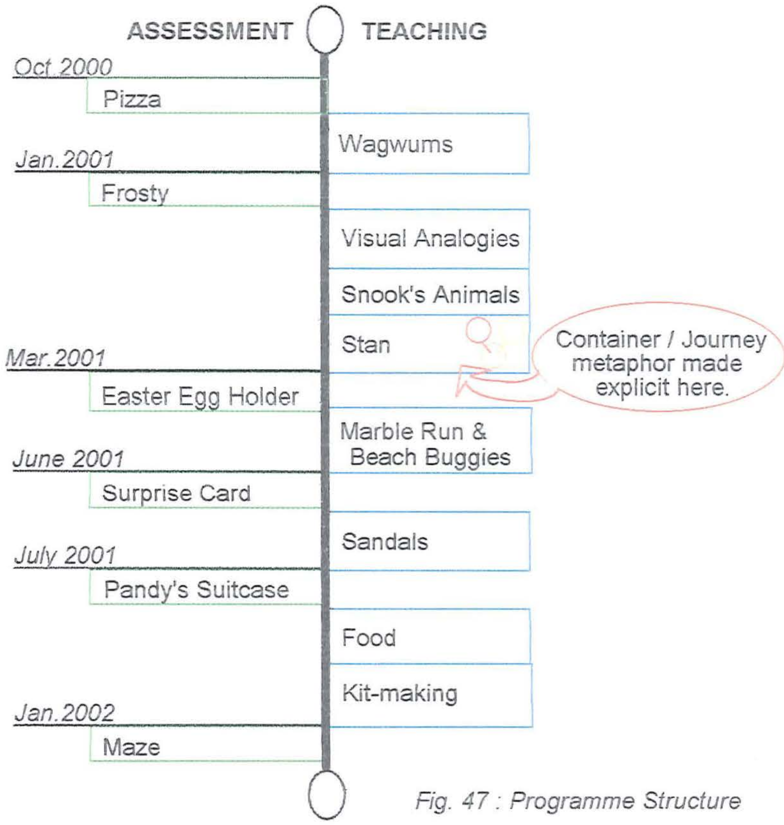



*Fig. 47 : Programme Structure*

I began to plan the Programme of lessons to be conducted with the Focus Class with the belief that understanding and being able to exploit the analogy between the drawing and the making processes is the key to being able to utilise drawing for designing. This meant devising a Programme to extend their understanding of design by making explicit the metaphorical nature of design drawing. This I would do through utilising the Container / Journey metaphor to explain the design process. At key points throughout the duration of the Programme, I would conduct

Assessment tasks with both the Focus Class and the Comparison Class in order to map the development of their design capabilities.

I had a wealth of activities from the Exploratory Phase which could be used but these needed allocating as teaching input activity or Assessment Task. I had extensive documentation of these activities, including method of presentation, children's drawings and design sheets, photographs of children working and products made, observations at time of delivery and analyses of the children's work. I also knew the limitations and pitfalls of these activities, some of which had been ironed out through repeated trials. I especially wanted to use these tried and tested activities for assessment as this would cut down on the unknowns and so increase the reliability of results. At the same time, I wanted to try some new ideas, including some ideas from projects conducted by other researchers.

The Stan activities based on "Flat Stanley" by Jeff Brown could not be omitted; I had too much experience and comparative data on these, yet knew they were not suitable as Assessment Tasks (no client, human figure produces stereotypical drawing response). However, my complete familiarity with a whole range of ways of presenting the activities made them ideally suited to being the vehicle for introducing the central Container / Journey metaphor to the Focus Class. If I produced better results through using this explanation than any previous presentation, then there could well be grounds for attributing the results to the explanation.

Pandy's Suitcase could be used as it was, since it had proved successful in the Exploratory Phase. The kit-making ideas (Insects in the Exploratory Phase) could be adapted to different subject matter for teaching input. Boat-making and work on food promotions, conducted with the Year 3 class I taught weekly in 1997-8, could be used with few changes.

New ideas were trialled with classes around the school during 1999-2000; for example, Easter Bunnies with wheelbarrows in March 2000, but this took too long to be a useful Assessment Task. The Surprise Box of Art Club 1999 had become a Surprise Tube activity conducted with groups of children across the school in May 2000 and could be completed in a single lesson. This was adapted to the Easter Egg Holder Assessment Task which was based in the same wide card tubes.

There was also the need to maintain parity of experience in terms of hand-skills between my Focus Class and the rest of the year group. The sandal project was designed to match textile work (Puppets) and I adapted the food series to bring it more into line with the planning of the Year 3 team. My final Assessment Task (the Maze) was a new activity designed to fit in with Year 3 Literacy Hour texts.

## 4.3.2 Programme Outline

The Programme began part-way into the Autumn term of the new school year in 2000 (to allow for a "settling in" period for my new Year 1 class) with its final Assessment Task session at the beginning of the Spring Term 2003. The Teaching Input Sessions delivered to the Focus Class were conducted almost weekly until the end of November 2002 (Thursday afternoons whilst they were Year 2, Fridays Year 3). The Assessment Tasks were usually conducted with each class on consecutive weeks, except for the Card and Maze, which were conducted as two consecutive sessions in the same morning.

Table 6 provides an overview to show the teaching objectives of each half term block of the Programme. As well as the modelling skills (with the focus on drawing) which would be developed across the course of the Programme, this Table indicates the practical techniques to be taught and also other skills associated with design capability, such as team-work.

*Table 6 : Programme Objectives*

| TERM | PROJECT | SKILLS | TECHNIQUES |
|---|---|---|---|
| AUT 2000 | Fantasy figures | To make what they have drawn<br>Making a pattern before engaging with materials<br>Evaluation at planning stage through discussion with partner<br>Develop ideas collaboratively | labelled diagram<br>design sheets/grids<br>story-boarding |
| SPR 2001 | Visual analogies | Using what they see to stimulate ideas<br>Develop understanding of and facility with visual analogies | transfer by tracing |
| | Ideas on a Journey | Understanding what constitutes clear design communication<br>Introduction of Container / Journey metaphor<br>Use drawing to support design journey | clarity of diagrams<br>recording materials |
| SUM 2001 | Modelling in other media | Evaluate each other's ideas and create a joint product<br>Use media other than drawing for planning<br>Use drawing part-way through design&make process | paper folding for runs<br>bead-making<br>flat-pack box |
| | Extended Project | Begin design activity from product analysis<br>Carry through ideas across several sessions | observational drawing<br>pattern development |
| AUT 2001 | Team-working | Use drawing to communicate ideas within a group<br>Work as part of a team<br>Develop meta-cognitive awareness of design processes | design development<br>graphic communication |
| | Designing for Others | Generate & critically review each other's ideas<br>Address needs of a client<br>Communicate & refine ideas<br>Prototype a product | |

Table 7 overleaf lists each session of the Programme. A brief resume of lesson content follows. Full lesson plans are to be found in Appendix B.

*Table 7 : Programme Sessions*

| TERM | WEEK | PROJECT | ACTIVITIES |
|---|---|---|---|
| AUTUMN 2000 | 1 | *Assessment* | *Cups, persons, pizza* |
| | 2 | Reality / fantasy | Wagwums (1) figures |
| | 3 | | Wagwums (2) clothes |
| | 4 | | Wagwums (3) vehicle |
| | 5 | | Wagwums (4) house |
| SPRING 2001 | 6 | *Assessment* | *Frosty the snowman* |
| | 7 | Visual analogies | Pictures from shapes |
| | 8 | | Iron's visual analogies (1) |
| | 9 | | Iron's visual analogies (2) |
| | 10 | | Letter Spirit Project |
| | 11 | Ideas on a Journey | Snook's Animals |
| | 12 | | Flat Stan |
| | 13 | | Round Stan |
| | 14 | | Customised Stan |
| | 15 | *Assessment* | *Easter Egg Express* |
| SUMMER 2001 | 16 | Non-drawn activities | Marble run |
| | 17 | | Necklaces |
| | 18 | Customising | Buggy (1) |
| | 19 | | Buggy (2) |
| | 20 | *Assessment* | *Surprise card* |
| | 21 | Extended Project | Sandals (1) - designing |
| | 22 | | Sandals (2) - templates |
| | 23 | | Sandals (3) - making |
| | 24 | | Sandals (4) - completion |
| | 25 | *Assessment* | *Pandy's suitcase* |
| AUTUMN 2001 | 26 | Team-working | Food (1) - menu & poster |
| | 27 | | Food (2) - diarama |
| | 28 | | Food (3) - sandwiches |
| | 29 | Designing for Others | Kit-making (1) - design |
| | 30 | | Kit-making (2) - prototype |
| | 31 | | Kit-making (3) - testing |
| | 32 | | Kit-making (4) - assembly |
| SPRING 02 | 33 | *Assessment* | *Maze* |

The Programme had to take account of the development and maturation of the children across 15 months of their lives. Broadly speaking, the activities near the beginning of the Programme were ones which I had previously conducted with Years 1-2 and those nearer the end were ones which I had conducted with Years 3-4.

Additionally, the activities at the beginning of the Programme were "tight", in the sense that the activity was teacher controlled. The children were developing skills under specific guidance. As the programme progressed, the activities became "looser" and there was more room for the children to use and apply the skills gained in the earlier part of the Programme and to develop ownership of the skills as well as the activities.

In considering how to present that account of the Programme, it was decided that a short account of the content of each project should be included here, as an overview. The full lesson plans are to be found in Appendix B. However, since the teaching of the Container / Journey metaphor was central to the Programme, it was decided to discuss this in far greater depth (Section 4.3.3).

It was further decided that the qualitative evaluation of the Teaching Input would be separated from that of the Assessment Tasks, as this would allow the Focus Class' developing understanding of design drawing be discussed in relation to the Programme delivery. Mutually supporting qualitative and quantified data would then be used to compare the capability of the two classes as revealed by their performance on the Assessment Tasks:

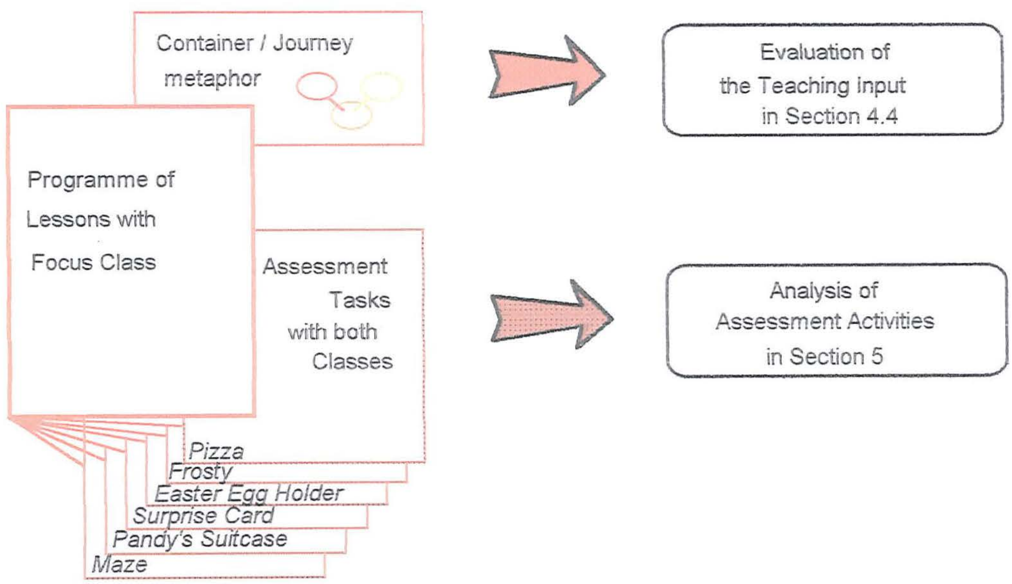



*Fig. 48 : Teaching Input & Assessment Tasks*

***Autumn Term 2000***

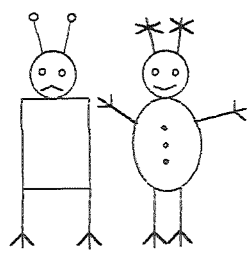
***Session 1: Assessment Task with Both Classes: Design a pizza***

A Baseline Assessment Task (Design a Pizza) was carried out in October 2000 using an activity that had been conducted in previous years with Year 1 classes in the Summer term but that this particular cohort had not experienced. This Assessment Task was designed to establish base-line capability within both classes. It was a design-and-make activity suitable for children at the beginning of Year 2 in which they were asked to use pencil drawing to generate design ideas for a collage of a pizza to be made from a range of sheet materials, fabrics and small items. There was an initial discussion of favourite toppings on pizzas and how the toppings are arranged to look appetising. The children were told that they would be given some white paper to try out some ideas about what they would make. Progression of ideas across drawings was explained and demonstrated. For both sessions I had the help of Mrs. M, one of our Teaching Assistants.

***Sessions 2-5: Teaching Input to Focus Class : Reality / fantasy***

This first series of lessons was a fantasy theme based on alien creatures called Wagwums and Foozles. The design-and-make activities (Figures, Clothes, Transporter, House) based around these imaginary creatures and their planet home involved the use of drawing for designing but I wanted to encourage discussion and clarification of their ideas with a partner. I did not want to create artificial situations, in which children had to draw just because I was interested in their drawings, where other means of modelling and developing ideas would be more natural. I believed that by discussing their plans with a partner, the usefulness of drawing to communicate ideas would also become apparent.

I wanted the children to see the link between drawing and making, and also that drawing could be ambiguous and temporal. The children were shown large pictures of the aliens and asked to make them in plasticine and matchsticks. It was impossible to see from the drawings of the aliens whether they were flat or rounded as viewed from the side:



For the Clothes session the children used newspaper to make a paper pattern by trial and error and then draw the clothes they were going to make and attach sample materials to a worksheet. For the Transporter and House, I wanted the children to design by discussion and then record their ideas by drawing and writing prior to making.

***Spring Term 2001***

***Session 6: Assessment Task with both Classes : Frosty the Snowman***

The aim was for the children to produce a drawn design and then make a model to demonstrate a means of getting Frosty the Snowman's shopping to him on his hilltop if the shop is on the opposite hilltop and there is a lake in between. The children were shown a model snowman, a picture of the solution of the problem of the Lighthouse Keeper's Lunch story they knew from Year 1 to stimulate discussion on how Frosty might solve the problem and they were reminded how to roll newspaper to make a reasonably strong structure (bridge-making in Year 1). A range of other materials were available: string, card, lollysticks, corks etc., plus they were free to utilise anything else they were allowed to use from their own classroom stock (e.g. contents of Junk box).

***Sessions 7-10: Teaching Input to Focus Class: Visual Analogies***

Prior to presentation of the Container / Journey metaphor, I wanted to conduct activities that would enhance the Focus Class children's facility with analogical thinking. Four activities were chosen to achieve this objective, only one of which I had conducted before. The others were adapted from ideas found as a result of literature and internet searches on the topic of visual analogy.

a) Circles Activity - this was an ideation fluency activity that I had used around the school, most frequently in Year 3: circles printed on a worksheet, each one to be made into something different.

b) The Abstract Shape activity came from the RIOTT programme by McCracken (1985): each child had a card of roughly horseshoe shape to use as a template and make a picture based on as many of these shapes as they liked.

c) Iron's Analogies (2000) were used as the basis for making a board game. Although intended as a single lesson, two sessions were needed to complete the games.

d) The adaptation of the McGraw's Letter Spirit Project (McGraw & Hofstadter, 2000) to a design-and-make task, requiring the children to extrapolate from letters A - G in a variety of fonts to writing the rest of the alphabet on squared paper and making a name sign for their bedroom door.

***Sessions 11-15 : Ideas on a Journey***

These four sessions were the focus for the teaching of the Container / Journey metaphor. A fuller discussion of them is to be found in Section 4.3.3.

The first step was to establish in the children's minds what a good "Container" would look like, before attempting to get them to move it forward on a "Journey" through the activities based on the Stan tasks that I used during the Exploratory Phase. The Flat Stan and Round Stan activities were used as the main vehicle for introducing the Container / Journey metaphor, re-inforced by Customised Stan, in which I wanted the children to devise their own adventure for Stanley. In the Flat and Round Stan activities I wanted the children to use drawing to record and develop their design ideas and in Customised Stan I wanted them to move towards recording their developing their ideas as if made in the materials. I knew this would be difficult as, in all my previous experiences, recording the materials has been the aspect that children found hardest.

***Session 15: Assessment Task with both Classes : Easter Egg Holder***

The design problem involved in the Easter Egg Holder activity was to design and make a holder for an Easter Egg from a 100 cm. wide cardboard tube and other recycled materials, such that a small egg (hard-boiled eggs supplied for measurement) will be held securely inside the tube and the outside is suitably decorated to give to a friend.

I was interested to discover whether my input to the Focus Class would show any immediate effects. The Comparison Class had also been using drawing to support designing during the Spring term but without the Container / Journey metaphor to explain its purpose. The Easter Egg Holder task would be the first test of my metaphor's effectiveness.

***<u>Summer Term 2001</u>***

***Sessions 16-19: Teaching input to Focus Class: Modelling in other Media***

In Summer 2001 (first half-term) the Focus Class used media other than drawing for modelling, to ensure that the children had not just learnt the design drawing skill at a declarative level, but could transfer the procedural skill of modelling to other media. I wanted to try modelling in plasticine before making in wood, modroc or other plastic medium. Ritchie (1995) found that the children were much happier to change their designs in a plastic medium than if drawn. This seems likely since no permanent mark-making is involved. It would probably be more interactive in terms of discussing, changing and adapting ideas. The activities chosen were a Marble Run (made in plasticine, card and small found objects) and Necklaces made from paper beads.

The children had yet to experienced any flat-pack box-making activities, in which they could think about customising whilst constructing, and so I planned a two-week Beach Buggy project. Drawing would be used to think about logos and decoration of the product, once the basic box cart had been built. The basic cart was built in the first session. At the beginning of the second session I reminded the children about Containers & Journeys. I showed a side, front and back design drawing for a beach buggy, which *"Since it is too small for everyone to see"* I redrew on the flip chart and explained to them how my thoughts had gone on a journey.

***Session 20: Assessment Task with Both Classes: Surprise Card***

This was conducted during the first week after half term by one of the researchers from the "Enriching Literacy through Design and Technology Evaluation Project" conducted the "Surprise Card" from that project This gave an extra dimension to the on-going assessment of the children's capabilities, a activity devised and conducted by someone else to counter possible problems associated with myself as programme writer, deliverer and assessor. It was also the only task with a pre-printed design sheet (see Appendix I).

I assumed that both class teachers would allow the children to make the cards that afternoon and did not discover that this had not happened until the following week, when it was too late. This meant that there was no "relationship to making" for this task. There was also no opportunity to interview the Target Group afterwards.

***Sessions 21-24 : Teaching Input to Focus Class : Sandals***

This was the longest design-and-make project conducted with the children, to enable them to see the role of drawing in product development. Although related in theme, other activities had not lasted more than two lessons. The main making session was conducted by Mrs R (class teacher) as I was away at conferences in the last week of June.

This project followed on well from the Surprise Card task, since both developed from product evaluation. In the first session of the sandals project, the children engaged in discussion of the different sandals in pairs or small groups and recording features they wanted to incorporate in their own designs. In the second session, a class discussion of good sandal design (and what was possible to make) lead on to making templates to fit their own foot. The sandals were made across two sessions.

***Session 25 : Assessment Task with both Classes: Pandy's Suitcase***

The Task was to design a suitcase / travel bag for the toy Panda to take on holiday, as developed during the Exploratory Phase.

From previous experience, solving this task involves grasping the interplay between fantasy and reality and accepting my terms of reference as to which parts of the task are "real" and which are "pretend" : design a travel bag, pretending that card is a suitable material, for a real toy panda in which he could put a real plastic mac in the context of pretending he could go on holiday. In 1999, many Year 2 children produced a picture of a suitcase and insisted that he could put his mac in it. I hoped that fewer children in the Focus Class would fall into this trap and misperceive the reality/fantasy divide inherent in the activity after the sandal project.

***Autumn Term 2001***

***Sessions 26-28: Teaching Input to Focus Class: Food***

Autumn 2001 (first half-term) focused on food technology, incorporating activities that I had previously conducted with Year 3 children (designing menus and making a diorama to advertise their healthy meal) with sandwich-making activities from the QCA scheme of work being followed by the rest of Year 3. I felt that my Focus class might feel deprived if they did not eat sandwiches too. Therefore I changed the Programme, spending two weeks on healthy food dioramas and the third week making and eating sandwiches. In practice, this faster pace for the dioramas worked well.

***Sessions 29-32: Teaching Input to Focus Class: Kit-making***

The final half-term block was aimed at bringing together all the strands on which we had worked: team working, addressing needs of a client, consideration of materials, as well as the use of drawing to support these activities: to generate and develop ideas, to communicate these ideas to others (both between working partners and to the client) and to record the final product.

I have conducted kit-making activities with Year 4 children in previous years, always in the Summer term and related to Year 1's topic of mini-beasts. Designing a Christmas present for Mum would be a suitable activity at this time of year and to which Year 1 would relate quite happily.

The Focus Class needed to put together a kit of parts for the Year 1s to make their gift, to include sufficient (but not too much) of each material, labelled with its intended use, any templates needed, a poster illustrating the final product and an instruction sheet.

The Year 4s had made simple errors such as putting decorative items (e.g. spots) into the kit but no base cloth on which to stick them, which caused considerable distress to the Year 1s, who assumed that not being able to make the kit was their fault. This time my Focus Class would test each other's instructions before giving them to their clients. They would produce a simple poster to explain their idea to the rest of the class, so that any difficulties could be identified through peer review. This would aid the reflective skills of all members of the class. The whole process required the children to think about making construction processes explicit and think what a younger child will be able to do and understand. They would need to have internalised the making process and use drawing to support their explanations.

***Spring Term 2002***

***Session 33 Assessment Task with Both Classes : Theseus' Maze***

Since I had not taught the Focus Class since the end of November, this Task would help to indicate that real understanding had taken place rather than just acquisition of taught techniques.

The activity was not one that I had conducted before. I had planned to conduct a three week block activity with both classes (Puppet Theatre) which I had used in 1997 across the school. However, since I was now working at Canterbury Christ Church University College, I did not have the time to visit the school weekly in order to do this. To do something which fitted in with their Literacy Hour work (Greek myths) seemed most time-effective and I found a pop-up book of Greek myths containing a 3 dimensional maze to illustrate Theseus and the Minotaur. The children were to use drawing to plan a 3-dimensional model of the maze to help Theseus escape from the Minotaur and show him how to use the string.

## 4.3.3 Teaching the Container / Journey Metaphor

The Container / Journey metaphor was introduced in the second half of the Spring term (as shown in Fig. 47) using the Stan activities I had used extensively in the Exploratory Phase of the research. I wanted to introduce the Container / Journey metaphor (Fig.39, Section 3.4.3) as early in the Programme as possible but I believed that children need some experience on which to base and build understanding of the new concept. I also believed that in order to absorb the idea, internalise it and make it their own, the children needed to be exposed to the idea in a range of contexts over a period of time. I did not just want adoption of a drawing technique, I wanted understanding of how drawing could support design thinking.

Mantell stresses the importance of making design techniques and strategies

> "explicit to the children, so that it might become part of their learning and over a period of time, be absorbed into their repertoire of techniques for designing."
>
> (Mantell, 1999: 91)

The vehicle for introduction of the Container / Journey metaphor was to be a series of three "Stan" lessons, as these were activities which I knew worked well with children of this age. Although much of the Exploratory Phase analysis was centred on these activities, I had become convinced that it was not a suitable task for assessment. Children of this age tended to produce a stereotypical figure drawing and I was concerned that I had frequently captured their current representation of a human figure, rather than real design thinking. I was confident, however, of its suitability as a vehicle for teaching input.

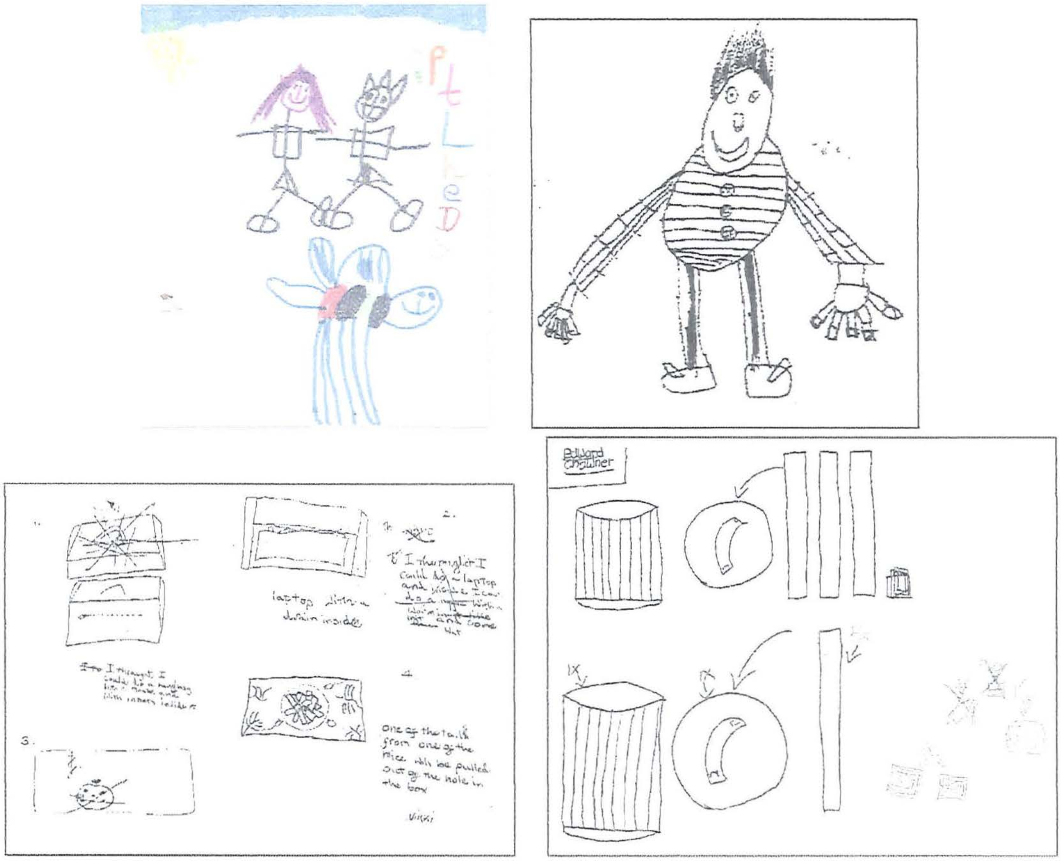
The advantage of using a task with which I was so familiar (and of whose possible drawbacks I was aware) were that there were few unknown variables. I had delivered the activity so many times that I could keep everything else the same except the explanation involving the metaphor and I planned to make an audio recording of my introduction to the children to compare with 1996 and 1998 deliveries.

I placed the Stan series at the end of the second school term of the Programme because I believed that I would have prepared the children through introducing the use of drawing for designing (Autumn) and heightened their awareness of analogical thinking (first half of Spring term). I wanted to introduce the concept as early in the Programme as possible but I believe that children need some experience on which to base and build understanding of a new concept. It cannot be introduced "cold".

The first session was introduced through a PowerPoint presentation of illustrations from Snook (1974). This lady was my art teacher at school, who wrote several books on a range of craft topics, using examples from pupils' work (including my contemporaries). There is considerable variation in her annotation, clarity of drawing and expansion to show helpful small details, which would help or hinder another person following the ideas: the teaching point I wished to convey to the children, to draw *"so someone else could make it"*. (The PowerPoint presentation used for this session is in Appendix D.)

Mrs R., the class teacher, read "Flat Stanley" to the Focus Class in advance of the three sessions to be based directly on the book. In the first lesson (Flat Stan), the children were shown the four examples in Fig.27 from my Exploratory Phase collection of drawings, two static and two showing progression of ideas.

*Fig. 27 Examples shown to Focus Class*



The children had little difficulty distinguishing between the genres and the Container / Journey metaphor was drawn on the flip chart and explained. The children then used drawing to develop their ideas for a Stan puppet, which they then made. In the following session (Round Stan), my aim was to re-inforce this learning and move the children further into using drawing to develop design ideas. I was able to show the children a range of examples from last week of ways they had used drawing to support their design journey. In practice, the timing seemed about right. I had built up sufficient relationship with the children for them to believe that what I was saying was important for them to learn and that I was interested in what they had to tell me about what they were learning.

Knowing that children needed to see as well as hear and to articulate their understandings as they develop, I planned to make my explanation as visual and interactive as possible. As a lead-in to the series and so the children would understand the features of clear drawings, the cycle would begin with a PowerPoint presentation (Appendix D) of illustrations from Snook

(1974), who was my art teacher at school and the author of many books on art, craft and embroidery, frequently using examples from her pupils' work including, in this work ("Making Birds, Beasts and Insects"), that of my school friends, in order to capture the children's interest. The considerable variation in Snook's annotation, clarity of drawing and expansion to show small details would all be used as basis of discussion on the importance of clarity of communication.

By showing examples of children's work in the Stan sessions, I hoped to enable the children to feel confident that this was something they too could achieve. My tactic was to show them examples of drawings as products and examples of design drawings and ask them to distinguish between the two genres. This would then lead into sharing the Container / Journey metaphor, drawn as I talked, onto a flip chart. The children would immediately put this into practice by producing their own design drawings for a Stan puppet to go into an A4 envelope.

The Container / Journey terminology would then become part of the shared meanings established between me as teacher and the children as learners. The terminology would be used as part of classroom talk throughout the rest of the Programme, so that the children would extrapolate, from its constant usage in a range of applications and situations, the nature of design process.

My aim was that "Through good teaching the child can become self-consciously aware of his or her design capacity and be able to make deliberate use of it." (Baynes, 1992: 42) and I believed that if told how and why drawing could support their designing, children would be able to access the process as well as the genre.

## 4.3.4 The Comparison Class' Experience

| Term | Project |
|---|---|
| Autumn (2000) first half | Badge-making |
| Autumn (2000) second half | Christmas activities |
| Spring (2001) first half | Snow-mobiles (related to topic on transport) |
| Spring (2001) second half | Moving pictures (QCA) |
| Summer (2001) first half | No D&T - SATs |
| Summer (2001) second half | Puppet-making |
| Autumn (2002) first half | Sandwich-making (QCA) |
| Autumn (2002) second half | No D&T but did Christmas activities in last 3 weeks |

*Table 8 : the Comparison Class Experience*

In line with other local schools, my school was in the process of adopting the QCA schemes of work for all foundation subjects. In this transition year, Comparison Class experienced a mixture of school-devised units and units from the QCA scheme (Ex. 28 shows an example from the Moving Pictures Unit).

*Ex. 28 : Moving Pictures*

As Design and Technology Co-ordinator, I was keen that the school should continue to deliver successful Design and Technology units that had been devised and developed by year group teams, as I felt that this encouraged teachers to think more clearly about the objectives and outcomes of their own teaching. I could see a danger in simply "doing the QCA" at declarative level of teacher thinking and assuming that delivery of the practical content would automatically lead to learning of the lesson objectives. Although this was not the case in Year 2 (Miss N. is a very reflective teacher), I was less happy with the ethos of the Year 3 team.

Making observations of the teaching input to the Comparison Class would have involved arranging supply teacher cover for my Year 1 class, which, unfortunately, was only available for monitoring Literacy and Numeracy lessons. I had copies of the year group's medium term plans as part of my role as Design and Technology Co-ordinator, which indicated design objectives in broad terms, in line with QCA guidance. Miss N. did not make detailed personal notes for teaching the individual lessons.

The Comparison Class were encouraged to draw design ideas before making a product but did not receive the same explanation as the Focus Class as to the purpose of design drawing in terms of the Container / Journey metaphor. They had workbooks in which design ideas were recorded, which their teacher marked and made written comments on. In contrast, my Focus Class worked on loose paper, stored in folders once no longer needed by the children. Feedback on design ideas was informal, on-the-spot and verbal and the drawings were frequently annotated in consultation with the child to ensure I understood their design intentions.

By using my 1999-2000 Year 1 class as the Comparison Class, I hoped that factors relating to my personal teaching style would be minimised and even at the end of the Programme in Jan.2002 I still had a viable teaching relationship with those who had been mine in Year 1. That their Year 2 classroom was just around the corner from my room and we saw each other daily throughout Year 2 helped to continue this relationship and I made short informal visits to see what they were doing in Design and Technology and take photographs. However, it was clear to me as the Programme progressed that the shared meanings which I was establishing with the Focus Class were not shared with the Comparison Class. This was more an instinctive feel than something than could be documented or quantified. I could just sense by their reaction to my explanations that the Comparison Class and I were no longer quite on the same wave-length.

## 4.3.5 External Events that Affected the Programme Delivery

The external events outlined here form the backdrop against which the Programme was conducted. Ely et al. (1997) stress the "certain emotional sturdiness" required of those who embark on naturalistic research. The contrast between the real happenings in the world of people and the positivist paradigm of controlled experimentation on large samples of subjects could not have been starker.

There was a long-drawn out muddle about how the 1999-2000 Year 1s would transfer to Year 2 in Sept.2001, involving differing interpretations and applications of the Government's "no more than 30" ruling for a Key Stage 1 class and the problem that the school's admission number of 96 would involve mixing Key Stage 1 and Foundation Stage children. The Local Education Authority agreed to an extra teacher which would mean the four Year 1 classes of 24 children remaining as such into Year 2. These were three parallel classes of September-May birthdays and a younger class of Summer-born children. My Focus and Comparison Classes were two of the older classes. However, the departure of another member of staff at Christmas meant splitting the Summer-born class to make an inevitable 32 in each of the other three. Although these extra children were present for all the sessions from January onwards, I did not include them in the research, which had begun without them.

The Comparison Class group did not remain as 24 children. One moved away over the summer break, during the research period another emigrated after a severe house fire, another gained a place in a small private school and a child with mild learning difficulties and behavioural problems was excluded when he became a danger to others. A child who remained in school was diagnosed as having Muscular Dystrophy and became confined to a wheelchair but I continued to include him in the data since he did not deteriorate cognitively across the Programme and had sensitive adult support.

In January 2000, the most disturbed child I have ever taught joined my Year 1 class. He seemed to be living out the fantasy roles of violent computer games and was excluded from school in March. At the same time, another child in my Year 1 class was terminally ill with cancer, dying in April. Both these situations deeply affected the rest of my class and there were occasions when I needed to give them priority over my research. The session planned for the day on which she died was, obviously, cancelled at short notice. I needed to be with my class when they were told.

In Autumn 2001 the sessions were changed to Friday afternoons (not my preferred time-slot) to fit in with the Year 3 timetable. The Ofsted inspection in the last week of the first half-term in Autumn 2001 caused two sessions to be lost: the Focus Class' teacher did not want to swap on the Friday afternoon before the Inspection and nobody, including myself, wanted to do anything other than celebrate with their own class on the following Friday once it was all over.

For the final Assessment Task I had originally planned to use an extended, three-week activity (making a puppet theatre) which would enable me to ascertain the children's ability to use drawing to plan, develop and adapt their plans across the duration of a longer project. This was not to be, since I was by then working at Canterbury Christ Church University College and was not able to visit the school weekly. The single session needed to fit in with work in other areas of the curriculum and so the final Assessment Task was related to the topic of Greek myths that formed part of Year 3's Literacy Hour: design and make a model of King Minas' maze to help Theseus get to the Minotaur and escape as easily as possible. This was a task which I had not conducted before and I worried a great deal about the wisdom of it afterwards.

However, despite all these pressures and unforeseen circumstances, the Programme was completed. I felt that, on balance, the unforeseen circumstances added to, rather than, detracted from the validity of the research. It was not conducted in a laboratory setting, away from the real world of children's real lives or the reality of corporate school life. That we began one session with a child asking "Miss, are you sad about S.?" or that I had to defuse the ongoing rivalry with the class next door (which degenerated into racist name-calling and fist-fights one Thursday lunchtime) did not contaminate the data in the way that it might have done if my view of educational research and data gathering had been different. If my Programme was going to make a difference to how the children used drawing for designing and if being involved in my research was going to have more than a marginal effect on their lives, then I could not deny the entry of the rest of our lives in through the classroom door just because I was now "conducting research".

# 4.4 Evaluation of Teaching Input to Focus Class

The success of the Programme was to be formally assessed through the Assessment Tasks and the Focus Class' (hopefully) greater learning about designing would be revealed by comparing their achievements with those of the Comparison Class. Table 5 indicated Programme objectives, project by project. This section of the thesis, therefore, addresses the question : how far were these objectives met in the course of the Programme?

The major source for this material was my Log Book, which was maintained throughout all sessions of the Programme, which contained notes on children's working and an evaluative commentary on each session written immediately after delivery. Themes and issues which surfaced across the Programme (summarised in Section 4.5.3) were also to emerge as important differences between the two classes, suggesting that these were specific outcomes of the Programme.

***(Sessions 2-5) Fantasy Figures***

When shown the large pictures of the aliens and asked to make them in plasticine and matchsticks, the children immediately produced variations, calling out *"Mine's got ..."* (whatever they had drawn that was different to the picture) and were surprised when I praised those who had copied the figures exactly. They did not realise they were being given specific instructions to follow rather than being asked to explore their own ideas. Donaldson (1992) also found that 6 year old children did not adhere to "this problem and this problem only"

The Clothes-making session began with a demonstration of how to use newspaper to make a pattern which fitted the alien (by trial and error). However, the children began making straight away in cloth, rather than choosing their fabrics and making newspaper patterns. So I stopped the whole class and explained again about why we need to plan - waste of cloth, disappointment when it doesn't fit, and so on.

Again, with the Transporter activity, following the instructions was the most difficult part. I said *"Talk to your partner and then each draw your best idea"* but the children began drawing immediately without discussion. I was clearly using different models of designing to that to which they were previously accustomed. Designing and making the House was less difficult as they were beginning to realise that they needed to listen carefully to instructions and I was beginning to pick up the role of language in designing:

*Need to be less fixated about recording in drawing if writing in sentences is more natural for the children and appropriate for the activity. They had told each other how they would make it - why not write that down?*

*Ex. 29 : Completed Wagwum Set*

***(Sessions 7-10) Visual Analogies***

This work in the first half of the Spring term was intended to develop analogical fluency as a generic skill. On reflection, I became less convinced that it would and more convinced that analogy-in-context is a basic human skill, which exposure to abstract analogical reasoning tasks would do little to improve. However, I think that these activities enhanced the children's learning in an appropriate way, but not, perhaps, for the reasons for which I had originally perceived.

This was especially true of the Iron's Analogies Games, where problems emerged when they were asked to devise their own games. On reflection, I realised that the game I made for them to play had no "wrong" pieces, so it could be solved by shape matching and not by analogy. Although my explanation and summary at each stage emphasised the visual analogy, it was not what the children were seeing in the activity.

Continuing the game-making for a second week was the right decision. The children had half-understood and were able to devise their own games, played them together and were keen to take them home to play with their families. The activity taught children the need to accept the rules of a game and to reason within those rules. This was to prove to be an important contributor to the Focus Class' design capability.

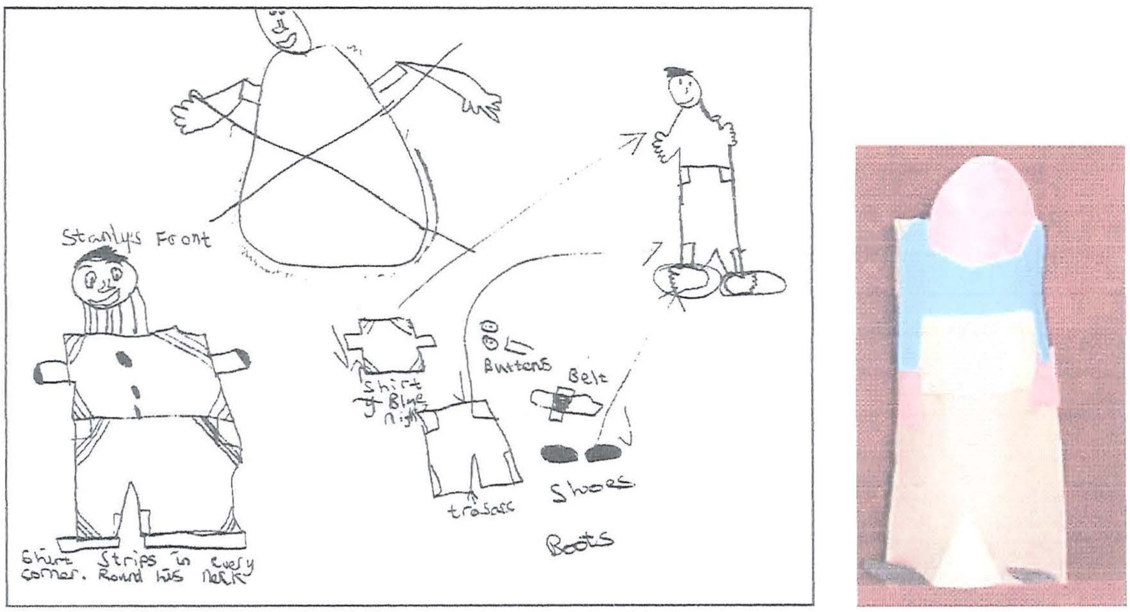
## *(Sessions 11-15) Ideas on a Journey*

My initial reaction to the series was one of real satisfaction. Even without formally assessing the results, I could see that they were considerably better than anything I had achieved with Year 2 before. I was looking at Year 3 work to make comparisons. Certainly some of them had produced work that was comparable to the best of the Year 3s in 1998. I felt *"This works".*

There were two different approaches emerging on opposite sides of the classroom, centred around the main boys' and girls' friendship groups. Gender differences are discussed in Section 5.9 but this was the only point during the delivery of the Programme at which I was really aware of a difference between the boys' and girls' approaches to designing.

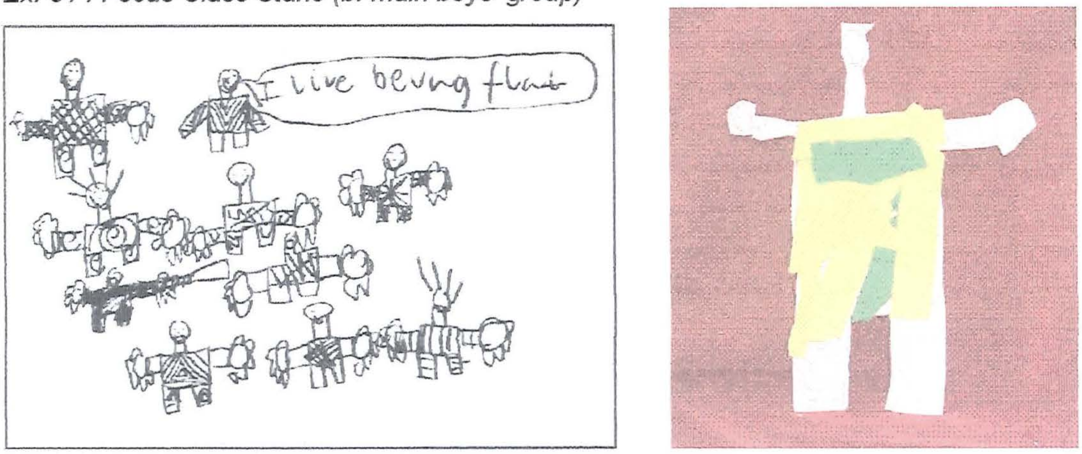
The girls tended to opt for a single idea which they progressed towards making (Natasha's Round Stan (Ex. 30) is typical) usually annotated and sometimes using writing rather than drawing where this was more appropriate (for example, Jolene wrote a list of crisp flavours that Stan might choose from). Their level of discussion with each other whilst drawing was cursory. They would trade ideas but were working in parallel rather than together.

*Ex. 30 : Focus Class Stans (a: main girls' group)*



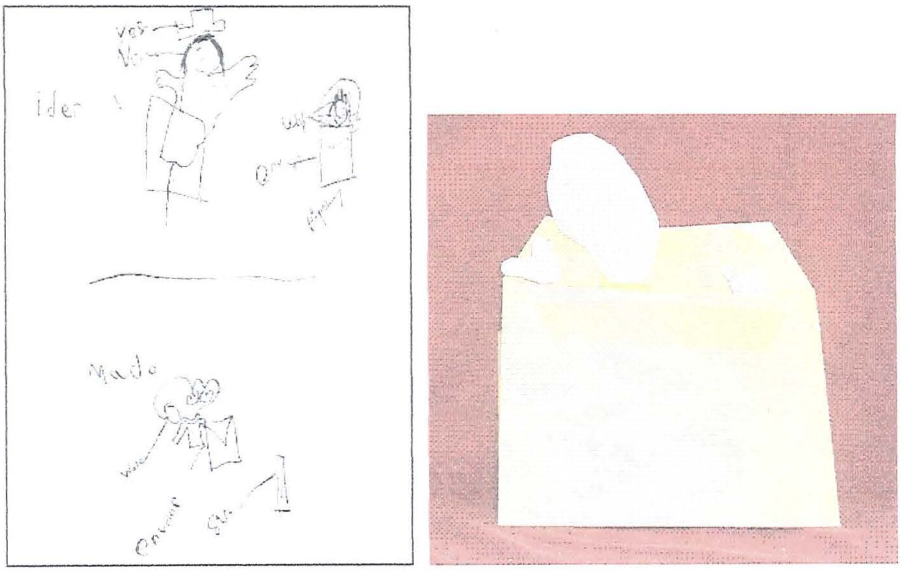
The main boys' group, however, seated at the other side of the room designed by discussion, as the debriefing transcript that follows Ex. 31, Randal's Flat Stan, overleaf reveals:

*Ex. 31 : Focus Class Stans (b: main boys' group)*



*Randal:* I did that one and then I thought of that one.... and that one...erm....I got that one from Craig. Then I did that one. Craig didn't like that one. He thought it looked like a crocodile *(giggles).* So he said why don't you do ..... Superman. So I did. But I did that one. *(Pointing to the first drawing in the second row - the spirals on the drawing are there -under the puppet's clothes!)*

How far this was gender-related or due to the seating arrangement in the room was difficult to say. The main boys' and girl's friendship groups were seated on the opposite sides of the room, with the younger Summer-born children in the middle. This might mean simply that cross-fertilisation of ideas was not happening across this barrier. Martin (Ex. 32), who was not part of the main boys' group, shows many of the characteristics of the girls' work :

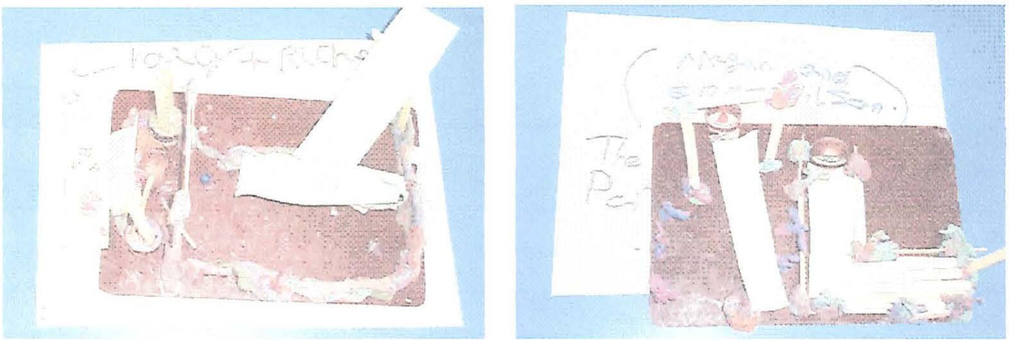


*Ex. 32 : Focus Class Stans (c)*

To appreciate the difference between the Focus Class' work at this stage of the Programme (immediately after the Container / Journey metaphor had been used to explain designing) and that of the Exploratory phase children, Natasha's work should be compared both to Ex.9 (by her older sister Nikki as a Year 4) and then to typical Exploratory Phase Yr. 2 work (Exx.13-15).

***(Sessions 16-19) Modelling in other Media***

For the marble run, socially competent children worked well together, the less social did not. Some pairs tried to have a board each or have "my half and your half". Randal and Carl built a wonderful joint product which changed and evolved continually for the whole session, which was at its best halfway through; I wish I had taken the photo then.



*Ex. 33 : Marble Runs*

I had planned for making beads from air-drying clay but no clay in school meant that paper beads were made instead. The children, boys and girls, thoroughly enjoyed the session, possibly because it was novel, simple and produced instant results. I wrote in my Log Book: *They all wanted to wear their necklaces to story-time, so they definitely had fun.* At the end of the term, I asked the children which were their favourite activities and this one scored highly. To me, this raised the issue of the need for an external client in Design and Technology for this age group. I wondered whether the children had enjoyed it more because they had made something for themselves.

These "no drawing" sessions enabled me to apply the Container / Journey metaphor to designing as a whole and not just to the drawing, which was used only for the development of decoration and logos for the sides of the Buggy. for which I produced a side, front and back design drawing on a small sheet of paper, which *"Since it is too small for everyone to see"* I redrew on the flip chart and explained to them how my thoughts had gone on a journey. The terminology seemed to have become part of our shared design vocabulary.

My Log Book comments reflect the child-centred view of a car :

> *They worked purposefully and well - where did the time go? Many of them made really good seats etc. inside, but some had them in funny places - lower than the axles. Interesting that they don't really think about where parts of a car are in relation to each other. Steering wheels were far away from seats. No thought of an engine - the steering wheel went into the front of the car.*

***<u>(Sessions 21-25) Extended Project - Sandals</u>***

Appendix J documents this project.

The children's choice of drawing or text for recording their product analysis was interesting. They wrote about the sandals that they observed but drew their ideas for sandals they would like to make. Words were used for observations; drawings for ideas generation and futuring.

Many children had difficulty understanding that the prototype made by drawing round their foot was not part of the final product. Some made two complete sandals in this thin card and seemed to find it impossible to grasp that it was just a pattern. It seemed that making a 3-D mock-up was harder for them to understand than drawing. I had this problem with Pandy's suitcase with Year 1 in 1998.

Everyone had a pair of fitting sandals by the end of Session 5 and the children were delighted with the results and walked around in them for the rest of the afternoon. I think they felt they had made something for *themselves* rather than the teacher, which casts interesting light on the *addressing client need* aspect of D&T; perhaps young children *need* to be their own client. Certainly much customer satisfaction in evidence. A good end to the Summer term.

*Ex.34 :Sandals (the main girls' group are to the right of the photo with their hands in the air)*

***(Sessions 26-28) Team-working : Food***

A range of team-working approaches were used, from arguing their way through the whole menu to delegating a different role to each team member. One group allocated roles, who then produced (and drew) several ideas which the team then discussed and then decided their final menu. Once making the dioramas, most groups delegated different parts to individual members. The presentations at the end of the session showed that the children were able to give account of their working methods and how they had worked as a group. I felt this was more valuable than the details of their models.

From previous experience, I had anticipated problems with recording of materials, although I stressed this loudly several times - *"or I won't know what to bring next week"* Consequently, there were embarrassed giggles when I handed back their discussion sheets and they realised they had forgotten what they would need (followed by relief when I produced two boxes of "possibly suitable" materials from behind the desk).

Making the sandwiches, I believed, would give the children opportunities to for thinking about presentation, as well as having an enjoyable afternoon testing different breads and spreads. The health issues associated with preparing food in an ordinary classroom meant that sharing each others sandwiches and trying each other's food combinations would, unfortunately, not be possible. I need not have worried about this. Once they had made their plate of sandwiches, they had no intentions of sharing them with anyone else.

***(Sessions 29-32) Designing for others***

There were three main areas of improvement based on prior learning:

- They understood prototyping and mock-ups: *"Now I can do a really good one for my Mum."*
- They had definitely got the materials message, every group had considered and recorded what they would make the gift from
- They could provide constructive feedback : they tended to say what they liked and made helpful suggestions rather than *"you haven't..."*

Trialling each other's instructions and gift led to changes in their own work as they realised that others had better ideas or produced more workable instructions. Although initially they were resistant to the idea of swapping instructions and making each other's, rather than making their own idea immediately, there was a genuine sense of enjoyable challenge once the first few pairs had swapped and comments were bandied across the room. It was all done in remarkable good humour and no one got upset when their "trialler" came back saying *"I can't make this because.."*

The role of the real client kicked in when I insisted that they put together the kit for Year 1 before finishing their own gift or the younger children would not have time to make theirs. The Focus Class could finish their own gift with own teacher later. My Log Book records:

> *Panic ensued as they realised that their work really was going to Year 1 and that the younger children would have a view on their success!*

The Focus Class worked in groups to design the kits, but then each child produced their own kit for a Year 1 child. Many of them wanted to know the name of the child to whom the kit would be going, so that they could put a message inside. I had envisaged the work going from a group of Focus Class children to a group of my Year 1s. I had not anticipated this level of personalisation and it seemed to be the more capable designers who asked for a named child. This might indicate that the level of engagement with the task was related to having a specific client in mind (as Stables (1993) observed). A hypothetical "Year 1 child" did not enable them visualise their kit in use.

The Year 1 children, in turn, wanted to know the name of the older child who had assembled the kit. Some of the Focus Class came to my classroom to show to me their own completed gifts and were delighted to find some of my Year 1s were working on theirs: *"They're really making them!"*

# 4.5 Reflections on Programme Delivery

Planning the practical aspects of the Programme delivery was relatively straightforward. From the Exploratory Phase I had a range of activities which could be used either for Teaching Input or for Assessment Tasks. Designing and evaluating teaching programmes was part of my work as a teacher and so I did not feel daunted by issues such as breaking down overall aims into identifiable objectives or ensuring progression across the Programme. This was equally true of evaluating the children's learning whilst teaching. Devising validation strategies and informing stake-holders were organisational tasks which needed to be done but I did not consider these especially problematic. The external events that affected Programme delivery (outlined in Section 4.3.4) were the kinds of things which affect any long-term teaching plans, being adaptable and flexible in the light of such changes are part of being a teacher.

Making the right decisions about the kind of data to collect ahead of conducting the Programme was more tricky. In non-participant research strategies, a small-scale pilot study is frequently conducted between identifying the problem and conducting the full study, both of which are conducted within the same paradigm. I had shifted from an exploratory to a delivery-plus-test model, which meant that although I took my conceptual understandings with me into the Structured Phase, much of the data-collection detail was aspirational at planning stage.

## 4.5.1 Evolution of Theoretical Understanding

It was inevitable that across the delivery of such an extended Programme that my understanding and ideas would continue to develop and refine as I reflected in praxis. As an experienced teacher, such reflection is second nature. As a researcher, such reflection revolved around the theoretical foundations on which the Programme was based.

I began the Structured Phase believing in a causal relationship between analogical reasoning ability and design drawing capability and although I still hold to that view, my understanding of how that relationship works changed across the period of time covered by the delivery of the Programme. When I designed the Programme, I believed that conducting activities in the Spring Term 2001 to develop the Focus Class' analogical reasoning skills would enhance their facility with design drawing. By the time I had conducted these activities, I no longer believed that the skill development worked that way. What they learnt from these activities, I came to believe, was *accepting the rules of the game*, which was to prove to be essential learning for the Focus Class.

What I had come to believe in the interim was that all learning is an extrapolation from what is already known. Green (2000) argues that teachers assume in practice that young children can and do learn through analogy and my own teaching experience supports his stance. Skills and knowledge transfer is predicated upon analogical reasoning. My Container / Journey metaphor for design drawing would work, therefore, because it was an appropriate metaphor for the design process, not just because it was an analogy. Improving children's analogical reasoning skills would not improve the appropriateness of the metaphor. However, teaching them to *play the game within the rules as given* would improve both their analogical skills and their design capability by teaching them to look for solutions within the problem as defined.

However, more important differences appeared to surface at Easter, after my input to the Focus Class of the Container / Journey metaphor. I felt that there was considerable learning of the nature of designing at the first presentation of this metaphor. I went back to my own classroom afterwards, flushed with success, and said to one of my Teaching Assistants, *"I now know how to teach D&T"* to which she replied *"Well, you've been doing it a long time"*.

From informal observation, it seemed that, once the Focus Class had grasped the idea that design was an on-going thing and that change and development were part of the process to which drawing could contribute, that they were able to build on and apply that understanding to a range of media. I had hoped that would be so and was gratified that, despite the inevitable interruptions to the Programme, the children did not lose this.

## 4.5.2 Emergent Themes from Evaluation of Teaching Input

***The Container / Journey Metaphor:***

The key concept I wished to communicate with the Focus Class was that of seeing design as taking ideas on a Journey. I believed from my informal observations of the children's response to the Stan activities in which the Container / Journey was embedded that this was immediately successful. Using these activities meant that I had instant feedback on the success of the metaphor, through comparison with findings from previous presentations.

From the introduction of the metaphor onwards these children felt more like Year 3s than Year 2s. I was aware that and I was speaking to them at the level I had previously used with the Year 3 class to whom I taught Design & Technology weekly in 1998-9. It would seem that the explanation of the nature of designing in terms of a journey and how to use drawing to record stages along the way had enabled them to access the genre.

***Learning to play by the rules of the game:***

Problem-solving, I believed from my reading of Wittgenstein (1969), was much to do with exploring the rules of the game and seeking to resolve the discrepancies between the rules and the problem. Liddament (1996) applied Wittgenstein's language games to designing. I had come to believe that creative designing was embedded within the resolution of the rules / problem dichotomy.

If my Focus Class were going to learn how to use drawing for designing, they had to learn to play by my rules. The pragmatics of the tight time schedule of the Programme required that they did so quickly. They needed educating into Donaldson's (1992) "this problem and this problem only" that she identified as so difficult for 6 year olds. My tightly teacher-led tasks at the beginning of the Programme were designed to ensure that this happened. This then became the foundation for accepting my definition of what design drawing was all about and enabled them to successfully access both the genre and the underlying concept.

***Language:***

*a) Shared Design Vocabulary:* I used and the children adopted appropriate vocabulary with which to discuss their work. Asking them to explain their thought process encouraged their reflective skills and meta-cognitive awareness. They began to learn what was important to me and that I would want to note down in my Log Book. Increasingly, they would bring their drawing or come and tell me the conclusions to their discussion. They were learning that designing as a process was valuable. They were not tempted to throw early attempts in the bin as "wrong", they would come to me with several drawings and explain how their thoughts had developed across several iterations.

*b) Design by Discussion:* The main boys group mainly designed by discussion, frequently producing almost identical design sheets. Debriefings and in-context questioning enabled me to understand that this was not "copying" but co-operation and that the apparent randomness of some of the ideas recorded on paper was due to this swapping and sharing of ideas. Craig was always full of helpful suggestions to others and his input appeared in several other children's drawings.

Not only did this repartee generate and stimulate ideas, it also provided a safe environment in which to hone evaluation skills. It enabled children to find out each others strengths and abilities, which was important for team-work. Not surprisingly, pairings and groupings from within the chatty, sociable boys' group produced successful designs. There were dangers in this, however. Randal and Craig's marble run was never finished. It became part of an on-going conversation that they did not want to dismantle at the end of the lesson.

*c) Multiple Literacies:* Although I wanted the children to use drawing to support their thinking, I did not want to fall into the trap of making writing less valued or of taking an artificially contrived role. The children used more writing than I had expected (or that I had observed amongst the 1998-9 cohort of the Exploratory Phase) and I endeavoured to encourage this to be used in an interactive, exploratory way (listing variations for example). I hoped that the children would be able to use drawing and writing to enhance each other.

They used writing for lists (e.g. of materials), labelling of parts and descriptive or procedural text (e.g. *"First I will cut out..."*) Writing sometimes seemed to be used when they were less confident of their graphic capability, for example, labelling to clarify communication, to tell me what part of a drawing was meant to be. I was interested, yet should not have been surprised, in the division between use of writing to describe the sandals they were shown and the use of drawing to record their design ideas. Discussion of the sandals' features translated directly into writing, whereas part-formed images in their heads were recorded as graphics.

## ***Communication***

I wanted the Focus Class initially to be able to use drawing to support their own design thinking. Later in the Programme (Autumn term 2001), they were asked to work collaboratively and at this point drawing for communication became important. Since they freely discussed and shared ideas, many children were already using drawing in this way. The video transcript of Craig and Noel, for example, shows their ability to interpret and discuss each others drawings.

One of my key teaching points in the showing of Snook's animals was clarity of communication and I specifically used the words "so someone else could make it". Ways of enabling another person to do so were discussed and this input had immediate impact on the quality of their drawings. Despite the message needed repeating in Autumn 2001, they were able to take this on board and the materials were specified without the need for prompting in the kit-making project.

## ***Evaluation of ideas***

My view of design as Container / Journey implies constant feedback and iterations, which drawing can support by enabling opportunities to reflect on half-formed ideas. I wanted the children to learn to evaluate as they generated design ideas and reflect upon possibilities and constraints in order to minimise trying to adapt a half-constructed idea which is not working.

This was written into the Programme through the team-working of the Food project and also the trialling of each others' designs for the Kit-making. However, the ability to do this was built on the foundation of product evaluation (Slippers) and on the expectation that designing would involve thinking of several ways of solving a problem or moving a possibility towards a design solution, which was inherent in the Container / Journey metaphor.

### ***Addressing the Needs of the Client***

The children showed the greatest engagement with the activities that resulted in something for themselves: the name plate for their bedroom door, the necklaces and the slippers. They became highly focused on the kit-making activity once I was setting time limits for completion so that their clients could assemble the kits.

Stables (1993) identifies three "clients" within the school setting : consumer, sponsor (usually the teacher) and designer (the child) and argues that the roles of each need to be made explicit in order to maximise children's motivation through their understanding of the purpose of the task. My observations accorded with Stables', that where children could clearly identify all three they showed greatest engagement with the task. But this was especially so if the consumer was themselves.

This caused me to wonder about the role of the external client and to feel that it is important to give children of this age a balanced diet of activities. They need real clients (parents for Christmas gifts, for example), they need to be stretched to imagine the needs of people they will not meet, but also they need to make things for themselves. I came to believe that it was an important part of Design and Technology education to have experience of making things for themselves and feeling the satisfaction of doing so.

# SECTION 5 - Analysis of the Assessment Tasks

# 5.1 Introduction to Section 5

The Assessment Tasks were the main vehicle for evaluation of the success of the Programme and were the only part of the Programme submitted to quantified analysis. In the account of the qualitative analysis and in each section of the reporting of the findings of the quantified analysis, emergent themes are identified, which contribute towards the Key Themes that Emerged from the Research (Section 6.2).

***Evaluation of Assessment Tasks (Section 5.2)***

Although, for each task, the children were to use drawing to record and develop design ideas prior to making, each of the Assessment Tasks had different characteristics and had slightly different demands. This allowed for some measure of comparison to be made between the way the children responded to different kinds of task. Section 5.2 outlines these differences.

***Qualitative Evaluation of Children's Performance (Section 5.3)***

Video recordings of children at work, together with audio-recorded de-briefing sessions and the use of a Log Book to make notes as they worked, all contributed observations about children's performance. The original intention was to analyse these data using a series of databases. It quickly became apparent, however, that the overall sense of growing capability was embedded within each situation and the loss of context through filtering and sorting hindered rather than enhanced reflective evaluation. The excerpts from the qualitative records quoted within Section 5.3 are selected as illustrative of the reflective reporting in context.

***The Quantitative Analysis Instrument (Section 5.4)***

The evolution of the quantified analysis methodology and the development of the analysis instrument is recounted in Section 5.4. Qualitative judgements on children's design drawings were converted into quantified data whose results were recorded and maintained as a set of child-level spreadsheets, which were then collated for class-level analysis. Section 5.4 traces the development of this quantitative analysis instrument from a Grid and Ticksheet, containing, respectively, aspects of design capability and specific skills, to a multi-layered analysis tool, to analyse and compare children's understanding of the purpose of design drawing, their choice of Drawing Type, their use of drawing with respect to different dimensions of design drawing capability and their demonstration of specific skills, such as annotation.

***Understanding the Purpose of the Design Drawing (Section 5.5)***

In the holistic assessment model that emerged (Section 5.4.3) the child's understanding of the purpose of the drawing is not only seen as paramount to the way that they subsequently use the drawing to support their designing, but as central to the assessment process. Section 5.5 presents the analysis of the quantified data relating to the way in which the children each of the two classes understood the purpose of drawing to support the development of their design ideas.

***Drawing Types (Section 5.6)***

The classification of children's drawings into Drawing Types developed during the Exploratory Phase (Section 3.3.5) is applied to the drawings of the Structured Phase. This is used to compare the children's choices about how to use drawing to support designing, as well as to examine the relationship between the choice of Drawing Types and the children's understanding of the purpose of drawing for designing (Section 5.6.2).

***Dimensions of Design Drawing (Section 5.7)***

Section 5.7 presents the findings of the analysis of children's ability to use drawing to support the development of their design ideas with respect to eight dimensions of design drawing. These were developed from the dimensions of design capability identified by Kimbell et al. (1991) in the light of observations made about children's design drawings in both the Exploratory and Structured Phases of the research.

***The Techniques Ticksheet (Section 5.8)***

Specific skills (such as the use of annotation or the recording of colour or materials to be used) were recorded on the Techniques Ticksheet. Section 5.8 examines these data and makes comparisons between the two classes' use of such techniques.

***Gender Differences (Section 5.9)***

Although not a main focus of the research, Section 5.9 examines the differences that emerged between the gender groups in each class.

## 5.2 Evaluation of Assessment Tasks

The Assessment Tasks were originally planned to occur at the end of each school term but various external events prevented the strict adherence to this plan. The opportunity to add the Surprise Card task to the Programme could not be missed and needed to be delivered at the same time of year as it had been to the children of the Enriching Literacy through Design and Technology Evaluation Project. The same considerations held for the placement of Pandy's Suitcase at the end of the Summer term.

However, this meant that three tasks (Easter, Card and Suitcase) were conducted quite close together and then there was a six month gap before the Maze task in January 2002. This was unavoidable given the external circumstances. Ofsted inspectors were in school at the end of the first half of the Autumn term and Christmas activities dominated the curriculum in December. I was determined to conduct the kit-making activity with the Focus Class as it was an up-dated parallel to the Insects activity of the Exploratory Phase and I wanted to evaluate the changes I had made to the activity as much as their designing skills. Delaying the final Assessment Task, however, meant that it acquired the status of a test of sustained changes beyond input to the Focus Class.

The design drawings produced by both classes in response to this final Assessment Task (the Maze) were very different to those produced in the previous three tasks (Easter, Card and Suitcase). I was especially frustrated that the my Focus Class' drawings lacked all the sophistication and clarity of communication I had endeavoured to teach them during the Autumn term. The most sophisticated Focus Class Maze drawings, for example, used a legend next to bird's-eye-view drawings to show which colour lines represented the string but no construction detail beyond a list of materials. The same children had included measurements in centimetres, a range of decorative features and detailed construction method for both the Easter Egg Holder and Suitcase.

However, during the process of the quantified analysis of the Assessment Tasks, it became clear that there were important differences within the tasks that I had not anticipated would affect the way that children use drawing to support their design thinking.

Frosty and Maze tasks were *problem solving scenarios* whereas the other three activities required the *design of a product*. The objects that the children were asked to produce for the Frosty and Maze activities were 3-dimensional models of a problem solution, which led to much less recording of materials, colour and construction technique. They used the drawing to clarify and solve the problem and then worked out how to model the solution directly with the materials. For product design tasks, the children were more likely to be planning a complete design solution, including colour, decorative features and construction details. It would seem that the children dealt differently with solutions that they regarded as "models" to those which they regarded as "products". Fortunately, the teaching input to both classes had majored on designing products and so there was parity of experience and one class were not at a disadvantage with respect to the other.

In her consideration of young children's problem-solving strategies, Roden (1997) wondered whether they might exhibit a different range or combination of strategies for different situations and which strategies might be common and which might be task-specific. This was a question I could apply to my data :

- comparing Pizza, Easter & Suitcase for development in drawing for product design;
- comparing Frosty and Maze for development in drawing to support problem solving;
- comparing structured delivery to less structured
- comparing these sets for similarities and differences.

In terms of Programme success, however, it was the *comparison between the classes* not the *comparability of the activities* which would indicate the hoped-for greater progress in my Focus Class, and their (hopefully) richer responses in a range of situations would be compatible with my aim of improving their design drawing capability regardless of task or presentation.

# 5.3 Qualitative Evaluations of Children's Performance

My hopes for the qualitative observations of children working was that they would give me an understanding of children's processes in using drawing to support designing and that this would provide the context in which the quantified analysis of those drawings would be pursued. These observations enabled me to determine the children's understandings of the role of drawing for designing, especially in terms of its relationship with making. The aim of this section of the thesis is to demonstrate the ways in which the two classes responded to the Assessment Tasks (supported by quotations from transcripts and Log Book entries) and to indicate the overall trends within these observations.

## 5.3.1 Assessment Tasks

In the excerpts from my Log Book, used as examples in this section, italics for observed actions and normal font for reported speech.

Drawings and products by Target Groups from both classes can be found in the Appendices: Appendix C (Pizza), E (Frosty), G (Easter), I (Card), K (Suitcase) and L (Maze).

### ***5.3.1a Assessment Task 1: Design a pizza***

For this first session with each class in October 2000, I had the assistance of Mrs.M., a Learning Support Assistant who worked with me in my Year 1 class. The Comparison Class, had the advantage of being familiar with me and my expectations and appeared to do better.

*Evaluation of Session from Log Book:*

> *Throughout session, Mrs.M & I commented how much more interesting they were than Focus Class. And how different & diverse their ideas were. In discussion with Mrs.L (Year 1 Teaching Assistant) later, decided it was not just that they were more creative, but also they knew me so well and knew what they were allowed to do - bend the rules a bit. Focus Class had simply followed the instructions.*

Comments from my Log Book on individual children also bear this out:

***Focus Class***

| | |
|---|---|
| Ellie | *Cut out chosen design from design sheet* |
| Louise | That's pepperoni! *Pipe cleaner bent round* |
| Chloe | *Decorated design sheet. Later added "apples" to design sheet after I asked her if that was it - she'd just covered the pizza in yellow "cheese"* |
| Noel | *Has stuck black tissue underneath pizza and nothing on top.* |

***Comparison Class***

| | |
|---|---|
| Zara | *Arranged matchsticks on pizza, marked their position* "So if anyone knocks it I'll know where they're meant to be" *Later, tried to put red tissue between match sticks (already stuck on) to be the sauce.* To Mrs.M: "I want to do more detail." *Re. Putting base colour on round the top layer - seen this with Year 4s - insect kits.* |
| Kirsty | *Modelling by drawing:* Me "Which one are you going to make?" Kirsty "The cheese one" Me "Which one is that?" *Kirsty pointed to first.* Me " What are the others?" - "Forgotten now" |
| Emma | To Mrs.M "Is this pepperoni colour?" *Wanted me to cut circles - how many? Counted the circles on her design drawing. Only child to meticulously colour all drawings.* |
| Garth | I can't make it that size. - *pointing to drawing. Only child to show any concern about size discrepancy.* |

The relationship which we both had with the Comparison Class children can be seen in the recording of exchanges, whereas Focus Class children did not readily discuss their work with us. However, the quantified analysis of their work would show little difference in achievement for the Pizza task. This would seem to bear out Taylor's (1982) argument for the merits of quantitative methodologies (referred to in Section 2.2.3). It would have been tempting to view the Comparison Class as better designers, whereas in fact they were more confident communicators.

The drawback of recording and reflecting on the interesting is that it can be viewed as typical, whereas it is atypical of the whole group. The following is a Log Book entry in which I recorded reflections as well as observations but was careful to note as non-typical:

*Wendy, Ellis and Alice : Copied design by drawing it on pizza. Sitting together. Everyone else (both classes) drew the outline of the pizza and filled with materials. Were these children more sophisticated or was just this their interpretation of how to do the task? Did this technique crystallise the mind's eye image or did it's freshness evaporate in the copying process?*

Further observations and quantified analysis of these three girls drawings on other tasks, would now lead me to suggest that the technique was Ellis' idea and the other two girls, as less confident personalities, followed her lead. Such insights into the complexity of social settings require the interaction of both qualitative and quantitative methodologies. Wendy is a confident child who finds designing difficult; Alice is very creative but extremely unsure of herself in unfamiliar situations. She was an elective mute during Years R & 1. Such heuristic knowledge of the children enabled greater depth of understanding of their actions.

## *5.3.1b Assessment Task 2: Frosty the Snowman*

Drawings and products by the Target Groups from both classes can be found in Appendix E.

This was conducted with each class during the first two weeks of the Spring term. The intention was to video the Target Group from each class in order to observe at leisure their use of drawing for designing and the extent to which they consulted these designs once making. This was my first experience of using a video camera and although the Focus Class group were recorded successfully, I was unable to record the Comparison Class group due to problems with the school's video camera. I had my camera available as back-up and so stayed near the Target Group for the duration of the session and took photographs of critical moments.

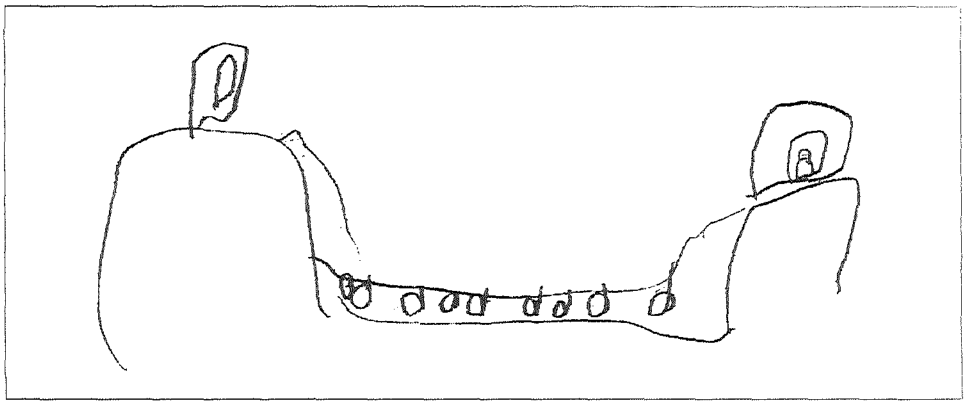
From the video of the Focus Class Target Group came this moment of two boys (Craig and Noel) discussing Noel's drawing (Ex.35, shown overleaf):

*Craig : (prodding Noel's paper):* What you could do is....like... have that and then that connected there.

*Craig:* Yeah. And then.... *(moving his pencil about in the air over the paper)*

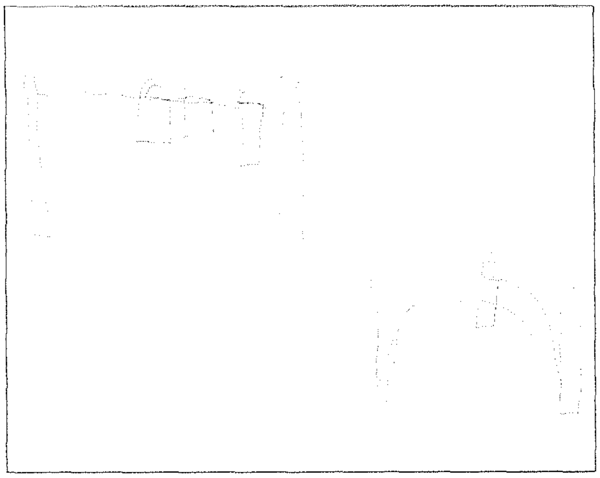
*Craig:* And, and... *(waving his pencil over Noels paper in the same way, indicating what Noel should draw)* And then that bit....

*Example 35: Frosty (a) : Noel (Focus Class)*



The video also revealed an alternative reason for children not making what they had drawn: that someone else's idea appears better. Damian had the idea of a tunnel through both mountains and under the lake. Randal spent most of the session trying to help him resolve the practical issues of making a tunnel out of rolled newspaper and making a pod to pass through it. Towards the end of the session, he hastily made himself one. This level of co-operative work was to prove a consistent feature of the main boys' group in the Focus Class.

In contrast to the boys' working together, Jolene and Natasha worked in silence and showed no interest in each others' work. Their only communication was on sharing sellotape or holding parts for each other whilst applying the tape. However, both girls produced successful designs and products. Jolene was the first child in the class to finish her work, having worked conscientiously and purposefully throughout the activity. Natasha used her drawing as a template, laying the sections of her bridge on it to check for size and curvature (Ex.36). The paler patches are where I have obliterated my annotations after scanning.



*Ex. 36: Frosty: Natasha (Focus Class)*

Sitting near the Comparison Class Target Group rather than relying on the video to record the event gave me a much more intuitive feel for the children's actions and choices. The photographs of critical moments acted as an aide memoire for the session. The children appeared to be conducting two separate activities: they would draw one or more suitable ideas and then use the materials to design a different solution, or even several different solutions. Jordan drew a bridge but made several solutions, opting eventually for an aeroplane because his friend Alistair had made one. Holly and Zara did not consult during drawing but once making they bounced ideas off each other and moved their bridge-making through several iterations and false starts, using up most of a box of straws in the process.

These observations were characteristic of the Comparison Class and will be seen repeated across all Assessment Tasks. They were consistently less likely than the Focus Class to use drawing to work out a solution to the design problem, preferring to model directly in the construction materials, yet in Year 1 they had been given more opportunities than had the Focus Class to acquire designing skills. The quantified analysis supported these observations on the Comparison Class.

Reflections in my Log book on the Focus Class make observations which were later to be important in identifying differences in the use of drawing between problem-scenarios and product design activities:

> *Looking at drawings prior to analysis - Many children appear to have reverted to single-draw. Does this show that I was too specific in my explanation, that showing them the Lighthouse Keepers Lunch stopped them from having their own ideas, or is the use of drawing task-dependent? Perhaps they had their ideas in their heads and discussed them but didn't draw them. Perhaps they simply opted for their first solution and didn't attempt to think of others. Viewing of tape indicates that Noel & Craig discussed ideas as they drew - and did not put pencil to paper to record the ideas they were discussing.*

The use of drawing *is* task-dependent. Once quantified analysis was undertaken, the observations made about Frosty would be revealed to be equally true of the Maze, leading to the realisation that these two tasks were problem-scenarios and that children use drawing differently in such activities than in product design.

## *5.3.1c Assessment Task 3: Easter Egg Holder*

This was conducted with each class during the last two weeks of the Spring term. Drawings and products by the Target Groups from both classes can be found in Appendix G.

I used my Log Book to record something of importance about each child's work, either a record of an exchange between us, an observation which lasted more than a few moments or I sketched some of their work in progress. I was able to ask about any part of their drawing which I did not understand, for example: *Louise (Comparison Class): egg holder inside at the bottom.* The page from the Log Book used as illustration in Section 4.4.1 is from this Assessment Task session with the Focus Class.

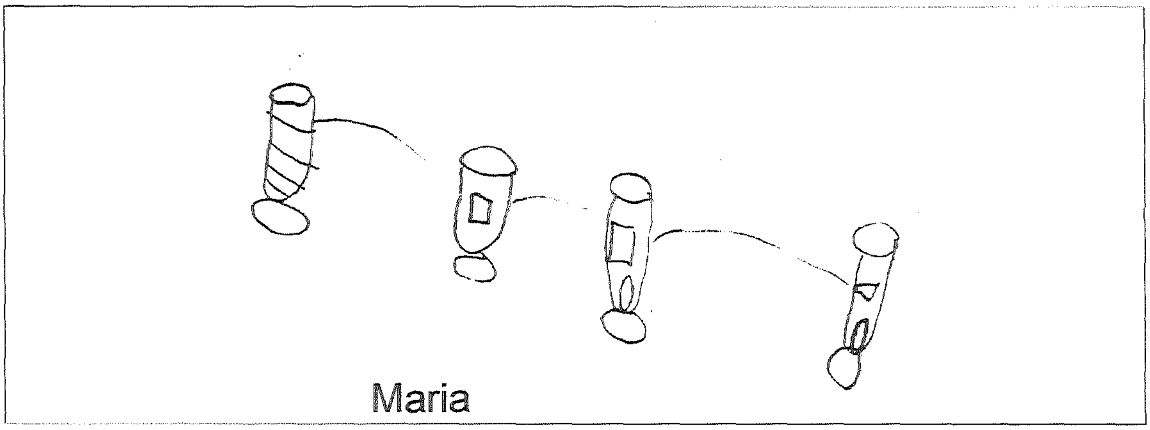
Even as I explained the task, the Comparison Class children began to say *"I know what I'm doing"* and seemed to want to make an instant choice, for which they produced a labelled diagram. Once working, they found other things around the room to use rather than using the materials provided by me (some did not even use the card tube that was central to the problem). They seemed to be working on a "free play" model of designing. It looked as if they had been taught a technique (labelled diagrams) which they did not relate to problem-solving or making.

The Focus Class, on the other hand, used the paper to generate ideas which related more closely to their making and used the materials provided. They appeared to understand that they were solving this particular problem, not a related one of their own, and engaged in the task as stated.

Audio recordings were made of the debriefing of the Target Groups for both classes at Easter: with me immediately after the session and later that week by Mrs.J (an experienced Learning Support Assistant studying psychology with the Open University). I provided a list of questions based on the task criteria and on the child's response (e.g. *"You seem to have drawn several Easter Egg Holders, can you tell me why?")*

The following pages provide examples (Exx. 37-44) and excerpts from four of the debriefing interviews to illustrate the difference in approach within the two classes. The interviews each highlight different aspects of children's design strategies and the role of drawing to support their designing.

***Maria (Focus Class)***




*Ex. 37 : Easter Egg Holder (a); design drawing, Maria (Focus Class)*

I had the following conversation with Maria whilst she was making the Easter Egg Holder. She did not appear to have made much progress. There were some pieces of ribbon on the table but she seemed to be doing more talking to Stacey than getting on with her own work. The joining arcs had not been drawn between the items on the page at this stage.

*Me:* Hi Maria, what are you doing?
*Maria:* That one *(Pointing to second picture.)*
*Me:* Is this a one with stripes, one with a square and one with a triangle?
*Maria:* Mm.
*Me:* So what are you doing now?
*Maria:* That one *(Again pointing to second picture.)*

Debriefing her later, Mrs. J. had the benefit of the arcs and Maria was a more forth-coming:

*Mrs.J.:* Tell me about how you have drawn this, Maria.
*Maria:* That's the tube. That's like the tube with a hole, square hole, I thought like to see the egg in. And that's how I done it.
*Mrs.J.:* So what's this?
*Maria:* Oh that's like.. I just draw, drew another one.
*Mrs.J.:* Why was that?
*Maria:* Dunno, cos, like, I was just thinking like what it might be like and I thought, like, if I had a triangle hole would be different.
*Mrs.J.:* So is this the egg inside?
*Maria:* Yeah.

It would seem that after her conversation with me, Maria realised that her drawing did not express her intentions. I had seen it as several different ideas, but the first drawing is the outside of the tube and the subsequent drawings are ideas about being able to see the egg inside.

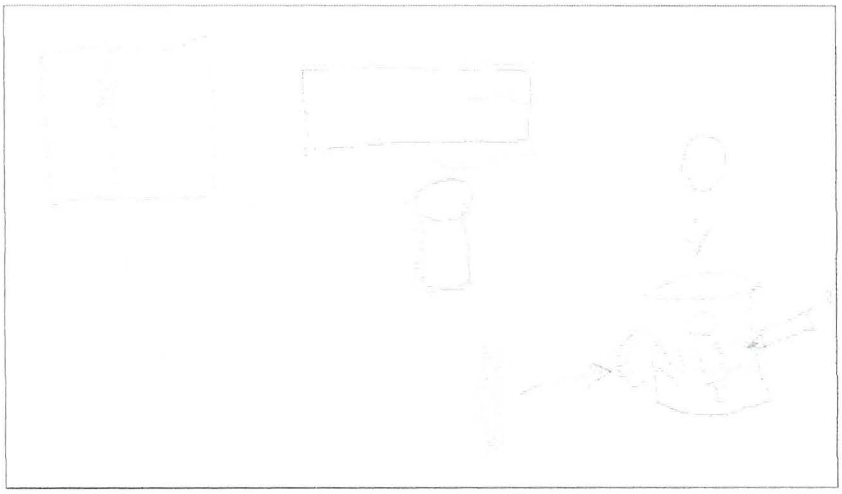
*Mrs. J:* So did you not do a hole in the end? In the side, I mean.... in the end, did you not do a hole in the side, after all?

Maria: *(giggles at Mrs. J. getting herself in knots here)* No it was too tough. The tube. I couldn't get the scissors through. That's why I didn't get as much done as Stacey. Because it was ages trying to do the hole and in the end I thought I'd better do the stripes or I wouldn't finish cos Mrs. Hope was saying there was only 10 minutes. So I got another tube cos... there was a spare one on Miss' desk.... and I did it again quickly and my first one was messed up.

*Ex. 38 : Easter Egg Holder (b); finished product, Maria (Focus Class)*

By putting together the Log Book notes, the photograph and the tape-recorded debriefing conversation with Mrs.J., the whole picture of Maria's design strategy can be seen. When I spoke to her, she was probably contemplating how to make the hole in the tube. Her reference to Stacey in conversation with Mrs.J. shows her interest in her friend's work (she frequently relied on other children and her class teacher was even concerned about her copying in the SATs tests). She realised that her drawing did not convey her design intentions and so added the joining arcs. This was a strategy she would use again (see Section 5.3.1e). Helping herself to the spare tube as a way of resolving the mess she had got into is interesting. I did not notice she had done this!

*Craig (Focus Class)*



*Ex. 39 : Easter Egg Holder (c); design drawing, Craig (Focus Class)*

*Craig:* I decided to cut the tube because it's too wide. That's that bit there.. that's scissors. Then sellotape to make it thinner. That's it bended round. That's the top - that circle. That's me decorating it *[pencil drawn on design sheet].* I did a handle but it was too thin, the card was too thin. It went *ugh*, all floppy.

*Mrs.J:* Are these rabbit's ears? *[on product]* That's different to your drawing. Why did you do those?

*Craig:* Someone else had done that and I thought "That's a good idea" so I stuck them on my top.

Craig's drawing provides support for working out how he will make the holder but he does not feel bound to include details that do not work well in practice. Instead he freely borrows a friend's idea. His comment "that's me decorating it" was unique and there was no way of knowing if other children were also visualising themselves making the product as they drew.

*Ex. 40 : Easter Egg Holder (d); finished product, Craig (Focus Class)*

*Jordan (Comparison Class)*

*Ex. 41 : Easter Egg Holder (e): design drawing, Jordan (Comparison Class)*

*Jordan:* That was going to be a Stickosaurus but I didn't want to do it because it was too hard. That was a big one with a lid but that was too hard because it fell over. Then I was trying to make a robot one.

*Me:* Is that the one you made?

*Jordan:* Yes. Well, no, not really. Cos it was too hard really.

*Me:* So what did you do?

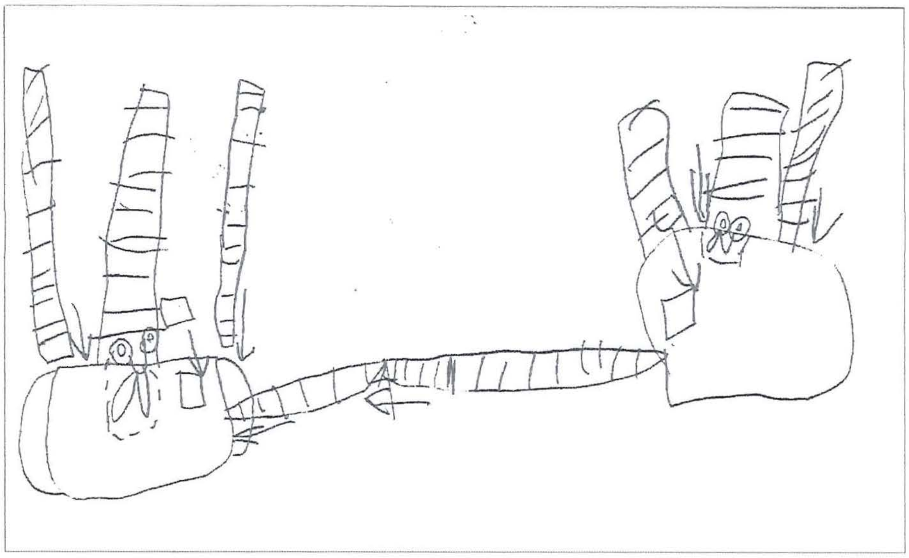
*Jordan:* Well I just sort of..... got all the bits I'd got....and... um..

*Me:* And made it out of them?

*Jordan* Yes, really. And it was like this.

*Ex. 42 : Easter Egg Holder (f); finished product, Jordan (Comparison Class)*

***Zara (Comparison Class)***



*Ex. 43 : Easter Egg Holder (g); design drawing, Zara (Comparison Class)*

*Mrs.J*: Have you drawn this twice?

*Zara:* No they're two parts. It goes over your arm.

*Mrs.J*: Oh, right, so what are these bits?

*Zara:* That's the string. And you cut a hole there and one there for the egg to go in. In the side of the tube. In both tubes.

*Mrs.J*: So why did you make just one half of it?

*Zara:* There wasn't time to do both sides. So I put... and it goes over your arm like this, look...

*Ex. 44 : Easter Egg Holder (h); finished product, Zara(Comparison Class)*

As creative as the two Comparison Class children clearly are, Jordan did not include the card tube that was central to the problem inherent in the task in his final design or product Zara needs two tubes for her design. They were given one each. So she was not modelling ideas with respect to the materials provided either. That this was common within the Comparison Class is illustrated in the photographs of the Easter Egg Holders in Appendix H.

Although this debriefing gave me an insight into what the Target Groups *thought* they were doing, I was not convinced that they were sufficiently self-aware to give account of themselves after the event. This was especially highlighted by Lee, whose account both to me and to Mrs.J. contrasted sharply with my classroom observation. I was convinced that the paper he submitted as his "design" was drawn after he made the product so that I would believe his work to be a success. I felt sure that the paper he had in his hand as he wandered around the room had a different drawing and had been quietly disposed of. I cued Mrs. J. to begin the conversation with the words *"So this is the drawing you made of your Easter Egg holder once you'd made it."* but he stuck to his story.

This convinced me that for accuracy's sake, questions need to be asked of the children immediately, as they worked. Also the recordings were limiting my recorded observations to the Target Groups. I was beginning to want to record other children's understandings of designing.

## *5.3.1d Assessment Task 4 : Surprise Card*

One of the researchers form the Enriching Literacy through Design and Technology Project visited the school and conducted the Surprise Card Assessment Task in the first week of June. I circulated with my Log Book and ensured that I had spoken to every child during the session. The design sheet used for this task, along with the work of the Target Groups from both classes can be found in Appendix I.

Both classes used the examples as a resource when designing their own cards:

*Focus Class:*

*Michael:* Drawing the demo cards & mechanisms- hasn't really designed something of his own.

*Emily:* *I told her to draw rather than write "love-hearts & flowers" - got rather into it* "Miss, I've got a pattern" *Later: Her drawing is the blue spiral demo + pop-up at top. Me: prompt to think about front. Later: Has carried on designing into Box 6*

*Comparison Class:*

*Zara:* has drawn round the blue mechanism provided

*Cassy:* her flower vase is to be like the demo card with the wobbly head

*Sophie:* her first drawing is of the green mechanism example

The Focus Class, however, were more likely to consider how the card would be made :

*Focus Class:*

*Carl:* *two pieces of paper on top of each other & folded* "And I'm going to keep on going down in size"

*Natasha: Hers opens like the booklet - 2 flaps revealing a central page*

*Comparison Class:*

*Kathy:* Me - what's inside? Kathy: I forgot to do the back of it.

*Chloe:* *A little girl on the front - words on inside left, picture on right*

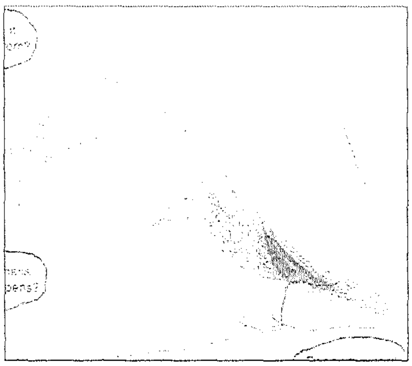
*Nicola:* The top bit is a flip-up football.

*Carys:* *Has changed her design after working out how to make it*

The following comment, from the most academically able boy in the Comparison Class, indicates perhaps how the Comparison Class children did not see the drawing as supporting designing of something that they were really going to make:

*Alistair:* *has drawn one huge picture*

*Later:* It's for Gran & Grandad - they like birds - when you open it there will be a bird which springs out really quickly and come alive & fly away. It's going to come out & flap its wings & fly.



*Ex. 45 : Surprise Card; Alistair (Comparison Class)*

The Design Sheet had a separate space (Box 6) for recording how the card would be made and the children were specifically told to fill this in. There was a difference in reaction to this instruction. Most of the Focus Class children did so within a few minutes, perhaps then going back to their main drawing (Box 5) to finish it off. Many of the Comparison Class ignored this instruction and continued with their main drawing. On second prompt, more of them wrote (rather than drew) something in Box 6 but on reading these, the comments did not take the design idea towards making, they simply described the graphic in Box 5.

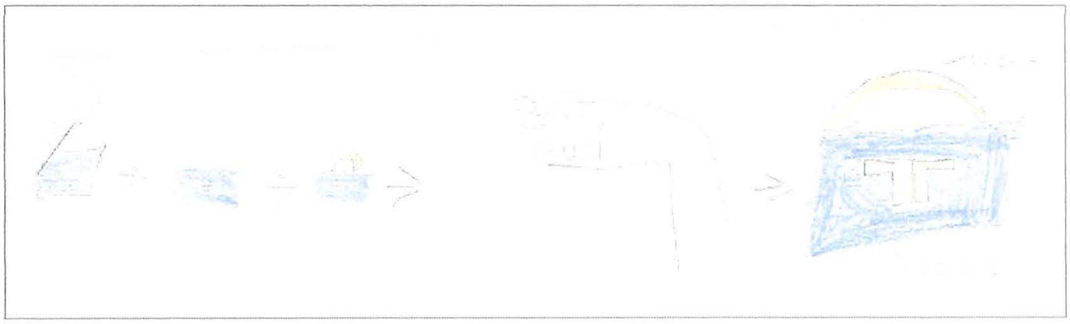
## *5.3.1e Assessment Task 5: Pandy's Suitcase*

This was conducted at the end of the Summer Term 2001, using the same format as Pandy 99 (Section 3.3.3b). Drawings and products by the Target Groups from both classes can be found in Appendix K.

I circulated and asked children what they were doing and noted things down, especially for the Target Groups in both classes. These children remained behind after the end of the session, to ensure that I had written down everything they wanted me to know about their suitcase and how they had planned it. This seemed to work well. I did not take photographs of the products of this Assessment Task as I kept the card prototypes of the suitcases as well as their drawings. This enabled me to see whether the children were taking their ideas forward from their drawing into the making.

Many of the Focus Class children measured the Panda with their rulers and although they sometimes forgot the importance of this information once they were making, many of the snippets of conversation centred on whether or not the mac would fit inside the suitcase:

*Martin:* *Immediately measuring mac with a ruler*
*Louise, Lisa, Ellie also get ruler to measure mac*
*Tasmin:* *measuring Panda's arm*
*Natasha:* *Measuring mac,* says "7"
*Later: Drawing round mac onto card*
*Noel:* *Made one card one & realised it was too small - tried the mac in it*
*Craig:* *Has made really good bag - but will the mac fit? bit small - came apart - making another*
*Lisa:* "Mine fits!" *(mac slides right through tube-like structure)*
Carl: *Has stuck 2 halves together* - will mac fit? yes



*Ex.46 : Pandy's Suitcase (a) : Maria (Focus Class) Recording Measurements*

Or on Construction issues:

*Lewis:* Single piece of card folded up rather than 2 separate sides.
*Ellie:* I am going to make a box because Mrs R. taught us how to make a box. *(Made really large box)*
*Kate:* Made box by gluing strips to rectangle base
*Stacey:* Shows me rectangle & mac - it's too small. What to do? Me - cut out another.
*Later:* 2 pieces of card, right size - mac sandwiched - how to join together? thinks she will use sellotape.
*Later:* Put bits of string at sides so it opens further to get mac in.

In the Comparison Class, attempts to make the mac fit were not supported by use of rulers:

*Alice:* *Folding the mac to try to fit onto white paper - it just about fits onto there:* "The mac fits"
*Holly:* *Has made a huge box shape*
*Rhiannon:* *Super little bag but too small. I suggest making another one bigger*

In the Comparison Class I was more aware of their lack of understanding of the role of the white paper for planning the prototype to be made in card:

*Robert:* *Is cutting up the white paper*
*Alistair:* "Are we allowed to cut out the paper?" *- he has drawn a single decorated item.*
*Later: Got card* - "It can't be this big can it?" *waving card about*
*Later: Is using his drawing as a transfer*
*Lee:* *Shown me white paper* - "Shall I cut it out?"
*Later: Came to me with cut out - it doesn't fit over Pandy's arm*: "I've done a little hole" *Me - Does the mac fit in it?* - Don't know haven't tried it.
*Later: Brought the mac & white single sided cut out*: "It fits" Me: What are you going to do now? - "Make it properly" *Then went on to make a 2 sided bag - so was the cut-out a prototype? But final product is much larger.*

The Log Book comments reveal the Comparison Class to be very similar to Year 2 children in my Exploratory Phase. Several children cut up the design sheet and used this in a variety of ways: to draw round onto the card, to stick onto the card and then cut out both, or to fold up and make into the suitcase (Robert). Lee seemed to have used the design sheet as a prototype but he was alone here, except perhaps for Alistair who used his drawing as a template after asking about cutting out.

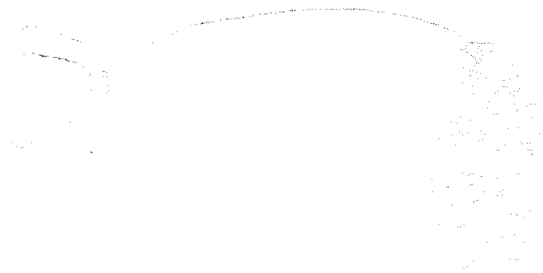
Also in evidence in the Comparison Class were the "Single-sided cut-outs" that had been typical of Year 2 in 1999 :

*Sophie:* *Single sided* - Me: Does it fit? - yes - Me: What are you going to do now? : Put little footballs, like on the drawing.

*Chloe:* *Pink paper stuck to cut out.* Me: Did it fit? - I don't know I didn't try it.
*Later:* "The middle bit fits, the side bits don't" *Me (unsure what she means as it is single-sided):* Do you want to try again & make it bigger? - yes

*Wendy:* *Drawing & making a carry stick* - "You put things in & hang it over your shoulder"
*Later: Single sided - fits over paw, went over shoulder - not happy - trying again.*

*Ex.47: Pandy's Suitcase (b) : Wendy (Comparison Class); single-sided cut-out:*



Only one girl in the Focus Class had difficulties of this sort:

*Kara has 2 rectangles* - what next? Me: stick them together? *Not sure. Went to look at Jolene's.*

Part of the problem appears to lie in the child's inability to perceive the divide between reality and fantasy inherent in the situation. Stables (1992b) cites research that suggests that the ability to handle reality is based on the ability to handle fantasy. On this view, the children who created single-sided cutouts and imagined that the mac could go inside were less able to handle the interplay between reality and fantasy in the situation. In my Exploratory Phase observations that it was the younger children who more commonly made this mistake (Section 3.3.3b). The older children understood and could work within the rules of the game. Stables (1992) relates this ability to handle both reality and fantasy simultaneously as fundamental to design. I was beginning to relate both to being able to play the game by the rules.

## ***5.3.1f Assessment Task 6 : Theseus' Maze***

The Maze task was conducted in Jan. 2002. Drawings and products by the Target Groups from both classes can be found in Appendix L.

The Focus Class were bubbly and chatty but as I circulated I realised that they were actually discussing where the Minotaur was, where the walls were, and so on, which then continued into mutual support during making:

*Michael & Maria (sitting next to each other) Drew outside view as well as top/down*

*Noel:* *Measuring his wall against the plan.* Connor: You don't stick it on there, mate. *[was he going to?]*
*Later: Noel now cutting out more green to make it same length as yellow base card. Has Connor distracted his correct thought about measuring?*

*Randal:* Can we change it cos it's quite hard to make that.

*Lisa:* *To me* "Can I make slots - I can make slots"
*Later: Holes in card are for Minotaur to go through - bits left are the bridges*

*Ellie, Carl, Natasha : Large box structures, similar outsides; insides different*

*Tasmin:* *Checkerboard floor pattern - copied from L (Non-assessed child)?*

*Emily:* *ditto but later: Drawn maze on yellow (different to plan) & then folded & stuck walls on it - though not on the lines - so is this a mosaic floor?*

*Hayleigh: Doing the one on top left of paper.*

*Stacey:* *Has* "lost her way". *Jolene sorted her out* "Look back at your drawings" *- folded edge of card for her.*

This sharing of ideas was in contrast to the Comparison Class who worked quietly but individually whilst drawing. In contrast to the Focus Class, there is a low level of co-operative work amongst the Comparison Class children. Kathy and Chloe were sitting next to each other and probably used each other's interpretation of the task to inform their own; this was the only instance of working together noted during the lesson.

*Kathy:* "Will you draw the walls or make it?" Me: whatever you like. Kathy*:* I'm drawing it and then put walls.
*Later:* I'm going to make figures and maybe a little boat so he can get back *[she has no internal walls]...* so I can put my bits inside.

*Chloe:* *Also only has walls -* "I'm going to make people.."
*Later: finished - drawn maze not made walls*

Kathy and Chloe were just two of the Comparison Class who drew a maze on the card and built walls around the outside edges. The Focus Class made internal walls - and no one struggled to know how to glue them. Comparison Class children needed to be told how to make tabs.

This wall-building was the most obvious difference between the finished products. The Focus Class could use a top-down view to support making a 3-dimensional object, which the Comparison Class could not really do. Once they had drawn the maze the Comparison Class struggled to jump back into 3-dimensional thinking. The lack of internal walls when making, suggests that the drawing had confused them into thinking that they were making a 2-dimensional object. Despite many of them being able to discuss their drawing with me (placement of Minotaur etc.) they did not make this the basis of a 3D model.

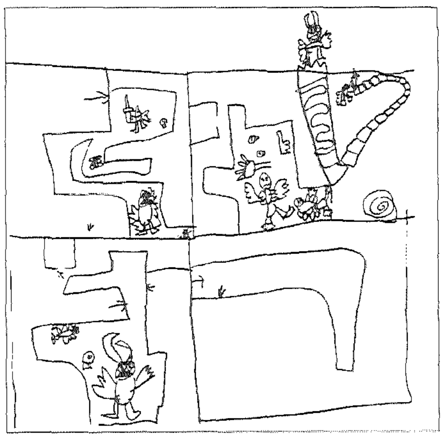
Making what they had drawn appeared to be so rare in the Comparison Class that I noted children who did. Much more typical was Ellis, whilst making: *"I've just worked out how mine's going to work"* and Alistair's belated realisation that what he had drawn was impossible to make:

> *Alistair : Wanted to do trap doors etc at the drawing stage - I nearly stopped him because I thought it would be impossible to make.*
> *Later:* "This is really, really hard. Look I've got all that to do. I'll have to do all that."

Peter and Robert were typical of the many boys who focused on the ghoulish:

> *Peter: Has drawn rope as well - really good drawing*
> *Later: Blue triangle in flat base "skulls". Not following drawing at all.*
> *Robert: Has drawn a maze on the card and a single door*
> *Later: Blue fan-folds - bones on top - where the Minotaur has left bones*

Robert's drawing was almost a comic-strip telling of the story rather than a design for making:



*Ex.48 :Theseus' Maze (a) : Robert (Comparison Class)*

The making of fan-folded structures with bones on top, shows the extent to which these children were creatively fantasising as they made their product. There was no sense of solving "this problem and this problem only" Donaldson (1992). This was even more marked amongst those who departed completely from the script:

*Jordan:* *Waterfall (blue) for Minotaur to have a drink*

*Zara:* This is for the crocodile to come in *(blue).* Lee: "It's a Minotaur" Zara: No, a crocodile is in the garden; I'm doing a boat, walls & a door.
*Later: Playing with it - walking the Minotaur about*

My evaluation notes on the Comparison Class session read:

> *Some of them were in a sort of narrative mode - making bones, water etc. for the Minotaur - on different understanding of what the problem solution might be like. They did not define & solve the problem at drawing stage & then find they needed to make changes (as did Focus Class) but developed ideas in the making - and these then diverged from the "model for Theseus so he knew the way out" scenario. They are making a model of the maze as a personal play object.*

I think too that the Comparison Class had left too many possibilities hanging and un-addressed before handling the construction materials, that they were still unfocussed on the problem to be solved and so used the materials to make what they fancied rather than solve the task. I think this observation gave me the biggest justification for the "Why draw anyway?" question that lurked constantly at the back of my mind throughout the Programme's duration.

My "Evaluation of Session" notes continue:

> *The different understandings and working methods of the two classes were immediately apparent. Some of the Comparison Class were still at the "drawing a picture to define the problem" stage. There were considerable numbers of the Comparison Class who ignored their plans completely, also quite a few drew a maze on the yellow base and then built a set of walls round the outside only. This seemed odd since they had all seen my pop-up maze example. The Focus class were making real 3-D mazes and threading the string through. Regardless of what is shown about their differing use of drawing, the different level of engagement with the task was remarkable.*

This last sentence captured the difference between the two classes. It was not in the sophistication of what they recorded on paper, but in what could not be captured except in my log book notes, in the *level of engagement* with the task as given. The Focus Class were problem-solvers. They understood what was to be done and set themselves to satisfy the criteria of the problem. The Comparison Class were not grappling with a real problem about making Theseus a model of a maze; they were doing something else, parallel to that. I think it was making themselves something with maze-like properties or characteristics. Many were playing with the idea of a maze in a freely creative way.

In comparison, the Focus Class were more prosaic and business-like. There were one or two bridges to get over deep water (even these were planned on paper before making) but on the whole they saw the activity as providing a solution to a specific, pre-defined problem. They had their flights of fancy in their discussions before, and in tandem with, putting pencil to paper and then they made their final idea. The Comparison Class drew in almost total silence but then discussed, adapted and completely changed what they were doing and lost the thread of the activity once they had the card in their hands.

## 5.3.2 Emergent Themes from Qualitative Evaluation

In drawing together the Emergent Themes from the qualitative evaluation of the Assessment Tasks, my aim is to indicate the differences that were apparent between the two classes on the basis of observations made in context and recorded in my Log Book and by video or audio recording.

Some of these relate to the Emergent Themes identified through my informal evaluation of the Programme as delivered to the Focus Class and build on my reflections in Section 4.5.2 "Emergent Themes from Evaluation of Teaching Input." However, other themes emerged from the data, which, it will be seen in Sections 5.5-8, relate more closely to the results of the quantified analysis of the children's drawings.

***The Role of the Drawing***

There was a distinct difference between the two classes perception of the purpose of the drawing. In the Focus Class it was a discussion document used to develop a design solution, whereas the Comparison Class were just defining the problem to themselves. The Focus Class used the drawing to support the development of a solution, whereas the Comparison Class seemed to be using drawing to record the task or define the problem. Not having sufficiently defined a possible task solution before cutting into the materials, the Comparison Class began to develop their design ideas once they were engaged with the materials and then made a product which was related to, rather than answered, the problem as set.

For the Maze task, more of the Focus Class were still drawing at half-time, suggesting that they were using the drawing to work out real ideas for making, They consequently showed a much tighter sense of connection between the drawing and the making. They were using the drawing to plan their maze and modelling real ideas on paper that they then transferred to the card; the Comparison Class were not. I think the Comparison Class almost saw the drawing as a prelude to the real business of designing, which they did with the materials of construction, whereas the Focus Class had learnt that the drawing was a means to designing.

Interesting light was shed on the Comparison Class' lack of understanding here when I discovered that neither class teacher had given the children time to make the Card on the same day as it was designed. They expected me to do this with each class the following week. From my viewpoint on designing, the children were very unlikely to remember what they had planned and be highly likely to abandon their drawn ideas and begin to design afresh. I realised later that the Design and Technology workbook in which the Comparison Class recorded their work also reflected a fragmented model of designing, making and evaluating. This contrasted sharply with my integrated Ideas on a Journey model.

***The Role of Discussion in Designing***

The Focus Class discussed as they drew, exchanging ideas, sparking off each other but also keeping each other on task. The Comparison Class drew without discussion. Drawing was seen as an individual, quiet activity. This was especially marked in the Maze activity.

The sharing and discussion of design ideas had been encouraged right from the start of the Programme (Section 4.3.2 & Appendix B). Co-operative work also featured throughout, which encouraged children to use each other as a resource for feedback on possibilities. Focus Class children often used drawing in tandem with speech. Drawing was frequently used to initiate or support such conversations (for example, that between Craig and Noel over Noel's idea for Frosty, Section 5.3.1b).

The point at which children declared their design intentions to each other was an important difference between the two classes' designing styles. The Focus Class said *"What I'm going to do is"* to each other as they drew, the Comparison Class delayed these conversations until they were engaged in making. By this time they had fetched their materials and then comments from peers which led to changes in their ideas were not recorded, defined or thought through ahead of cutting into the materials.

***Solving the Problem in Hand***

The Comparison Class seemed to have a cavalier attitude towards the task instructions. If they could not solve the task, they changed the task to one which they could solve or would prefer to solve, even to the point of discarding the essential elements of the problem. This was evident at Easter, when children were observed omitting to use the card tube that was central to the problem to be solved *("How do you make a holder out of this tube for this egg?")*, or on the Maze task, making snake pits and piles of bones instead of grappling with how to make walls with doorways leading to the Minotaur.

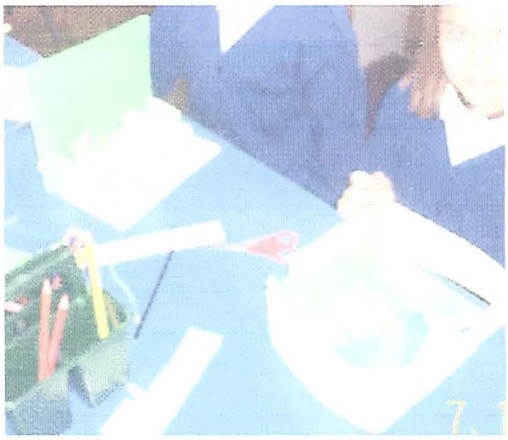
In contrast, the Focus Class were solving the problem in hand. They accepted the task as set and sought to find a way to solve it. No one discarded the card tube at Easter, cut out a picture of a stick and kerchief or made rivers with crocodiles outside King Minas' castle. This was not just a matter of degree but of complete contrast between the two classes. The Comparison Class appeared to be less able to take on board the idea that the constraints of the task as stated were important success criteria. The Focus Class did, and I came to the conclusion that the Programme had enabled them to understand the rules of the game and, in Donaldson's (1992) phrase, solve "this problem and this problem only".

***Reality / fantasy***

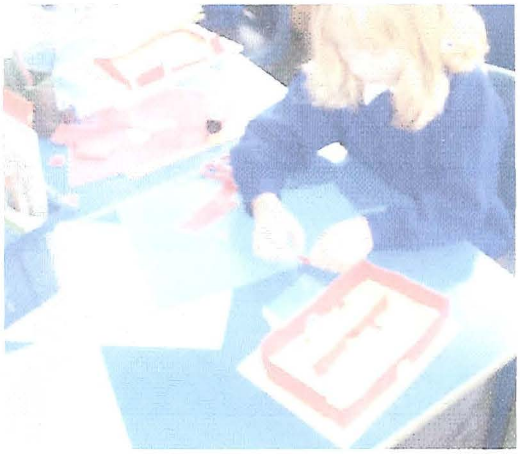
For Pandy's Suitcase, none of the Focus Class had problems knowing that they were meant to be making something that a plastic mac could be put into. Several Comparison Class children drew a single rectangle with a handle, cut it out and declared the mac would fit in it. An identical scenario occurred with my Year 1 class of 1998 in which I placed the Panda's clothes against the piece of card and let go (Section 3.3.3b). In 1999, I made a conscious decision not to record Year 2s making this mistake as I could not be sure they got the right answer from me or each other. It was clearly a misunderstanding of the reality / fantasy divide as related to this task which was common amongst Key Stage 1 children. It was more remarkable that the Focus Class did not make this mistake.

This seems also to be related to playing the design game by my rules and knowing where the reality / fantasy divide was meant to be. Many Key Stage 2 children appear to be able to do this and the Programme had enabled the Focus Class to do so too. The difference between the two classes in this respect is best illustrated by the photographs (Exx. 48-9, shown overleaf) taken towards the end of the Maze Assessment Task:

*Ex. 49: Theseus ' Maze (b) Jolene and Hayley (Focus Class) built the internal walls before attaching walls and roof:*



*Ex. 50: Theseus ' Maze (c) : Zara (Comparison Class) making a boat for Theseus. The "Maze" has just one internal wall; Kathy's maze (in background) has none - these were simply drawn on the yellow base.*



# 5.4 The Quantitative Analysis Instrument

A more rigorous analysis instrument was needed for the more detailed assessment of children's drawings during the Structured Phase. The databases used for recording results in the Exploratory Phase were themselves exploratory. They had evolved over time and had highlighted aspects of design that I had found interesting or noteworthy. Although they had come from observations and evaluation of the collection of drawings that I had, they were idiosyncratic. I needed an assessment system that was more firmly grounded in the work of others, in order that my work had greater credibility.

## 5.4.1 Creating the Analysis Instrument

From the Exploratory Phase I had my Drawing Types which I had intended to continue use as the primary means of assessing the children's work, which, together with the qualitative data from observational field notes and audio and video tapes of the Target groups, would give (to my mind in April 2000) a good rounded view of how children used drawing for designing.

The main problem, which I had not seen at that time, was that whilst in the Exploratory Phase I was documenting what *was*, for which six non-linear Drawing Types would suffice, I was now attempting to improve the children's performance and I did not have a continuum by which I could define *"better"*. Section 5.4 documents the development of a more appropriate analysis instrument.

### *5.4.1a Starting Points*

My theoretical starting point was the Kimbell et al.'s (1991) Dimensions of Capability shown in Fig. 49 :

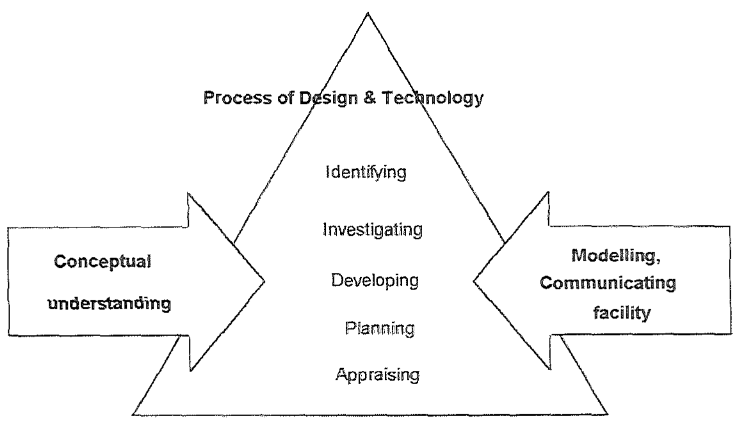



*Fig. 49 : Kimbell et al.: (1991: 23, Fig 2.7)*

I combined this with the insights gained whilst compiling the Taxonomies of design drawing (Section 3.4). I felt that the relationship between the drawing and the product was important, and something which had been part of my assessment system from the start. I was also influenced by the National Curriculum Attainment Targets, since these were how we were required to think about design capability in school.

I identified, therefore, eight Aspects of Capability in relation to design drawing:

- Generating and Developing Ideas,
- Exploring the Problem,
- Addressing Client's Needs,
- Appearance of the Product,
- Communicating Ideas,
- Planning Construction,
- Evaluating Whilst Drawing,
- Relationship to Making.

There was no implied precedence of one Aspect over another, either in choice or ordering, except that Generating Ideas was likely to come early in the process and Relationship to Making last. Generating and Developing began as two separate categories but were combined since I seemed to be repeating myself once I started to construct the instrument.

### *5.4.1b Grid and Ticksheet*

The analysis tool was first conceived as a series of linked spreadsheets and databases and this continued to be the method of analysis, despite the subsequent re-definition of the analysis instrument and the display of results as radial plots in Sections 5.5-9. Appendix N details the development of the analysis instrument  by tracing the evaluation of one child's drawings, as well as explaining how these individual records were collated into the spreadsheets in Appendix O, on which the analysis on Section 5.5-9 are based.

Initially, an Individual Marking Grid was constructed (Table 9 overleaf, and also Appendix N: AN2.1), together with a Techniques Ticksheet (Table 10, and also Appendix N: AN2.2) and a Collation Sheet (Appendix N: AN2.6). This was constructed by considering examples of children's work that I felt typified each of the Drawing Types (Section  3.3.5) from Stan, Panda and Art Club experiences. For example, I looked at a stereotypical Single-draw and composed a single line descriptor for each of these Aspects of design capability.

## Table 9 Individual Marking Grid

| | PICTURE | SINGLE-DRAW | MULTI-DRAW | MULTI-DESIGN | PROGRESSIVE | INTERACTIVE |
|---|---|---|---|---|---|---|
| GENERATING & DEVELOPING IDEAS | drawing a picture of an object, not designing a product | single, simple drawing | several attempts to improve drawing of single idea | several unrelated draiwngs showing range of ideas | progression of ideas across drawings | uses drawings reflectively to generate new ideas |
| EXPLORING THE PROBLEM | not exploring design problems | minimal use of drawing to explore ideas | aiming to improve the drawing not explore solutions | brainstorming onto paper without developing a solution | uses drawing to develop a design solution | combines previous ideas with new ones to produce the best solution |
| ADDRESSING CLIENT NEEDS | minimal understanding of client needs and wants | drawing conveys partial understanding of addressing client need | drawing shows understanding of the needs of the client | several ideas for satisfying client needs are recorded but not developed | the client's needs and wants are considered as the design proceeds | the client's needs and wants are treated as part of the iterative process |
| APPEARANCE OF PRODUCT | views the drawing as the product | minimal consideration of final appearance of product being designed | only one overall finishing scheme considered | experiements with several finishing schemes | ideas about finishes are added to design during the drawing stage | ideas about finishes develop interactively within overall design development |
| COMMUNICATING IDEAS | use of narrative or other drawing genre | minimal recording of design ideas | several drawings of same idea | quick sketches of a range of ideas | conveys sense of object to be made, e.g. by labelling, instructions etc | clearly conveys ideas about object to be made e.g. multiple viewpints |
| PLANNING CONSTRUCTION | not planning to make the object drawn | no evidence of materials or construction issues | minimal consideration of construction | indicates which idea will be made, but not how | materials or *construction features* shown on drawing | constructional issues considered en route to final design |
| EVALUATING WHILST DRAWING | no evaluation | minimal evaluation | rejected early atempt(s) at drawing single idea | considered and rejected range of ideas | decisions made about the object whilst drawing | changes made as a result of reflecting upon previous design drawings |
| RELATIONSHIP TO MAKING | making an object is viewed as a separate, new activity | minimal relationship between drawing and making | object made is the same as the object drawn | object made is one of the ideas drawn | progression from drawing into making | uses drawings as resource during making |

*The example shown in Appendix O indicates how the marking grids for each task were collated.*

The Techniques Ticksheet was intended to capture the *"how"* and was a compilation of techniques that I had observed children using during the Exploratory phase of the research (e.g. annotation, recording materials), arranged under headings to match the Grid. The Ticksheet was to cause much less trouble than the Grid, as it required simple yes/no answers rather than qualitative judgements. Comparison between the original list (Table 10 below, & Appendix N: AN2.2) and that finally used (Table15 in Section 5.4.3b(ii) & Appendix N : AN2.4) shows how the interaction between Grid and Ticksheet impacted on the Ticksheet.

*Table 10 : Techniques Ticksheet (Version 1), also to be found in Appendix N: AN2.2 :*

| SATISFIES CRITERIA OF DESIGN BRIEF | PLANNING CONSTRUCTION |
|---|---|
| *as set by teacher* | indicates materials by list |
| begins from task requirements | indicates materials by labelling drawing |
| maintains task requirements into msking | materials indicated are suitable |
| *as required by client* | materials indicated are available |
| begins from client needs | indicates cuts, folds &/or fixings |
| maintains client needs into making | indicates measurements |
| | indicates equipment needed |
| RELATIONSHIP BETWEEN | indicates parts to be assembled |
| WORDS & PICTURES | can be made in time available (roughly) |
| pictures only | technically realistic (child can make it) |
| thinking recorded mostly in pictures | |
| thinking recorded mostly in words | EVALUATING WHILST DESIGNING |
| single words or phrases relatiing to picture | choices related to appearance of product |
| list (e.g. of materials) | choices related to design specification |
| full sentences to describe planned product | choices related to client needs |
| labelled diagram (with) arrows or lines | choices related to material constraints |
| words/pictures interact to record process | choices related to construction |
| lengthy verbal explanation | justifies choices made |
| instructions - words only | |
| instructions - pictures with few/no words | RELATIONSHIP TO MAKING |
| instructions - labelled diagrams | same/adapted object |
| | same/adapted shape |
| FEATURES OF THE DRAWING | same/adapted size/proportions |
| appropriate level of detail | same/adapted colour |
| shows dynamics/movement | same/adapted pattern, decoration, picture etc |
| various viewpoints | same/adapted materials |
| expansions to show small details | same/adapted fixing technique |
| cut away diagram to show inside of product | able to justify changes |
| idicates how parts will fit together | |
| | |
| APPEARANCE OF PRODUCT (FINISH) | |
| indicates pattern or motif | |
| indicates colour | |
| considers more than one finish | |
| justifies choice of finish | |

## 5.4.2 Refining the Instrument

Since it contained qualitative statements, the Grid was to become the subject of extended refinement through moderation and eventual redefinition through metamorphosis into the multi-level holistic analysis instrument described in Section 5.4.3. As well as involvement in the evaluation of the children's work (as outlined in Section 4.2.3), my moderation panel were involved in the development of the analysis instrument itself. This enhanced the reliability of the analysis instrument as well as the evaluative judgements made about the children's drawings and products. Appendix N demonstrates this process.

I needed to know quickly if the Marking Grid was viable and so the moderation panel each blind marked twelve examples of the Pizza task (Target Group children) using both the Grid and the Ticksheet. We were all used to working to a "best fit" paradigm of SATs scoring and used a grid to assess literacy achievement across Key Stage 1, so that my colleagues had no more expectation than had I that children's work would fall neatly into the columns. However, few children's work spread across as many as three columns.

Where I was certain about my classification on the Grid, my colleagues tended to agree; where I was less certain, they diverged widely. All three teachers said that they needed to know more about the task and my expectations in order to know to what extent the children had satisfied some of the grid criteria. The Ticksheet was much less problematic: children either did something or they did not. This feedback from my moderating colleagues was to become part of the iterative process of refining the instrument. That the instrument needed refining had become obvious very quickly. Because I knew what I meant by the Drawing Type categories, I had paid less attention to how someone else would interpret the individual cell descriptors without having the mental image of what I was looking for. The Grid was an aide memoire for me and did not work as an evaluation tool for others.

Both my moderators and the Research Group at Goldsmiths College questioned the relationship of the Ticksheet to the Grid. I had realised that I was flagging up concern for my marking if the scores differed by more than 2. It became apparent that, for example, children were getting points on the Grid for simply putting a tick by their choice of idea if they were "Multi-designers". This seemed a lot for not much. Referring to the Ticksheet for Communicating Ideas, Multi-design turned out to be rather more than "tick which one of all those ideas you think you'd like to make". If nothing else, Ticksheet was useful for showing up inconsistencies in the Grid.

However, to be useful as an evaluation tool, the Ticksheet should not, I felt, just be a supporting cast for the Grid. It needed a clear reason for its own existence. Thus, any information which was repeated on the Grid was deleted, except where I felt I wanted to record information in more detail.

## 5.4.2a The Purpose of the Design Drawing

As part of my attempts at improving the Grid, I consulted the Taxonomies of Design Drawing that I created from my reading and the design tasks conducted with children in the Exploratory Phase (Section 3.4.1). First on the Internal list was "Purpose" which appeared to solve my Grid problem instantly: This is the essential difference in how the children treated the drawing process and is revealed in the drawings they do.

On this view, the Individual Marking Grid was a *Purpose of Drawing Grid*: what do the children see the purpose of the drawing as being:

| DRAWING TYPE | PURPOSE |
|---|---|
| PICTURE | Finished product, unrelated to future making. |
| SINGLE-DRAW | Record of an idea to show the teacher. |
| MULTI-DRAW | Improve the drawing before showing the teacher. |
| MULTI-DESIGN | Brainstorming ideas relating to the design brief. |
| PROGRESSIVE | Develop an idea towards considering how to make the product. |
| INTERACTIVE | To work out what they want to make and how to make it. |

*Table 11 : The Purpose of the Drawing*

A "Purpose Row" was added to the Grid and each Descriptor Cell altered in line with its contents. I felt initially that this had radically improved things. Thinking in terms of identifying the child's perception of the *purpose of the drawing* simplified the whole process and my moderators and I could place them on the Grid much more easily. There was only one child (Emma) whose work required considerable discussion between us. The divergence between us was less wide, probably as much due to the discussion following the first iteration which enabled my blind-markers to more fully understand my classifications as to improvements of the Grid. The establishment of shared meanings meant that their interpretation of the Grid was now more likely to be consistent with each other and myself. I hoped, therefore, that future disagreements over placement of children's work would be due to interpretations of the drawings, not interpretations of the words on the Grid.

*The Purpose of Drawing Grid (Table 12) overleaf is also to be found in Appendix N: AN2.3*

## Table 12 Purpose of Drawing Grid

| | PICTURE | SINGLE-DRAW | MULTI-DRAW | MULTI-DESIGN | PROGRESSIVE | INTERACTIVE |
|---|---|---|---|---|---|---|
| CHILD'S VIEW OF PURPOSE OF THE DRAWING | Draw the object. | Record an idea of what might be made, to show the teacher. | Make the drawing as good as as possible before showing the teacher. | Brainstorming | Develop chosen idea and idicate how it might be made. | To work out what will be made and how to make it. |
| GENERATING & DEVELOPING IDEAS | drawing a picture of an object, not designing a product | single, non-stereotypical, drawing | several attempts to improve drawing of single idea | several unrelated draiwngs of a range of ideas | progression of ideas across drawings | uses drawings reflectively to generate new ideas |
| EXPLORING THE PROBLEM | design problems are not adressed in the drawing | minimal use of drawing to explore ideas | aiming to improve the drawin rather than explore solutions | brainstorming onto paper without developing a solution | uses drawing to develop a design solution | combines previous ideas withnew ones to produce best solution |
| ADDRESSING CLIENT NEEDS | minimal understanding of client needs and wants | drawing conveys partial understanding of addressing client need | drawing shows understandin of the needs of the client | several ideas for satisfying client needs are recorded but not developed | the client's needs and wants are considered as the desig proceeds | the client's needs and wants are treated as part of the iterative process |
| APPEARANCE OF PRODUCT | views the drawing as the product | minimal consideration of final appearance of product being designed | only one overall finishing scheme considered | experiements with several finishing schemes | ideas about finishes are added to design during the drawing stage | ideas about finishes develop interactively within overall design development |
| COMMUNICATING IDEAS | use of narrative or other drawing genre | minimal recording of design ideas | several drawings to express same undeveloped idea | demonstrates range of ideas often through series of quick sketches | conveys sense of object to be made, e.g. by labelling instructions etc | clearly conveys ideas about object to be made e.g. multiple viewpints |
| PLANNING CONSTRUCTION | not planning to make the object drawn | no evidence of materials or construction issues consider | minimal consideration of construction | indicates which idea will be made, but not how | drawing indicates consideration of materials or construction features | constructional issues considered en route to final design |
| EVALUATING WHILST DRAWING | no evaluation relating to designing the product | minimal evaluation | rejected early atempt(s) at drawing single idea | considered and rejected range of ideas | decisions made about the object whilst drawing | changes made as a result of considering and discussing design drawings |
| RELATIONSHIP TO MAKING | making an object is viewed as a separate, new activity | minimal relationship between drawing and making | object made is the same as the object drawn | object made is one of the ideas drawn | clear progression from drawing into making | uses drawings as resource during making |

*The example shown in Appendix O indicates how the marking grids for each task were collated.*

However, this was still modelled on the Drawing Types and by April 2001 I had realised that the Drawing Types were themselves becoming a problem and perhaps needed to be separated from the Grid, removing the temptation to decide the Drawing Type and then check boxes with this in mind, rather than viewing each Aspect row separately.

My moderation panel each blind-marked all Target Groups drawings for the Easter Assessment Task and again supplied feedback. At this meeting, it emerged that they were less worried by the Drawing Types problem as I was, since for them this was simply another criterion and they did not have all the encumbrances of pre-conceptions that I had through devising them.

In Summer 2001, I conducted two workshops on design drawing, one in school and one at the Design and Technology Association Conference in Coventry. This meant that moderation of the drawings had been carried out by twelve of the teaching staff at school and by about fifty conference delegates with a range of backgrounds in Design and Technology education, giving me increased confidence in my classification categories.

## *5.4.2b Representing Progression*

However, by mid-summer 2001, other problems with the Grid had became obvious to others (if less so to me): not all my categories were sliceable into a 5-graded scale. For example, the children had either addressed their client's needs or they had not. I had constructed the Grid by extrapolating from the Drawing Types categories by considering the work of individuals who fitted these categories. The cell descriptors were constructs which fitted the examples I had used; but did they generalise? I was constantly changing the descriptors in the light of the drawings and the moderation process.

I took all this to the Research Group Seminar. Some in the group favoured circles rather than grids; a more holistic, less deterministic feel to circles - had I done a Grid to fit neatly onto an A4 sheet? No, it was so it fitted on a spreadsheet (and so judged to be even more suspect).

A more realistic left-right representation could probably be as Fig. 50:

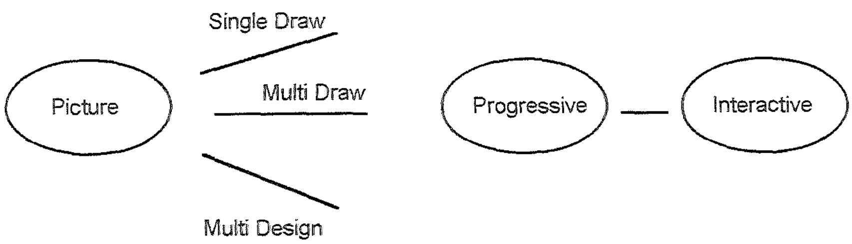



*Fig. 50 Non-linear Progression across Drawing Types (a)*

which suggested the progression of understanding and skill but allowed for multiple routes through the Drawing Types, which was emerging from my analysis of the data, although I still felt that Multi-design was more sophisticated than Multi-draw.

The Research Group made other suggestions, for instance:


*Fig. 51 Non-linear Progression across Drawing Types (b)*

Perhaps, the Drawing Types are descriptors which have overlapping characteristics, some of which overlap and some of which are discrete (at the time I was using "aspects" as the term of reference for Grid items and "features" for Ticksheet ones). This was all becoming too complicated and the possibilities seemed endless and the Grid seemed to be the least appropriate vehicle for discovering the answers to such questions. Without looking at both the Grid and Ticksheet, it would not be possible to see that the way the drawing is annotated is often an important feature of Progressive drawings.

The problems were, I believe, two-fold:

*Firstly*, the Drawing Type categories had arisen from the examination of drawings across the 5-9 age range over a period of 4 years, at a time when the teachers' understanding of Design and Technology had been less clear and my interest in design drawing had little impact within the school. Now I was looking more closely at a narrower age range, over a much shorter time period, looking for improvements, and the techniques used by the children were more varied and sophisticated than had appeared amongst Year 2 in 1998-9.

*Secondly*, there was the difficulty of determining what constituted "improvement". The Drawing Types were not (and never had been) seen as a linear scale, although in essence they represented progress (the "muddle in the middle" between possible pathways through Multi-draw and/or Multi-Design notwithstanding). It was generally felt that I was deciding on the Drawing Type first and then judging the children's performance on the Aspects according to my Drawing Type classification. In order to minimise this effect, I removed the Drawing Type label from the top of the Grid. I did not feel in practice that this was making much of a difference to my judgements. The Grid had been constructed by teazing out what I meant by my Drawing Types, so that with or without the word on the top of the Grid, I was likely to come to similar conclusions about individual design drawings.

I think that focusing on the instrument and defining what the Drawing Types meant had distracted me from the rationale behind the Structured Phase of the research: improving children's performance. The real difficulty was in finding a way of capturing the essence of growing understanding and sophistication. Analysis should aim to show whether the Focus Class had made greater progress overall and were using a greater range of techniques in comparison to the Comparison Class and, if so, how significant was the Container / Journey metaphor in contributing to their understanding (i.e. was there significant improvement in the Focus class from Easter which was not matched by the Comparison Class and was that difference maintained?).

By the time the Programme was completed (Jan 2002), I had an instrument which could answer the question *"What do children do?"* rather than one aimed at addressing the question *"Are they better as a result of your input?"* What I had not done was to have the courage to say that as a result of the Exploratory Phase I knew what children *do*, albeit broad-brush. This lack of faith in viewing the outcome of the Exploratory Phase as *results* meant that I had gone round in circles trying to work out how to justify the Drawing Types, rather than using them as just one layer in a multi-level comparative analysis of two groups of children: one who received a Programme to improve their design skills and one who did not.

## 5.4.3 Re-defining the Analysis Instrument

The realisation that my Grid and Ticksheet were not working well was to result in the complete restructuring of the analysis instrument. Fortunately, it did not result in a complete re-marking of all the children's work, since it was only the middle-band children who were affected by the changes in the re-structuring of the instrument. However, Mrs.R. offered to second-mark all the children's work. I was concerned that we ensured that all drawings with identical characteristics had received identical evaluation. This process took longer than either of us expected but gave me increased confidence in the reliability of the resultant quantified analysis.

During the evolution of the Grid, I had identified Purpose of the Drawing as a major factor in determining the kind of drawing the children would produce, But until all the drawings from the Structured Phase had been examined and discussed, I had not identified perception of purpose as *the* major factor. I had been aware of Bridget Egan's work in this area for some years (for example, Egan, 1996) and we have had an on-going dialogue at conference venues since 2000. Her interviews with children in Years 1 and 6 revealed that many children did not understand the function of the drawing in the design process. Those who did articulate some measure of understanding tended to see drawing as recording, not development, of ideas. I agreed with her that children's understanding the role of the drawing was important, and had put this at the head of my revised Grid, but I had not considered the import of this being *the determining factor* in how the children used drawing to support designing.

## *5.4.3a A Holistic Analysis Tool*

Parallel to this, I was searching for texts relating to analysis methodologies for evaluation of young children's learning, looking for ways to address the issues raised by the research group, and which might provide an more appropriate model for an analysis tool.

A child-centred framework for defining and assessing quality in early childhood education is described by Pascal & Bertram (1989), (Fig.52). Each segment represents an area of the child's development or competence. It is person-centric (not curriculum-centric) and emphasises that the child is central to any assessment process and that all dimensions of the child's learning are inter-related, not discrete or linear.

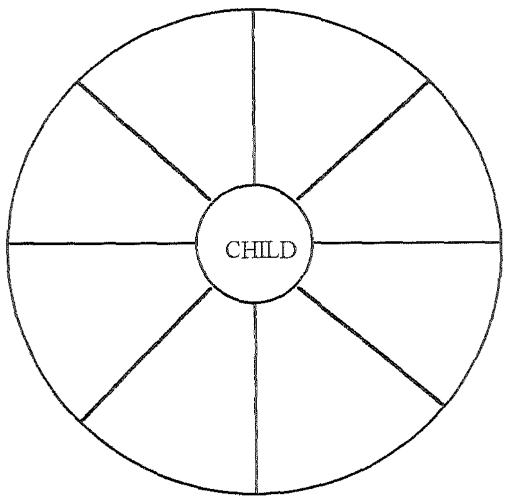



*Fig.52 : Pascal & Bertram's (1989) Assessment Model*

This seemed ideally suited to my needs. Not only does this mesh with my view of the holistic nature of education for young children, but I could see potential in this model for describing the child's view of design drawing, centred on the child's understanding of the purpose of drawing, the arrows suggesting development in the child's understanding (Fig. 53, overleaf) :

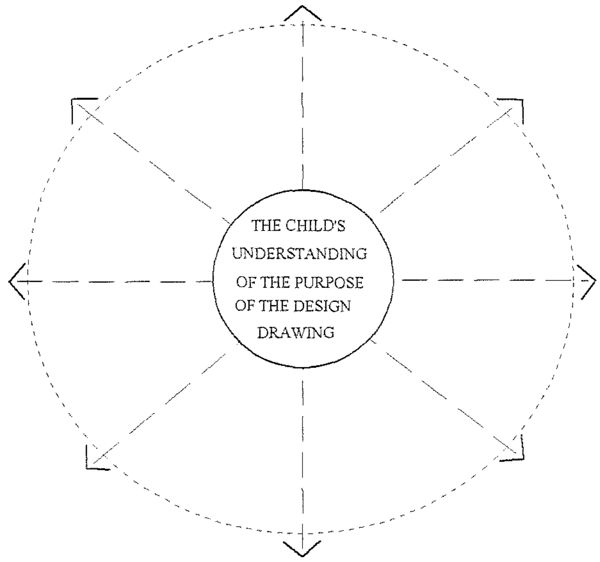



*Fig.53 : Purpose of Drawing Holistic Assessment Model (a)*

Rings could be added to represent different levels of capability :

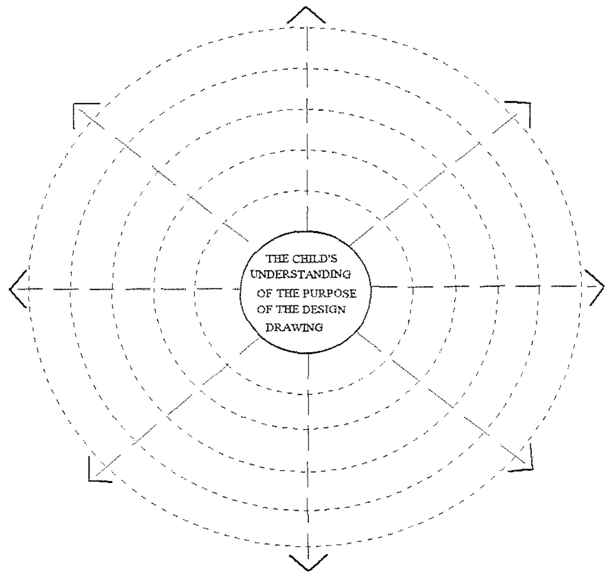



*Fig.54 : Purpose of Drawing Holistic Assessment Model (b)*

and, following Pascal & Bertram's model, the Aspects of design drawing would fit into each of the segments of the circle (Fig.55a, overleaf). However, to display assessment results graphically (as radial plots generated by a spreadsheet), the Aspects needed to be placed on the lines (as in Fig. 55b) rather than within the segments:

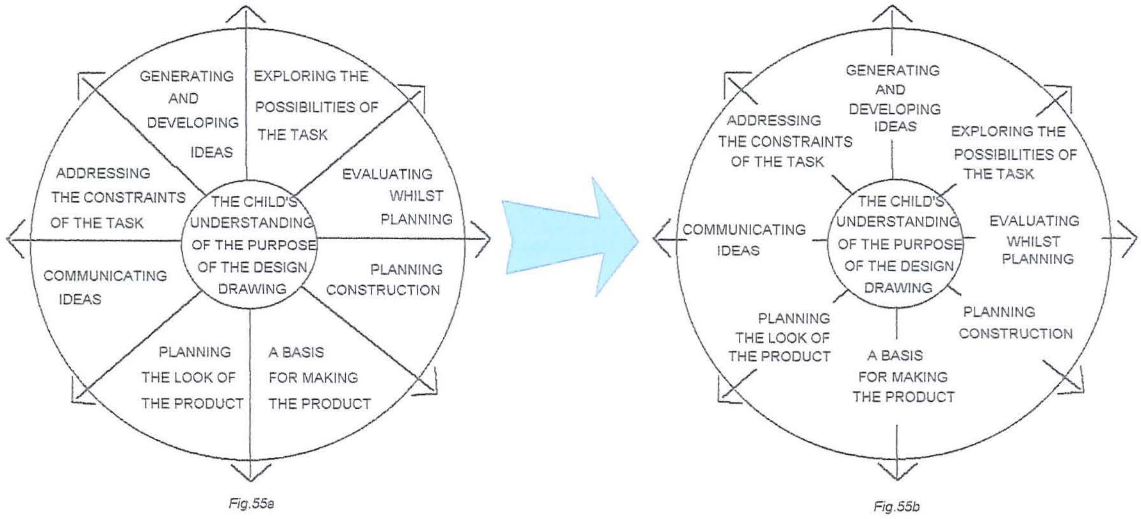



*Fig.55 : Dimensions Wheel*

This has the added advantage of having eliminated the boundaries between the dimensions, which suggests, even more strongly than Pascal and Bertram's (1989) original model, the inter-connectedness of the dimensions. This is particularly apposite for my view of design drawing: my Drawing Types had assessed the drawing as a whole rather than separating out parts and the Grid had been created from these holistic assessments.

I decided to call this model a Dimensions Wheel, since Pascal & Bertram (1989) specifically use the word "dimensions" and, as in their understanding of a child's developing competencies, all the dimensions of using drawing for design are represented as inter-relating rather than discrete. This change of terminology was not purely cosmetic but represented a real change in the way I was now viewing the centrality of understanding the purpose of the drawing. This was then worked out through the Dimensions on the spokes of the wheel, refinements of the Aspects from the Grid.

In analysis of the Assessment Tasks drawings the concepts of constraints and possibilities had become viewed as a duality. Addressing the Constraints of the Task was to include all task criteria as set, not solely the needs of the user, as previously. This emerged during analysis of the drawings via the Ticksheet, through comparing findings within the "Satisfying Criteria" sub-group (see Table 15 in Section 5.4.3b(iii)). For example, at Easter some children did not include the oversized tube in their design, although this was central to the problem and I felt this was more important that whether they had written "For Mummy" around the rim. Likewise, in terms of "possibilities", Exploring the Possibilities of the Task meant more than producing multiple ideas. Novelty is also important: six different ways of colouring the cardboard tube being less creative than turning it into an Easter Bunny whose ears popped up as the lid was lifted.

The arrangement of the Dimensions on the wheel is important. If there is an entry and exit point to this diagram it is that children generate ideas which address the task constraints and possibilities, evaluating as they communicate to themselves and others, plan construction and think about what they product will look like (colour, decoration etc.), which all becomes the basis of the product which they make. The more a child thinks through all these issues, the more successful their design will be. The extent to which they use drawing to record and support thinking about their design as it develops contributes to the overall success of the project. This accords with the Kimbell et al.'s (1991) model of the design process (Fig.21).

In effect, there were two layers to this quantitative analysis instrument based on Pascal & Bertram (1989). An understanding of the *purpose* of design drawing, which is reflected in the way in which children *use* drawing to support design thinking (dimensions).

### *5.4.3b A Multi-layered Analysis Tool*

As neat as the double-layered Purposes and Dimensions wheels were, I actually had four parts to the analysis system:

- Purposes Continuum
- Drawing Types
- Dimensions Continua
- Techniques Ticksheet.

In order for this analysis system to have cohesion, there needed to be a clearly defined relationship between the elements. That the Purposes Continuum and the Dimensions Continua would mesh together into one coherent system was implicit in the way that both had been created from the Grid. There would also be a relationship between the Continua (Purposes and Dimensions) and the Drawing Types, as the Grid had been created from the Drawing Types. However, although I did not want to let go of my Drawing Types, I now knew that they had to be related to the Purposes and not the other way around.

The Drawing Types were part of the external evidence of what was going on inside the children's heads and related to their understanding of design drawing in the same way as the External and Internal Taxonomies related to one another as two sides of the same coin. Meshing them together was not necessarily going to be neat and tidy. I was beginning to wonder if I had unwittingly collected my evidence to reflect this internal / external duality and that the struggle I was having to organise it resulted from this lack of realisation. It would appear that I had:

| | |
|---|---|
| **Internal** .......................................... | Pupose Continuum and Dimensions Wheel |
| **External** .......................................... | Drawing Types and Techniques Ticksheet |

These internal / external relationships were parallel to those inherent in the Understanding Technological Approaches Project (Stables, 1997), which examined the relationship between the modelling strategies used by children (discussing, looking, drawing etc.) and the internal processes of their design intentions (generating, developing, planning, etc.). I had come to a similar way of viewing the judgements I was making on the children's drawings but from a different route: the need to make sense of the multiple layers of my analysis instrument. I was considering these as tentative ideas, worrying that it all seemed too neat to be substantiable, only to find that others had trod the path before.

***5.4.3b(i) The Purpose Continuum and the Drawing Types***

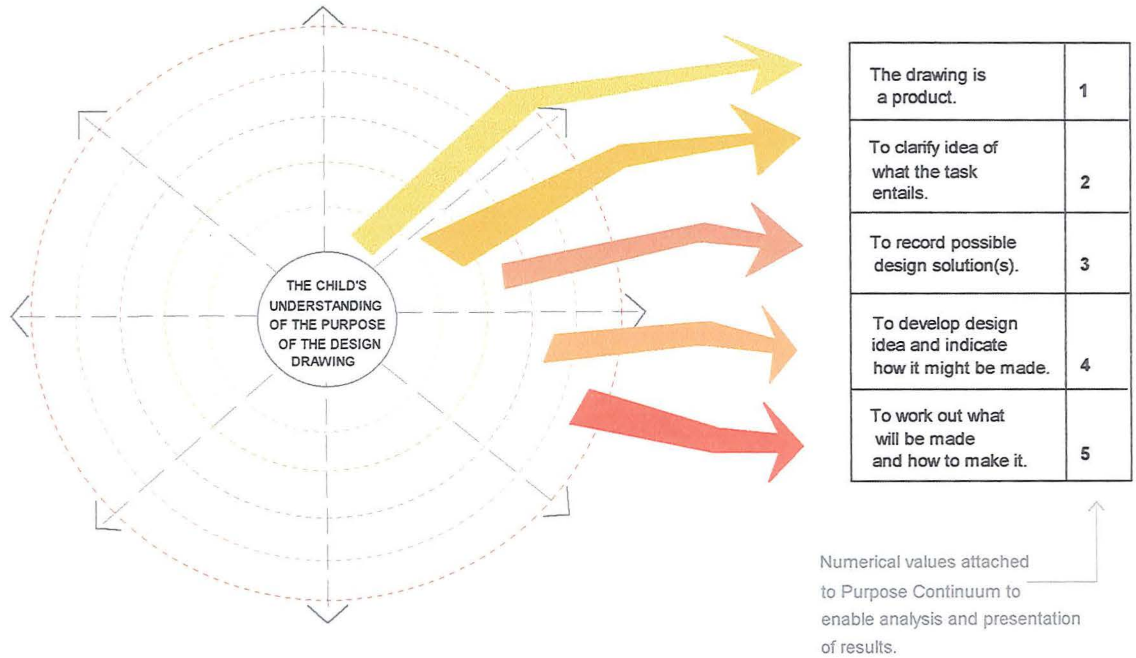



*Fig.56 : Transforming the Purpose Rings into a Continuum*

I had come to believe that the way in which children use drawing to support their design thinking is largely determined by their understanding of the function of the drawing within the process of designing. Making comparisons about how the children perceive the purpose of the drawing in each of the Assessment Tasks is, therefore, probably as much a measure of how the children perceived the *usefulness* of drawing to support the task in hand as a measure of their perception of the role of drawing in designing per se.

*Table 13a :The Purpose Continuum (see also Appendix N: AN2.5)*

| 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| No drawing | Views the drawing as the product | Clarifying their idea of what is to be made | Using drawing to record design possibilities | Develop idea and indicate how it might be made | To work out what will be made & how |

*Table 13b : Drawing Types*

| Drawing Type | | | | | | |
|---|---|---|---|---|---|---|
| No drawing | Picture | Single-draw | Multi-draw | Multi-design | Progressive | Interactive |

Placing the Drawing Types below the Purpose of Drawing Continuum shows how the two might relate to one another. The assumption could reasonably be made that more sophisticated Drawing Type would be paired with a more sophisticated understanding of the Purpose of drawing for designing, and vice versa. It would be expected, therefore, that viewing the drawing as product would relate to either a Picture or Single-draw; clarifying ideas to Single or Multi-draw; recording design possibilities to Multi-draw or Multi-design, developing the idea to Multi-design or Progressive and, finally, working out what would be made to Progressive and Interactive. The results of this comparison are detailed in Section 5.6.2.

The advantage of this holistic model based on the child's understanding of the Purpose of the Drawing was that it cut through the problems inherent in the non-linearity of the Drawing Types classification (and what I now thought of as the "muddle in the middle" of Multi-draw, Multi-design and Progressive categories) and the reality of children using drawings appropriately differently in response to different tasks. Multi-draw straddles Clarifying and Design Possibilities, allowing it to be more than a Single-draw but still clarifying the problem without developing the idea, yet it can also recording a design possibility because the child is doing more than just the tokenism inherent in the Single-draw. For Multi-design it allows for both the almost random brain-storming and the multiple discrete ideas for which a connecting thread can be seen.

Fig.57 shows how this relates to the Container / Journey metaphor :

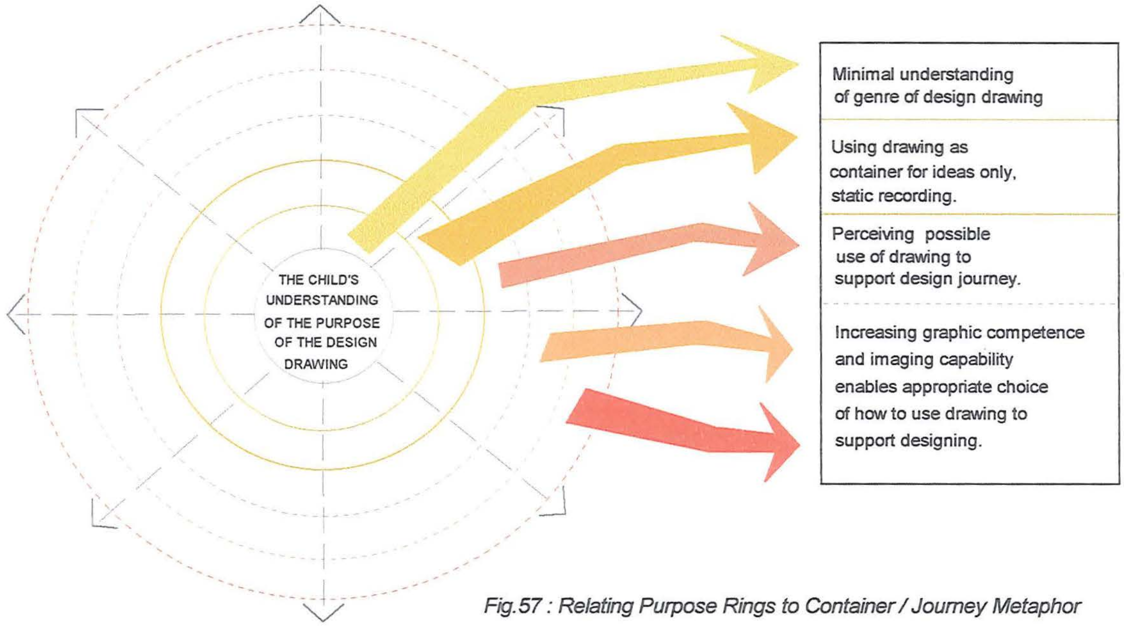



*Fig.57 : Relating Purpose Rings to Container / Journey Metaphor*

Solid lines indicate plateaux of understanding. The two innermost rings represent a static use of drawing, with limited relationship to the designing and making of a product. The red shade rings indicate a growing understanding of how drawing may be used to progress design ideas and thus records a design journey.

***5.4.3b(ii) The Dimensions Continua***

The same quantification was applied to the descriptors on each spoke of the Dimensions Wheel (Fig. 58), with each ring relating to a level of understanding:

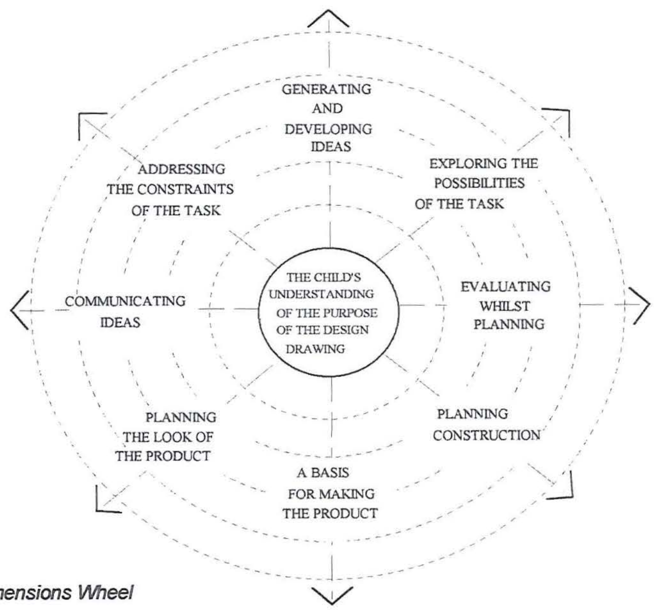



*Fig.58 : Rings on the Dimensions Wheel*

These descriptors formed the Dimensions Continua, to which numerical values were applied, as indicated in Table 14, overleaf, and also Appendix N: A2.5). Comparison with the Grids in Sections 5.4.1 - 2 and Appendix N will reveal how the Continua relate to earlier iterations of the Assessment Instrument

The relationship between the child's understanding of the *purpose* of drawing for designing and the way in which they *use* drawing to support designing as measured on the Dimensions can be seen by reading down the Continua. Thus a child who appears to be in Band 1 of the Purpose of Drawing Continuum will probably demonstrate many of the characteristics in Band 1 of the Dimensions Continua. However, it would be too simplistic a notion to expect that many children would fall neatly into the same Band for all aspects of their work, especially as their understanding develops. The degree to which the children's Dimensions Continua scores related to the Purpose Continuum scores is considered in Section 5.7.3.

*Table 14 : The Dimensions Continua*:

***Generating and Developing Design Ideas***

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Drawing a picture, not designing a product | Simple sketch, showing object to be made | Design ideas generated but not developed | Progression of ideas across or within drawings | Uses drawings reflectively to generate new ideas |

***Exploring the Possibilities of the Task***

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Design possibilities are not addressed in the drawing | Stereotypical response, showing little creative thought | Recording possible creative solution(s) to the task | Using drawing to develop novel design solution(s) | Combining novel solutions to produce innovative design |

***Addressing the Constraints of the Task***

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Minimal understanding of task / user needs | Drawing shows some understanding of task constraints | Records way to address task &/or client needs/ wants | Task constraints considered as the design proceeds | Task constraints treated as part of iterative process |

***Planning the Look of the Product***

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Appearance of a product is not considered | Little consideration of final appearance of product | Overall decorative scheme considered | Ideas about finishes are added to design whilst drawing | Ideas about finishes develop within overall designing |

***Communicating Design Ideas***

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Use of narrative or other drawing genre | Simple unlabelled sketch(es); relying on shared meanings | Conveys some sense of the object to be made; e.g. indicates materials | Conveys sense of object to be made; e.g. working diagram | Clear enough for someone else to make the product |

***Planning Construction***

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Not planning to make the object as drawn | Minimal consideration of construction whilst drawing | Drawing indicates some consideration of construction | Drawing demonstrates consideration of construction | Constructional issues considered en route to final design |

***Evaluating whilst Drawing***

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Yet to define the design task | Minimal evaluation at drawing phase | Considered and rejected a range of ideas | Decisions made about product whilst drawing | Changes made as result of considering design drawings |

***A Basis for Making***

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Making an object is seen as separate new activity | Product relates to ideas recorded in the drawing | Object is one of the ideas drawn | Clear development path through drawing into making | Using drawing as resource during making |

***5.4.3b(iii) The Techniques Ticksheet***

The Ticksheet reverted to being a record of the techniques used by the children in the recording of design ideas through drawing. Having split this into headings relating to the Aspects as perceived under previous versions of the Grid, there needed to be some re-arranging of the way the data were to be collated but fortunately no re-assessing of children's work.

Although less problematic in terms of development, and therefore having had few words devoted to it, the Ticksheet frequently recorded the detail on which was based the decision as to where to place work on the Continuum or the Grid. The more holistic decisions were not made on the basis of intuitive "feel" but on the basis of the firm evidence of the content of the children's drawings. During the checking and collating process, it was frequently the individual Ticksheets that were consulted to verify that equal credit was being given to equal work. Recording related information in two different formats (Grid and Ticksheet) aided consistency of judgements made about the drawings across tasks and children.

Overleaf is shown Table 15, The Techniques Ticksheet (Version 2), to be found also in Appendix N : AN2.4.

The results from the analysis of the techniques used by the children based on the analysis of the Ticksheet results can be found in Section 5.8.

*Table 15 : The Techniques Ticksheet*

| GENERATING AND DEVELOPING |
|---|
| single drawing of a product to be made |
| single idea recorded as working drawing |
| more than one attempt at drawing same idea |
| develops single idea into a working drawing |
| range of ideas recorded as quick sketches |
| range of ideas, one developed towards making |
| range of ideas, some developed towards making |
| progression of ideas across drawings |
| drawings combined to generate new ideas |
| combines ideas to produce best solution |

| SATISFYING CRITERIA |
|---|
| ***as set by teacher*** |
| begins from task requirements |
| drawing used to address task |
| aware of task constraints and possibilities |
| maintains task requirements into making |
| ***as required by client/user*** |
| begins from client/user needs |
| maintains awareness of needs whilst drawing |
| several ways of satifying client/user's needs |
| increasingly focuses on satisfying needs |
| maintains client/user needs into making |

| COMMUNICATING DESIGN IDEAS |
|---|
| ***relationship between pictures and words:*** |
| use of appropriate drawing genre |
| pictures only |
| single words or phrases relatiing to picture |
| thinking recorded mostly in pictures |
| thinking recorded mostly in words |
| equal weighting between words and pictures |
| labelled diagram (with) arrows or lines |
| list (e.g. of materials) |
| full sentences to describe planned product |
| instructions - words only |
| instructions - pictures with few/no words |
| instructions - labelled diagrams |
| ***clarity of drawing:*** |
| not relying on shared meanings to interpret d'ing |
| conveys sense of object to be made |
| clear enough for someone else to make product |
| ***level of detail:*** |
| sufficient level of detail |
| not inappropriately over-detailed |
| shows dynamics/movement |
| various viewpoints |
| expansions to show small details |
| cut away diagram to show inside of product |
| indicates how parts will fit together |
| ***detailing finished appearance:*** |
| indicates picture, pattern or motif |

| PLANNING CONSTRUCTION |
|---|
| ***recording materials:*** |
| indicates materials by list |
| indicates materials within sentences |
| indicates materials by drawing |
| indicates materials by labelling drawing |
| materials indicated are suitable |
| materials indicated are available |
| ***recording construction:*** |
| indicates cuts, folds &/or fixings |
| indicates measurements |
| indicates equipment needed |
| indicates parts to be assembled |
| ***if construction planning suff. recorded:*** |
| technically realistic (child can make it) |
| can be made in time available (roughly) |

| EVALUATING WHILST DRAWING |
|---|
| attempts to improve drawing of single idea |
| considered a range of ideas |
| adaptations made to single initial idea |
| adaptations made to one of two/several ideas |
| changes related to appearance of product |
| changes related to task specification |
| changes related to client/user needs |
| changes related to material constraints |
| changes related to construction issues |
| justifies choices made |

| RELATIONSHIP TO MAKING |
|---|
| ***same as drawing:*** |
| same object (single drawing) |
| one of objects drawn (multiple drawings) |
| same colour |
| same proportions |
| same pattern, decoration, picture etc |
| same materials |
| same fixing technique |
| ***different from drawing:*** |
| different object |
| different colour |
| different proportions |
| different pattern, decoration, picture etc |
| different materials |
| different fixing technique |
| reasons for changes apparent |
| ***adapted from drawing:*** |
| adapted object |
| adapted proportions |
| adapted pattern, decoration, picture etc |
| adapted materials |
| adapted fixing technique |
| reasons for changes apparent |

### 5.4.4 Summary of Section 5.4

The redefinition of the analysis instrument in the light of Pascal and Bertram's holistic child-centred view of quality evaluation had given me a much needed transformation of my perspectives on the children's achievements. It meshed with my view of child-centred education and provided a more holistic model for the assessment of the children's design drawings. The Continua could still be analysed by spreadsheets and radial plots could be used to display the results in a format that reflected the structure of the model.

As appears often to have been the case, the strands which came together to create the final analysis instrument were things that I had perceived, put to one side and then picked up again and re-combined when I found that I already had the elements of something useful. The creation of the analysis tool for the quantified data had taken over two years. It had needed testing on the real data to find where it fitted and where it did not, as well as being subjected to moderation and theoretical evaluation. Dealing with these issues not only transformed the analysis instrument but also how I viewed the analysis of my data.

# 5.5 Understanding the Purpose of the Design Drawing

To aid readability, certain conventions have been adopted and used consistently throughout Sections 5.5 - 5.9:

- In all charts with shared borders, the axes legends are directly below the chart title,
- The number of children is indicated as n=sample number,
- The sample size on the charts is expressed as percentages,
- The colour conventions are as indicated on p.14 in the Content Table.

As indicated in Sections 5.4.2a and 5.4.3, I had come to realise that the child's understanding of the purpose of the design drawing was central to the way in which they used drawing to support the development of their design ideas. Therefore, this became the primary criteria on which the drawings from the Assessment Tasks of the Structured Phase were analysed.

By examination of each drawing, supported by Log Book notes, photographs, video and audio recordings, the children's understanding of the purpose of the drawing in each Assessment Task was ascertained according to the criteria on each ring of the holistic analysis model (Section 5.4.3b) as agreed by my moderation panel (Section 4.2.3).This was converted to the numerical equivalents indicated in Table 13a and recorded on individual child spreadsheets. These numerical data were collated into class spreadsheets, from which the charts shown in this section were produced (see Appendices N & O).

## 5.5.1 Comparing Class Profiles

Comparisons were made between the classes on both a means and range basis. The mean score for each class' score on the Purpose Continuum for each task was calculated and compared. This is presented as a radial plot in Section 5.5.1a, below. The ranges of results for each tasks are displayed as bar charts to show the percentage of children within each band of the continuum in Section 5.5.1b.

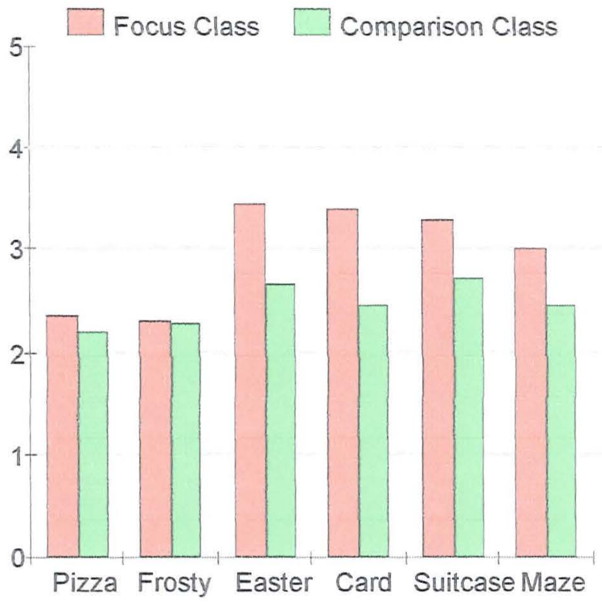
### ***Section 5.5.1a Mean Scores***

Chart 5 overleaf (created from the spreadsheet in Appendix O: AO1, Sheet 1) shows the mean scores for each class on the Purpose of Drawing Continuum, from which the difference in understanding between the two classes can be seen. The mean score for each class for both

Pizza and Frosty tasks demonstrate similar levels of understanding of the purpose of drawing for designing in both classes, both in product design and problem scenario tasks. The slight differences can be accounted for by the micro-factors of individual variations in capability and even, perhaps, who was absent on the day.

***Chart 5 : Means of Purposes of Drawing Scores***

| **Conversion of Purpose Continuum to Axis of Plot:** | | | | | |
|---|---|---|---|---|---|
| No drawing | Views the drawing as the product | Clarifying their idea of what is to be made | Using drawing to record design possibilities | Develop idea and indicate how it might be made | To work out what will be made & how |
| 0 | 1 | 2 | 3 | 4 | 5 |




That the Focus Class made little progress between Tasks 1 & 2 helped to allay my fears about the "me factor" in the situation. It demonstrates that there was nothing special about my teaching style or way of doing Design and Technology that would necessarily make this group of children perform considerably better than the Comparison Class being taught by my highly competent colleague, Miss N. The results of both tasks are consistent with my expectations based on observations of Year 2 children in the Exploratory Phase.

Immediately after the explanation of the Container / Journey metaphor, however, the Focus Class children demonstrate a great leap forward in understanding, whereas the Comparison Class made only a slight gain, perhaps due to the difference between the Frosty and Easter Egg Holder tasks. The progress made by the Focus Class at Easter takes them clearly into the next band of the Purpose Continuum. Rather than using drawing to clarify their idea of what is to be made, they using drawing to record design possibilities and moving towards developing these ideas, indicating how they might be made. This difference in understanding between the two classes is maintained across the rest of the Programme.

It would be difficult to account for this outside of Programme effects. If there was a difference between my teaching ability *per se* and that of Miss N., then there would have been a difference in the two classes for the Frosty task, as this occurred three months into the Programme but before the Container / Journey input. That the differences between the classes continues across the subsequent Tasks, all with different demands and expectations, demonstrates that real understanding and shift in the children's perception of the function of drawing for designing had taken place.

***Section 5.5.1b The Range of Results***

Chart 6 (created from Sheet 2, Appendix O: AO1) overleaf shows that:

*a)* most children in both classes began with some understanding of the purpose of drawing in a design context, both for a problem scenario and a product design;

*b)* at Easter, most of the Focus Class children used drawing to record and develop design possibilities, whereas in the Comparison Class the percentage who did so is off-set by those who are still using drawing simply to clarify their ideas;

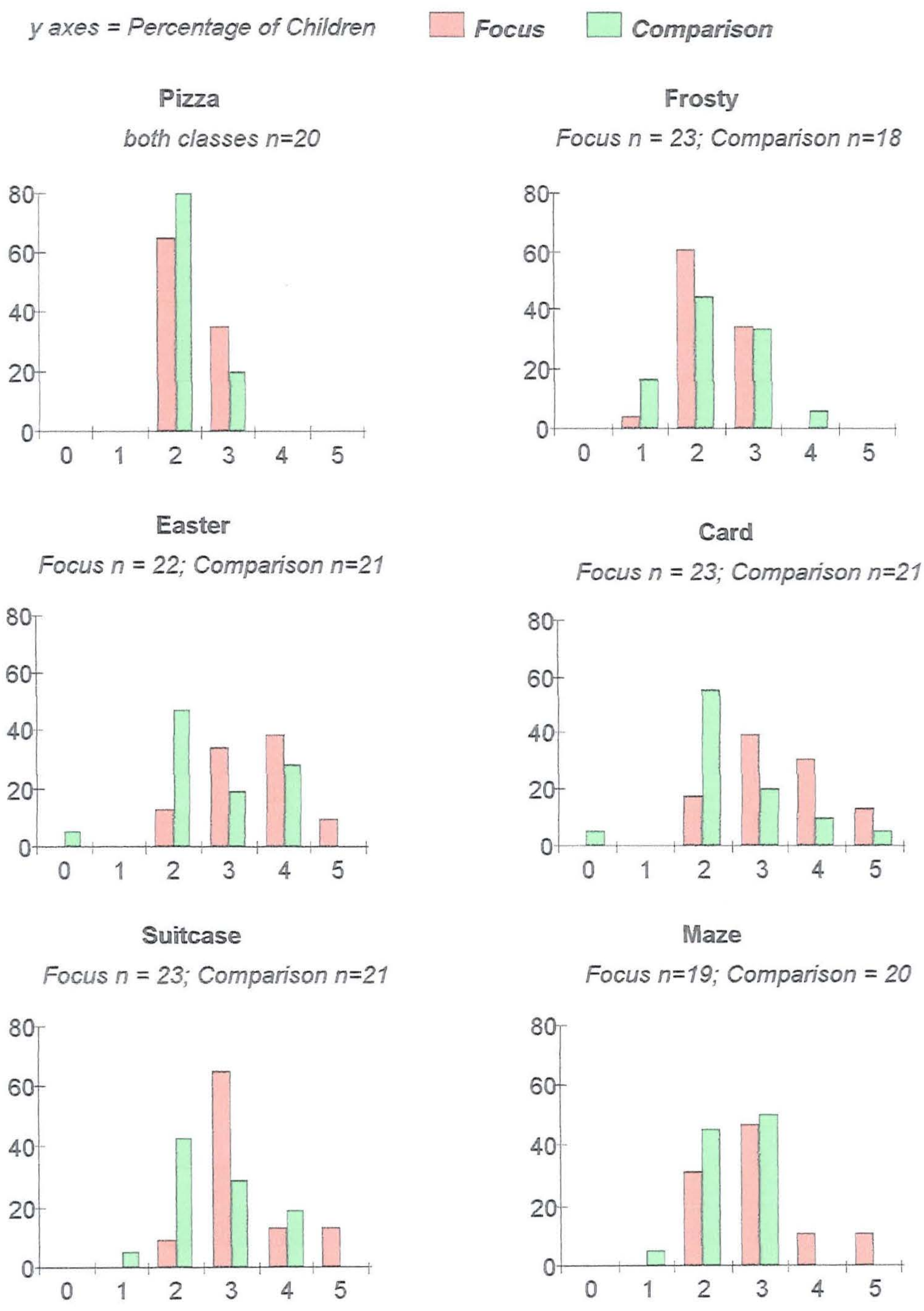
*c)* in the more structured task Card, the Focus Class were using drawing for designing, whereas in the Comparison Class just over half of the children used the drawing to record an "intent to make one of these", clarifying but not developing design ideas;

*d)* for the Suitcase, the majority of the Focus Class used the drawing to record a range of ideas, place-marking their design options, with a group of higher achievers developing ideas towards making. Nearly half of the Comparison Class have not moved beyond recording a simple sketch, defining the task as "making a suitcase";

*e)* for the Maze, a roughly equal number of children in each class used drawing to record design possibilities. It was what the others did that made the difference. No one in the Comparison Class did better than this; whereas only a third of the Focus Class children used drawing for clarification without development.

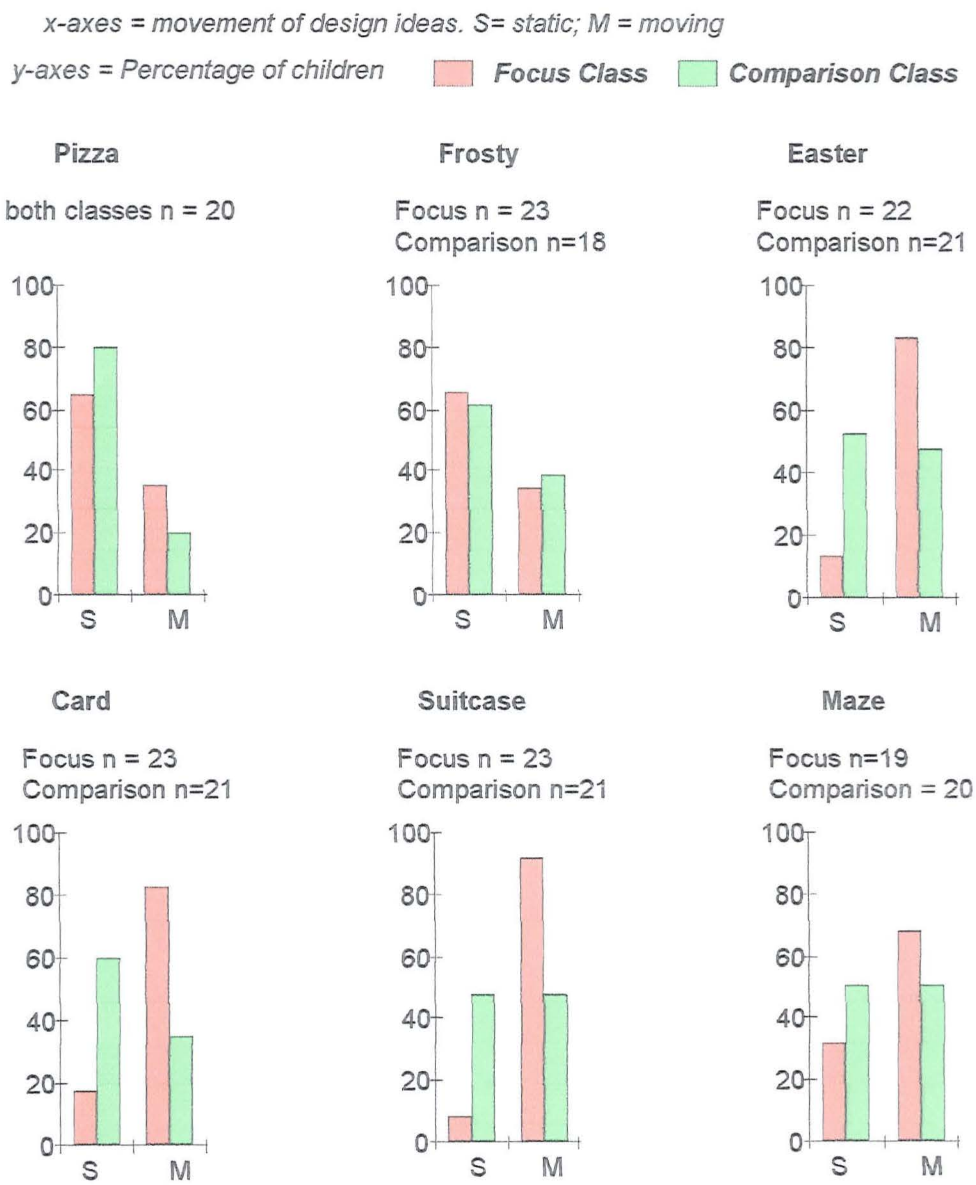
*Chart 6 : Purpose of Drawing Profiles*

| Conversion of Purpose Continuum to X-Axes: | | | | | |
|---|---|---|---|---|---|
| No drawing | Views the drawing as the product | Clarifying their idea of what is to be made | Using drawing to record design possibilities | Develop idea and indicate how it might be made | To work out what will be made & how |
| 0 | 1 | 2 | 3 | 4 | 5 |



From Frosty onwards, at least 40% of the Comparison Class still remain at the stage of using drawing to clarify what it is to be made and do not use drawing to develop design ideas. The difference between the two understanding of the way in which drawing can be used to support ideas development can be seen in Chart 7 by splitting the Purpose Continuum into "static" (Categories 0-2, i.e. *No drawing, Drawing as Product* and *Clarifying*) and "moving" (Categories 3 - 5 : *Design Possibilities, Developing Ideas* and *Working out what and how*):

***Chart 7 : Developing Design Ideas***



The radical sustained change amongst the Focus Class children at Easter, which is maintained across the product design tasks supports the hypothesis that the Container / Journey metaphor was understood by these children and that they learnt to use drawing to support the development of their design ideas. The Comparison Class bars show a gradual increase in understanding, as one would expect across such a length of time but, at most, only half the class' drawings showed any sense of design development on any one task. Despite the unfamiliarity of using drawing for a problem scenario rather than a product design, three-quarters of the Focus Class children still exhibited a sense of movement of ideas across their drawings for the Maze. The Comparison Class remained evenly split, presumably perceiving no difference in the way drawing might be used in either type of task.

## 5.5.2 Developing Understanding over Time

To ascertain the extent to which the children's understanding of the purpose of drawing for design progressed across the course of the Programme, analysis was conducted at individual child level. Since I had observed that children were using drawing differently in problem scenarios (Frosty and Maze) to the product design tasks (Section 5.2), the results were analysed separately. The hi-lo charts (Chart 8 overleaf, for which Appendix O: AO1.2 shows the numerical data) were created to demonstrate this development over time, using data from the quantified analysis of the drawings from the first and last task of each type. This is not a pre- / post-programme comparison, since the Suitcase task occurred part-way through the Programme, not at the end, and Frosty did not come at the start. However, each pair of tasks were roughly equidistant in time (Pizza - Suitcase 10 months, Frosty - Maze 12 months).

The Assessment Tasks increased in difficulty over time, to keep pace with the children's maturity across the 15 months of the project, so that a retrograde step on the chart does not imply forgetting or regressing. It is more likely that the child has not been able to apply their understanding in new or more complex circumstances. As in indicated in Section 4.3.3, both Teaching Input activities and Assessment Tasks were tailored to the children's age at time of delivery, based on my experience as a teacher and the results of the activities conducted in the Exploratory Phase of the research.

The x-axes in Chart 8 represent each child in first name order for both classes but, due to absences, the tenth point, say, on each x-axis does not necessarily represent the same child. Only children present for both tasks on each chart were considered.

**Chart 8 : Changes in Understanding the Purpose of Drawing for Designing**

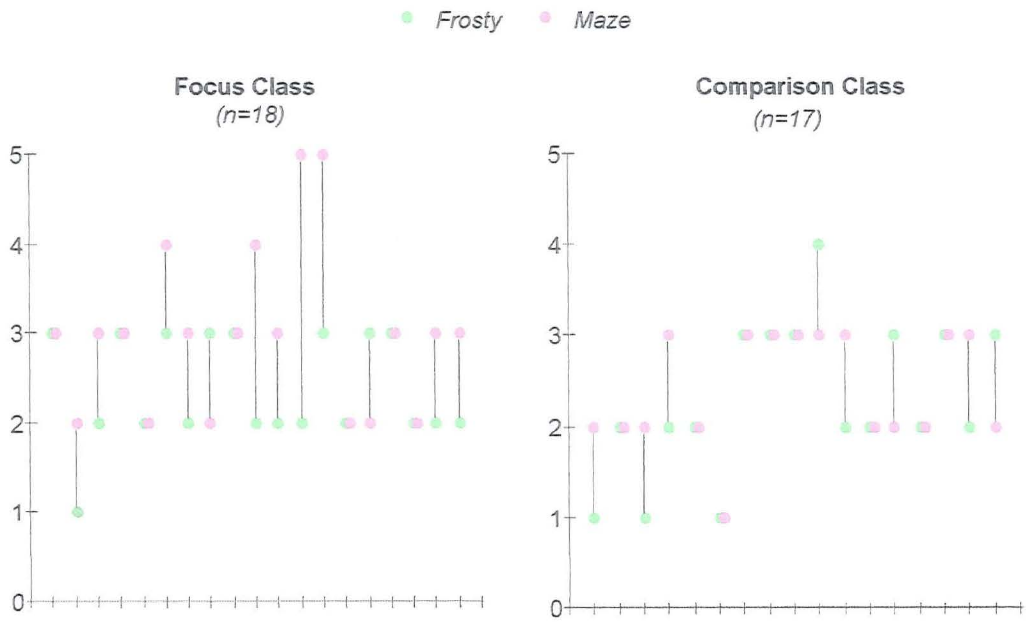
*x-axes = Individual Children*

*n = number of children present for both tasks represented on chart*

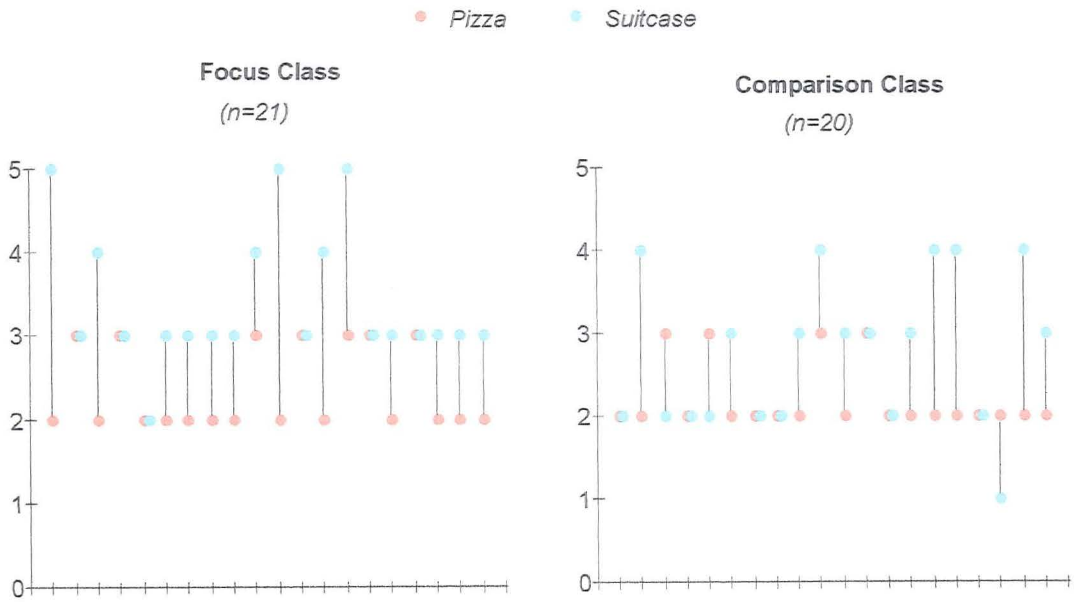
*y axes = Scalar equivalent of Purpose Continuum as per the following table :*

| Child's View of the Purpose of the Drawing | | | | | |
|---|---|---|---|---|---|
| No drawing | Views the drawing as the product | Clarifying their idea of what is to be made | Using drawing to record design possibilities | Develop idea and indicate how it might be made | To work out what will be made & how |
| 0 | 1 | 2 | 3 | 4 | 5 |

**Problem Scenarios**




**Product Design**

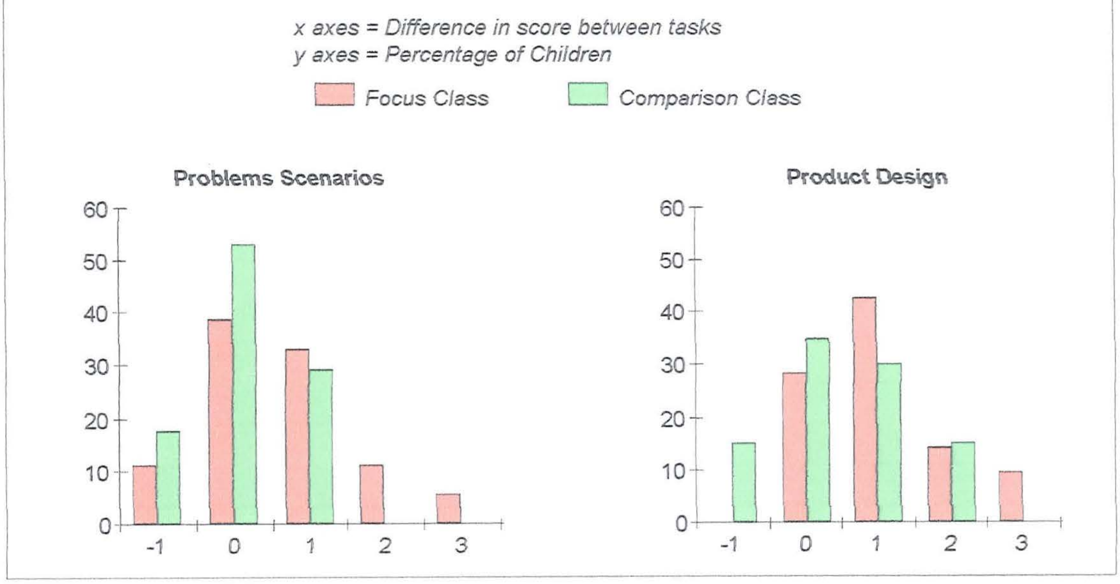


From Chart 8, it can be deduced that :

- there appears to be more progression of understanding in the product design tasks than in the problem scenarios, and in the Focus Class than in the Comparison Class;
- the most movement can be seen in the Focus Class' product design and the least in the Comparison Class' problem scenarios;
- the problem scenario chart indicates almost no change in Comparison Class' understanding of drawing to support thinking towards a problem solution. In contrast, some of the Focus Class have made considerable progress in understanding the use of drawing for problem-solving.
- the product design tasks: in the Focus Class, all but one of the children are using drawing in a designerly way, whereas only about half of the Comparison Class children have progressed beyond using drawing for clarifying the task

These results were compared by creating class profiles across each pair of tasks (Chart 9), to determine whether this would indicate that the Focus Class gained greater understanding of the purpose of drawing for designing than would be expected simply by maturity across the course of the 15 months of the Programme. This was a form of norm-referencing the two class samples, rather than comparisons to external criteria, since the variables within the tasks were not sufficiently controlled. However, in Chart 9 the profiles favour the Focus Class in both Problem Scenarios and Product Design.

*Chart 9 : Growth in Understanding at Class Level*




*Problem scenarios:*

The Comparison Class' profile represents roughly the expected outcome for tasks matched appropriately to the age and maturity of the children, delivered several months apart. The Focus Class' profile represents an increase in understanding of the purpose of design that is greater than that expected by maturity alone and, I would argue, represents the result of receiving the input delivered through the Programme.

*Product design:*

Both classes had considerably more practice in product design across the course of the Programme and it is clear that the Comparison Class are happier here. However, the two profiles still demonstrate a greater gain in understanding among the Focus Class children.

If one considers the Comparison Class as representing ordinary maturation and growth in understanding without specific teaching input about the purpose of design drawing, then these profiles would suggest that the Programme and the Container / Journey metaphor played an important role in developing the Focus Class understanding of the purpose of design drawing, that probably could not be deduced by the children without that specific teaching.

## 5.5.3 Emergent Themes from the Purpose of Drawing Analysis

Section 5.2 suggested ways in which the data could be examined in order to answer questions about the similarities and differences in the children's responses across as well as within tasks and this emerged as a key theme within the analysis of the children's understanding of the purpose of the drawing. This section examines the data from both cross-task and cross-class viewpoints.

### 5.5.3a Cross-task Comparisons

*Comparing Pizza, Easter & Suitcase for development in drawing for product design:*

From a position in which roughly three quarters of all the children used drawing to clarify to themselves the nature of the object to be made (Pizza), the profiles of the two classes for the two subsequent product design tasks develop not only differently in respect to each other, but also in respect to the two tasks. In the Comparison Class, nearly half of the children remain at this level of understanding. Even for the Suitcase, they produced a simple outline drawing of the object to be made. Nearly all of the Focus Class children moved on from this level. However, their use of drawing was different for each of the two subsequent tasks.

My initial reaction on viewing the results for the Suitcase was that they had regressed but consideration of the task with which they were presented reveals that they made task-appropriate decisions. For the Easter Egg Holder, the children were each given a card tube, which stood on their desk as they drew. They were asked to make this tube into something, consequently they used the drawing to develop ideas about how they might do this. They played with a range of ideas but their thoughts were firmly centred on using the drawing for the development of how to make the chosen one. For the Suitcase, they were shown a toy panda and his plastic mac and told that he needed them to design him something to carry his mac on holiday. Consequently, they recorded a range of travel bags with different patterns and logos and decided which was most suitable for Pandy. Decisions about which idea they could most easily make were made in their heads.

As part of the teaching input about Containers and Journeys, I had aimed to teach a level of understanding of the role of drawing and how it could support designing, that would allow children to use drawing as a tool for thought, as, when and *how* they felt it to be appropriate. The way that the Focus Class matched their use of drawing to differences within the product design tasks appears to suggest they were capable of making choices based on understanding of permission: not just what could be done but what they were allowed to do with the drawing.

*Comparing Frosty and Maze for development in drawing to support problem solving:*

Exactly a year separated these two activities. It would be expected, therefore, that the children's understanding of the use of drawing for designing would have moved on. For the Focus class, it can be seen to be so. Only a third of the class used drawing to clarify what a maze is, whilst an equal percentage used the drawing to move their ideas towards planning construction. In the Comparison Class, more children used drawing to record design possibilities than for Frosty, but this was by recording of several different mazes, not the development of a design idea in the sense of playing with or recording design decisions. This accords with the observations reported in the qualitative analysis (Section 5.3.1f) that the Comparison Class children had left too many issues about their mazes unresolved before making.

*Comparing structured delivery to less structured :*

The Card task was the only Assessment Task not devised by myself and also it was the only one for which a pre-printed design sheet was provided and for which the children were talked through the activity. In my Assessment Tasks, I explained the activity and then gave the children blank paper on which to try out ideas before they started making.

The Focus Class performed roughly at a similar level to Easter, with slightly more children producing a range of design possibilities rather than recording how they would make the product. Since they were given specific instructions to indicate how the Card might be made, I did not count *"It is made from card"* and a picture of a glue pot. There had to be a clear progression of ideas between Boxes 5 and 6 (see Appendix I).

It might have been assumed that this structured approach would have enabled the Comparison Class to do better than my blank paper. It could be argued that the Focus Class were now used to my way of working and that they would, therefore, perform better within any Assessment Task that fitted the pattern to which they had become accustomed. The Card task gave all children an equal opportunity to show their design understanding: it was a novel situation with an unknown presenter. This task would enhance the reliability of the Assessment Tasks results through this different perspective on children's performance.

As Chart 5 in Section 5.5.1a shows, both class' performance on the Card task is closely related to their performance on the Easter and Suitcase tasks. The Focus Class have maintained their enhanced understanding of the purpose of design drawing into unfamiliar territory. Many of the Comparison Class were still at the stage of using drawing to clarify their ideas and were not able to use drawing in any more sophisticated way, even when talked through the stages of product evaluation, identifying a client, generating ideas and planning construction. They frequently used the Planning Construction space (Box 6) to describe their drawing in Box 5.

### 5.5.3b Cross-Class Comparisons

*Similarities between both classes across all tasks:*

The majority of children from both classes had some sense of the purpose of drawing in a design context; there were very few children drawing pictures or not drawing at all. Equally, there were few children who were using drawing to work out in any detail how their idea would be made. This might be indicated in general terms but overall the children preferred to work out how to make their design solution once they had the construction materials in their hands. On all tasks, most children used drawing to clarify the task to themselves, record design possibilities or to develop an idea towards making.

*Differences in task responses, both classes:*

In problem scenarios, the tendency was for children to use drawing for recording possibilities about how the solution will be realised but their perception of the outcome of the activity *as a model*, means that they abandoned drawing for modelling in the construction media at a much earlier stage of their idea development than in product design tasks, where the desire to produce a pleasing artefact provided the incentive to think through production before beginning to engage with the materials. The higher achieving children perceived that drawing provides a means of supporting such planning.

*Differences in task responses between classes:*

Closer examination of the differences between the product design tasks suggested that Focus Class children appeared to able to use drawing differently according to the task parameters and thus have a sense of drawing as a tool whose purpose is to aid their designing. For example, for Pandy's Suitcase, confidence in their ability to make the bag meant greater use of drawing to explore type, shape and decoration than to develop construction methods. Most of the Comparison Class, however, did not appear to reach the level of understanding of design drawing at which they could manipulate the tool sufficiently to make such task-appropriate choices.

*Differences between classes regardless of task:*

At the start of the Programme, the average child in both classes was using drawing to clarify the task to themselves. By the end of the project, the average Comparison Class child was still doing this, in line with expectations from the Exploratory Phase. Splitting the Purpose Continuum into "static" and "moving" categories revealed that from Easter onwards (after the sharing of the Container / Journey metaphor) the majority of the Focus Class children were using drawing as a design tool.

Within the Focus Class there were a group of consistently high achievers who were beginning to use drawing to work out how their product might be made. The number of Comparison Class children doing this was small.

# 5.6 Drawing Types

Despite the re-defining of the analysis instrument in the light of my reading of Pascal and Bertram's (1991) and the realisation of the centrality of the child's understanding of the purpose of drawing in designing, I did not want to abandon the Drawing Types that I had identified during the Exploratory Phase of the research. in particular, I wanted to discover how these related to the child's understanding of the purpose of the drawing.

## 5.6.1 Analysis of Drawing Types Used

The range of drawings with which both classes presented me as a result of the Assessment Tasks stretched across the whole range of Drawing Types identified during the Exploratory Phase of the research (Section 3.3.5). There were, however, a much higher level of annotation among the Structured Phase cohort (analysed in Section 5.8.2c(i)). Within the Comparison Class, one child (Peter) wrote rather than drew in response to two Assessment Activities and there were several for whom the drawing served only as an illustration of their text.

The unlabelled Multi-Draw, which had been quite prevalent in the earlier study, was almost non-existent. Text was used to explain what their drawing was intended to illustrate rather than redrawing more carefully. This gave me many examples of Single-Draw-with-Text that I was initially unsure how to classify. Some of them were clearly in the Progressive category because the text extended the information contained in the drawing but others were static

I decided, therefore, that :

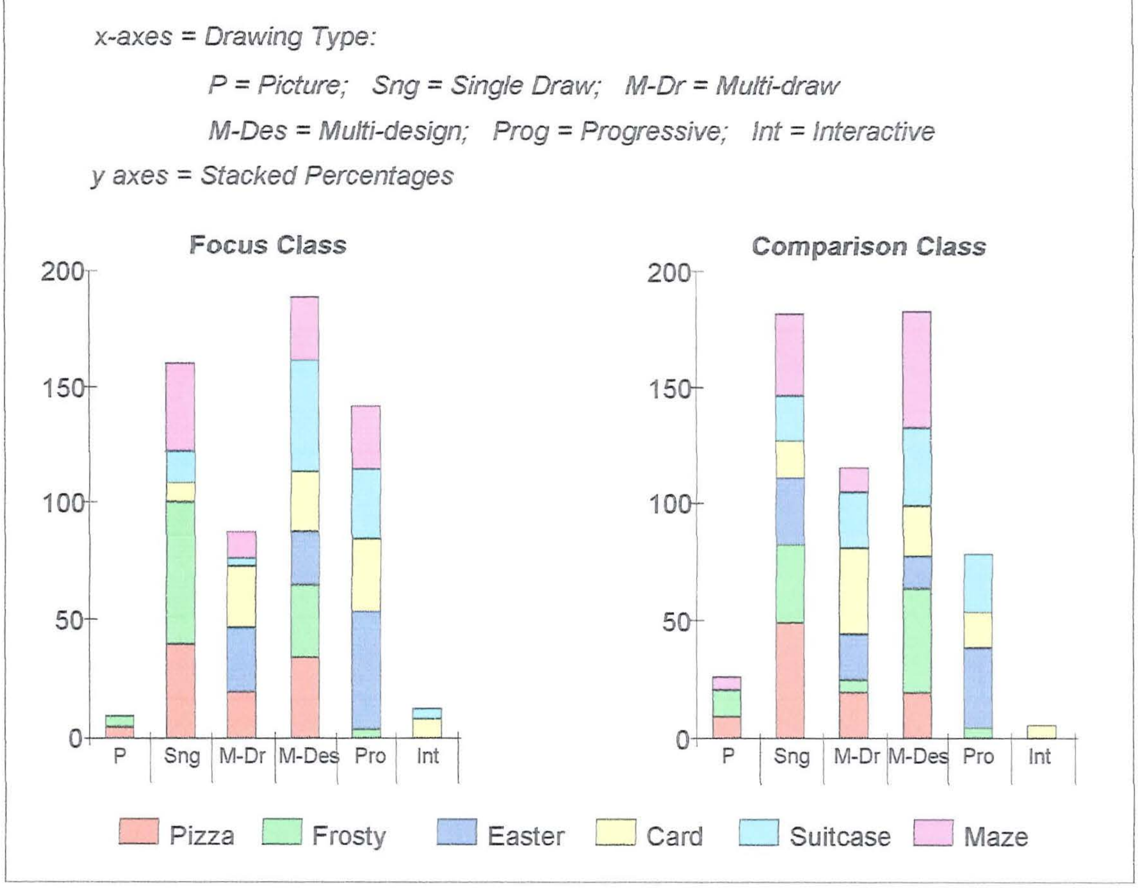
- *static Single-Draw with cursory labelling* would be designated Single-Draw,
- *Single-Draw with extending text* would be designated Progressive,
- *Single-Draw with explanatory text* (which did not extend ideas beyond that recorded in the drawing) would count as Multi-Draw since the children appeared to be using the text in place of redrawing.

Appendix O: AO1.3 shows the Drawing Type analysis as quantified data, based on Table 13b, Section 5.4.3b(i). This was necessary for quantified analysis. In the charts which follow, however, the numerals have been re-converted to the Drawing Types that they represent. The discussion of the analysis of the Drawing Types does so from two viewpoints: by Type and by Task. Each view illustrates different aspects of the children's choice of Drawing Type.

## 5.6.1a Viewing by Type

Chart 10, which represents this viewpoint shows *stacked percentages*, showing the overall use of the Drawing Types by each class.

***Chart 10 : Drawings by Type***




Drawing a *Picture* was rare, albeit more common in the Comparison Class. Thus, virtually all of the children understood something about the genre of drawing for designing, even if what they drew was not really informing their planning of an object to make.

*Single-Draw* was favoured by both classes for Pizza and Frosty. The Focus Class hardly used it for the later product design tasks (absent completely at Easter), although it re-emerges for the Maze problem scenario. Roughly equal numbers of Comparison Class children use Single-Draw in all tasks.

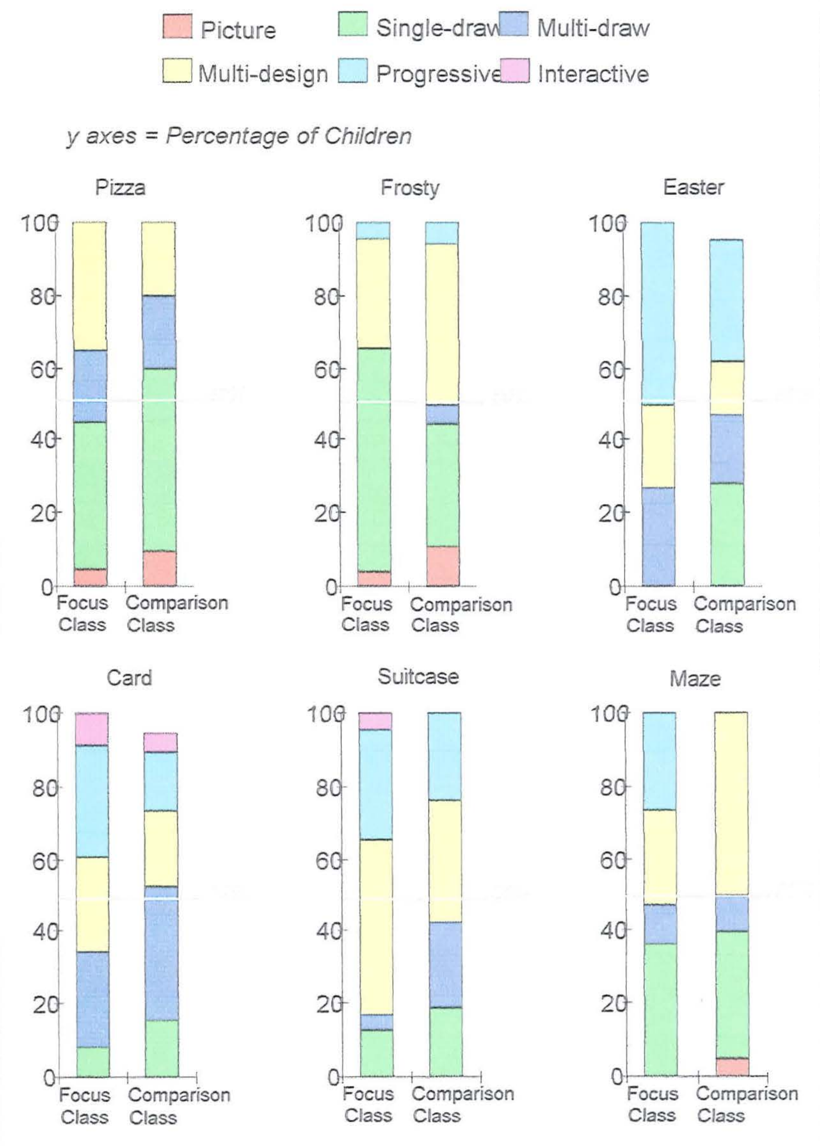
The lower incidence of *Multi-Draw* to support designing can be seen clearly. However, it was more common among Comparison Class children than in the Focus Class, suggesting that the Comparison Class were continuing to use the drawing to clarify the problem rather than develop a solution.

Similar numbers of children in both classes used *Multi-design* overall. In the Focus Class this seems to be spread evenly across all tasks, with just a few more for the Suitcase, whereas for the Comparison Class this was most prevalent for Frosty and Maze, the two problem scenarios. *Progressive* drawings are much more common among the Focus Class children from Easter onwards, including its use for the Maze (where it is completely absent in the Comparison Class). *Interactive* drawings are rare in either class.

## 5.6.1b Viewing by Task

The stacked percentages in Chart 11 do not exceed 100% as they represent the range of drawing types within each task. Those for the Comparison Class for Easter and Card do not reach 100% due to one child not using drawing at all.

*Chart 11 : Drawing Types by Task*



*Problem scenarios*: The balance of Drawing Types for Frosty and Maze is quite different among the Focus Class, whereas it remains almost unchanged within the Comparison Class. Far fewer Focus Class children use Single-draw for the Maze than for Frosty and Progressive drawings are strongly in evidence.

*Product design* : The interface between the first three categories (*Picture, Single-Draw* and *Multi-draw*) and the higher categories (*Multi-Design, Progressive* and *Interactive*) is very different in each class from Easter onwards. This distinction between categories represents a more sophisticated use of drawing for design, whether by recording options to consider or recording the development of one idea towards construction.

The 50% line has been indicated on the chart to enable appreciation of the difference between the classes in this respect and Table 16 compares the overall percentage of Single-Draw plus Multi-draw with those of Multi-design plus Progressive drawings for each class across all tasks. Since the Single-Draw and Multi-Draw Drawing Types represent the static, whereas Multi-design and Progressive involve the use of drawing to record and support the movement of design ideas, the Focus Class are strongly pitched towards movement. In terms of the Container / Journey metaphor, they are travelling.

| | **Focus Class** | **Comparison Class** |
|---|---|---|
| Single-Draw + Multi-Draw | 37% | 47% |
| Multi-Design + Progressive | 60% | 49% |

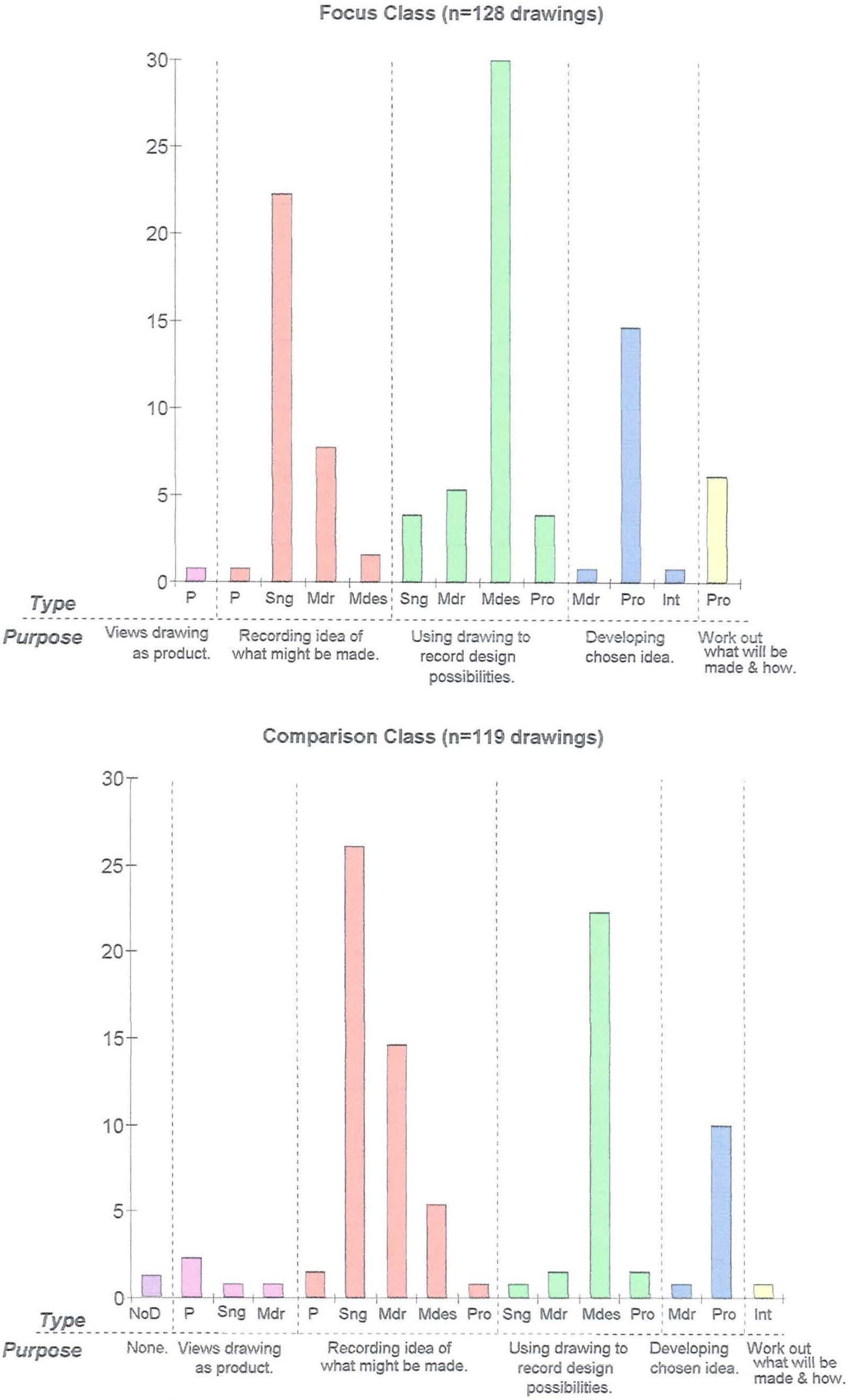
*Table 16 : Static Drawings vs. Moving ideas*

## 5.6.2 Relating Purpose Continuum to Drawing Types

That more a sophisticated understanding of the purpose of design drawing should result in a more sophisticated use of drawing seems common sense. To relate the Purpose Continuum to the Drawing Types, the two scales were placed alongside each other as shown in Section 5.4.3b(i). The Child's View of the Purpose of the Drawing represents a continuum on which the numbers are ordinal points on a scale not cardinal numeric values, whereas the Drawing Types are discrete and although there is a clear difference in the two ends of the Drawing Types scale, the middle ranges are not necessarily consecutive stages (as discussed in Section 5.4.2b). It is not surprising, therefore, that as shown on the chart overleaf, a range of Drawing Types were employed to support different understandings of the Purpose of the drawing.

***Chart 12 : Relationship between Purpose & Drawing Type***

*y axes = Percentage of Children*



This comparative activity acted as a useful double-checking device, as it forced me to re-consider categories and classifications of individual children's drawings as the range of Drawing Types used within each Purpose Continuum band became apparent. More importantly, it enabled me to separate my Drawing Types into Static (Picture and Single-draw) and Moving (Multi-design, Progressive and Interactive), which was a major advance in relating the Drawing Types analysis to the Container / Journey metaphor, with the corollary that bands 0-2 and 3-5 on the Purpose Continuum also fall either side of the watershed.

"*Viewing the Drawing as the Product*" was rare. Most children understood that they were to draw something that they were then going to make. However, on the Suitcase task, some of the Comparison Class children cut out their initial drawings and sellotaped them together to make the suitcase rather than using the paper for planning a product which was then made in card. These appear as the Single-draw and Multi-draw entries in this category.

*"Recording idea of what is to be made"* might lead to a Picture (for example, drawing Pandy carrying his suitcase) but it was more likely that this would be a Single-draw, or possibly a Multi-draw if the child were not happy with the first drawing or they might have redrawn to re-inforce to themselves that this was the object to be made. The Multi-design examples categorised here were those who showed just two ideas that were broadly similar and the Progressives showed very limited development of a single idea.

There was a tokenism in these children's drawings, which often masked the detailed discussion they had with peers about their ideas. They were developing design ideas but not using drawing to record them, consequently the details of their ideas were frequently forgotten by the time they had sought approval from the teacher and fetched their materials for construction. They were frequently clarifying the task to themselves rather than using drawing to develop a solution. The single idea, however many times drawn or well-labelled, is static, a statement of what might be made. Design possibilities implies fluidity of ideas.

"*Using drawing to record design possibilities*" emerged as predominantly the province of Multi-design, despite my determination to include well-developed (possibly labelled) Single and Multi-drawings here. Some children (especially in the Focus Class) produced a single line drawing (a Single-draw) which was so heavily annotated that it was clear that design development had occurred although the idea was not re-drawn.

"*Developing design possibilities*" could be as simple as re-drawing the same idea and annotating the second drawing (Multi-draw) but was most likely to be through Progressive drawings, where a clear thread of ideas could be seen, perhaps through instructions to make or detailing small parts. The production of a design drawing in which construction as well as a range of ideas were considered was extremely rare amongst these young children. There were some (Focus Class) who developed a single idea all the way through from rough sketch to annotated instructions. There was one child in the Comparison Class (Emma) who recorded a (limited) range of ideas for her card in Box 5, including evidence of combining ideas to produce a final design, and then used Box 6 to produce brief instructions.

Where ideas develop across the page in such a way, then they are clearly Progressive. In the final category (*"Working out what will be made and how"*) could be placed most of the best Progressive drawings from the Focus Class. Of those children who appeared to be using drawings Interactively, there was one who was not considering construction, although her ideas were being developed by mixing and matching previous ideas.

Completely missing was the production of a range of diverse ideas from which one was chosen and developed towards production. Those children who were in the Design Possibilities / Progressive band started with one idea and adapted it through several iterations. They did not follow through and record construction. Those who did record construction had chosen to record just one idea which they developed. It appears to be an either / or : record lots of ideas or develop just one.

The range of ways in which children might do this is best illustrated by examples:

Nicola (Comparison Class) produced a complete set of instructions for making Pandy a suitcase, drew a line under it and wrote *"another way to make a suitcase is"* and produced a second, unrelated set of instructions, almost as if by the time she had produced her first set, she had changed her mind. She did not make either.

Stacey (Focus Class) recorded three false starts for her Easter Egg Holder. Next to each of the sketches she had written *"First I will..."* as if she had started to think the first one through, rejected it, started again, and so on four times. She also made something different.

Jordan (Comparison Class) produced a Single-Draw series at Easter. He drew one idea, tried to make it and was unsuccessful and drew another idea and tried to make that, equally unsuccessfully and repeated this cycle again and then gave up drawing and made his Easter Egg Holder from all the parts left on his desk (the debriefing transcript in Section 5.3.1c accurately describes his process as observed). It was unique. No other child in the Exploratory or Structured Phase worked this way.

### 5.6.3 Comparison to 1998-9 Results

Informal observations of the children's drawings in the Structured Phase of the research indicated that there was greater sophistication in drawing technique overall than I had observed in 1996-8. The number of unlabelled Single-Draw and Multi-Draw examples was overall much lower than for Year 2 in the previous studies.

I think this was due to two factors. Firstly, my known interest in investigating Design and Technology, especially drawing, had given the subject a higher profile within the school. Secondly, the heavy stress on literacy which now pervaded Key Stage 1, through the introduction of Literacy Hour, meant that many children wrote a great deal, which was completely uncharacteristic of any of the 1996-9 children, regardless of age. Year 1 children were being taught the techniques of non-fiction genres for presenting information through labelled diagrams and lists and by Year 2 they were able to write instructions. This appears to have had a positive impact on the clarity of their communication of design ideas.

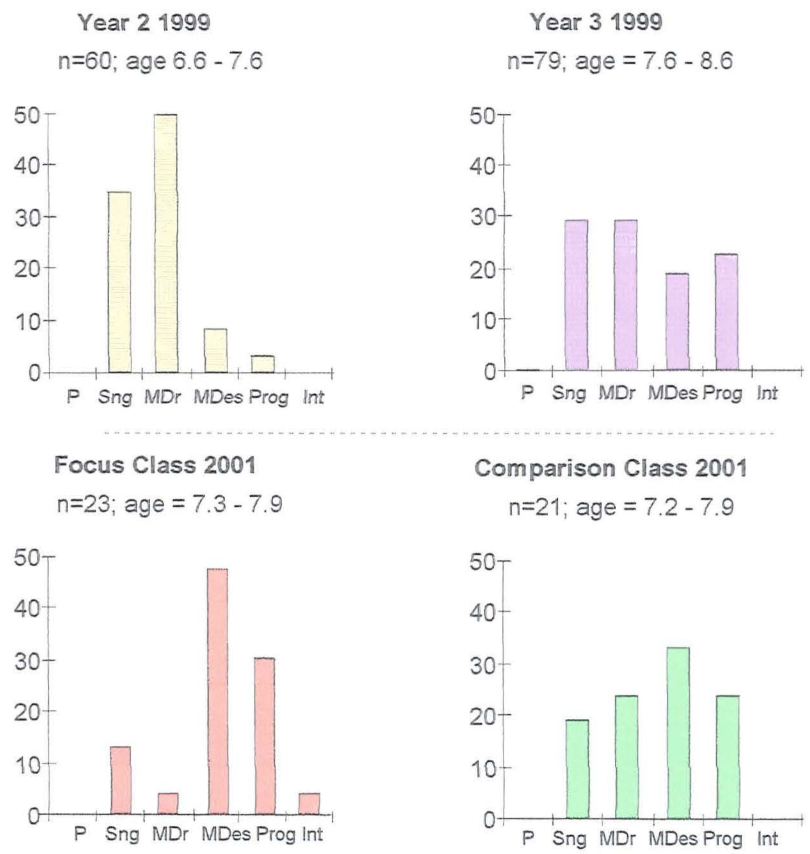
However, my instinctive "feel" of the Focus Class whilst teaching them throughout the Programme had led me to believe that they were performing more like Year 3s of previous experience. When I encountered the Comparison Class for the Assessment Tasks, they felt like Year 2s. This was especially so for Pandy's suitcase (which I had conducted as a whole school task in 1999). The Comparison Class children had similar misunderstandings as I had previously observed in Year 2 : single-sided card cut-outs, cutting up the design sheet, etc. Since I had whole school data on Pandy's Suitcase, I decided that this would be the best task to use for comparison between this cohort and the 1999 children. The comparison could only be done by Drawing Types due to changes in the analysis instrument between Exploratory and Structured Phases. Chart 13 (overleaf) shows the comparison between the 1999 data from the spreadsheet shown in Appendix N: AN1.4 and the data from Appendix O: AO1.3.

As can be seen from the ages of the children, the Structured Phase cohort straddled the Year 2 and Year 3 age ranges from the Exploratory Phase and the cohort size is very different, since for Pandy99 there were two classes of Year 2 and three of Year 3. However, useful comparisons can be made.

*Chart 13 : Pandy's Suitcase : Comparative Results*

*x-axes = Drawing Type: P = Picture; Sng = Single Draw; M-Dr = Multi-draw*
*M-Des = Multi-design; Prog = Progressive; Int = Interactive*

*y-axes = Percentage of Children*




I did not find it surprising that the Comparison Class' profile is closer to 1999 Year 3 than to 1999 Year 2. I had been aware that Design and Technology standards had risen across the school, which, as subject co-ordinator, I found pleasing. The overall spread of scores, evenly divided between Single-draw, Multi-draw, Multi-design and Progressives, would seem to be an expected outcome for 7-8 year olds in this school.

For the Focus Class, a very different profile emerges, which does not conform to expectations for Year 2 or Year 3. The predominance of the use of drawing to record design possibilities and to develop those ideas to indicate how they might be made is beyond expectations based on previous observations or the performance of the Comparison Class. This would strongly suggest that the Programme had made a difference to the way that they used drawing to support their designing.

## 5.6.4 Emergent Themes from the Analysis of Drawing Types

***Improvement on 1998-9***

The comparison between this cohort's results of the Suitcase task and that of 1999 showed an overall improvement in the sophistication of children's design drawings, as judged by their choice of Drawing Types. This was interesting because, although my instinctive "feel" of the Focus Class as I was teaching was that their performance was more like my expectations of Year 3, I had not perceived that the Comparison Class were more sophisticated designers than the previous cohort. Looking at the comparative chart reveals why: the Focus Class were using drawing in a more sophisticated way even than the Year 3s in 1999.

From a teaching perspective, especially in my role as Design and Technology Co-ordinator, this was heartening. Despite the pressures of the National Literacy and Numeracy Strategies, we had raised standards in Design and Technology. From a professional perspective, I had been concerned that Miss N. might feel that her teaching was being compared with mine. This result demonstrated her professionalism, that despite the pressures of being Mathematics Co-ordinator at the time of introduction of the Numeracy Strategy, she was able to provide her class with high quality learning experiences in a climate in which Foundation Subjects, and Design and Technology in particular, were being squeezed to the edges of school's priorities.

***Annotation***

The level of annotation of drawings was an important difference between the 1999 cohort and this present one. Neither Miss N. nor I had specifically encouraged the children to write on their drawings and yet they chose to do so. This added complications to the assessment. I had to make a conscious decision about whether to ignore this writing or to include it as part of the whole. There had been so little writing in the 1999 cohort that this had not really been an issue. But where writing had occurred, I had always considered it as evidence of design intentions.

I decided I must continue to consider writing as part of the whole. Firstly, because that the children often used labelling appropriately to clarify their intentions for my benefit or that the choice to write rather than draw was often based on common sense (making a list of materials is more sensible than drawing sheets of different coloured card), and secondly, most adult design drawings include words, for similar reasons to those of the children. I would, however, focus my attention on the graphics and not consider greater quantity of writing as automatically "better" just because it made the design intentions clearer. This was an important decision to make at this stage, prior to looking closely at the Dimensions of Design Drawing, especially Communication of Design Ideas, where readability could influence decisions over content.

### ***The Position of Multi-draw***

The Drawing Type which occurred across most Purpose categories was the Multi-draw. I had wondered at one stage whether I should eliminate this Drawing Type altogether. It was less common than Single-draw, Multi-design or Progressive and seemed to occur at the boundaries between Purpose categories. Several drawings were too detailed or well-labelled to be a classic Single-draw, but the added details clarified rather than extended the ideas. A neat row of Easter Egg Holders, all identical except for spots and stripes, hardly seemed to be Multi-design or "Recording Design Possibilities".

However, there were some Multi-draws which began to move ideas towards a design solution. Labels that were crossed out and changed or parts of drawings erased and redrawn differently bore witness to a movement of ideas, albeit slight. Frequently, the child would spend a long time on the first drawing, make quick changes and then go and fetch the materials to make the new idea. Ideas were on a journey but the drawing was performing a secondary role in supporting the final decision-making.

## 5.7 Dimensions of Design Drawing

The findings reported here are based on the analysis of the children's drawings based on the Dimensions Continua (Table 14) and collated via individual child collation grids (Appendix AN2.6) into whole class spreadsheets (Appendix AO1.4).

In the same way that the Drawing Type analysis was presented from two viewpoints to enable clarity of representation and discussion, so in this section too the discussion has been separation into analysis by task and by Dimension. The analysis by task (Section 5.7.1 "Developing Capability in all Dimensions over Time") uses radial plots (Dimensions Plots) to represent the data analysis, in line with the holistic model of design drawing (Section 5.4.3). This mode of representation is not used, however, as the basis of the cross-task analysis in Section 5.7.2 ("Comparing Capability in each Dimension across Tasks").

The abbreviations for each Dimension used on the charts in this section are as indicated here in Fig. 59, at the ends of the spokes of the Dimensions Wheels:

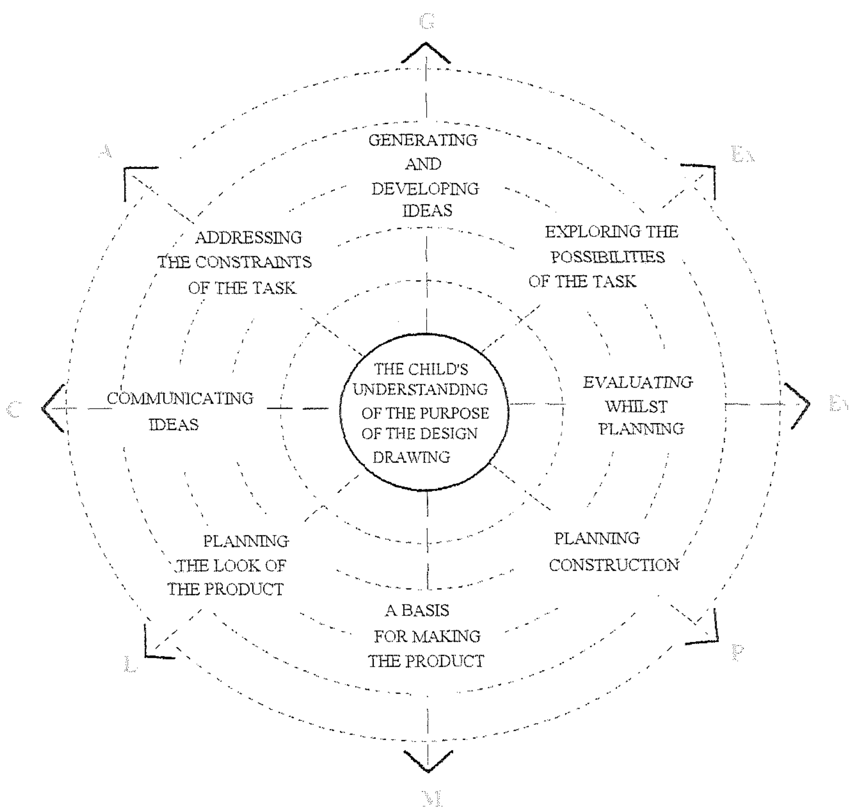
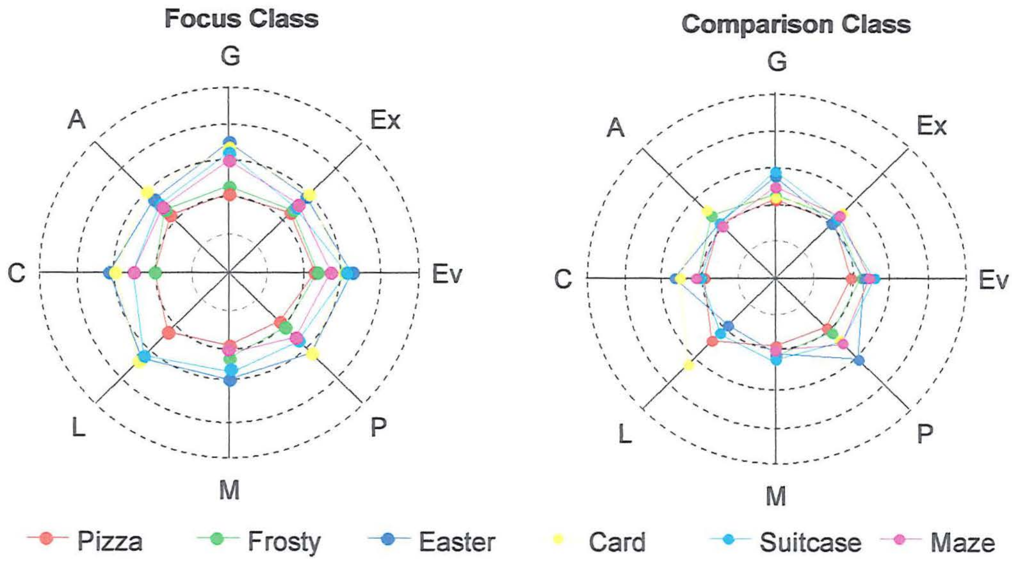



*Fig. 59 : Abbreviations for Reading Dimensions Charts*

## 5.7.1 Comparing Capability in all Dimensions over Time

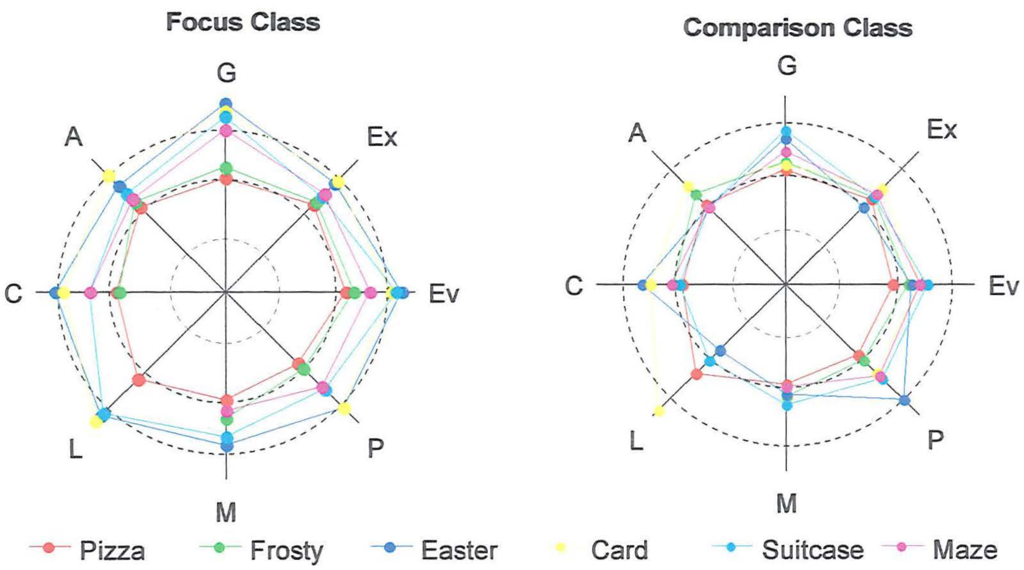
The information represented in Charts 14 & 15 was created from the spreadsheet in Appendix O : AO1.4 Sheet 1.

*Chart 14 : Dimensions : Mean Scores - all Tasks (a)*




An enlarged view of the three inner rings is used throughout discussion which follows:

*Chart 15 : Dimensions : Mean Scores - all Tasks (b)*



It can be seen from the Dimensions Plots in Chart 15 that (as represented by mean scores), that the understanding of the use of drawing for designing in the Focus Class has expanded across the duration of the Programme, whereas that of the Comparison Class has remained fairly constant except where specific task related instructions (Planning the Look of the Card) or taught techniques immediately prior to the task (Planning Construction at Easter) had enhanced their performance.

Assuming that each Dimension is of equal importance, the more circular the Dimensions Plots, the more balanced the use of drawing to support designing. The Focus Class plot gives the greater sense of growing, developing, balanced understanding. I think this suggests the growth of a more holistic understanding of design drawing than that represented by the Comparison Class plot, for whom there appears little overall pattern in their responses to the tasks, perhaps suggesting a developing facility with techniques without an overall understanding of the purpose of the drawing. The inference could be drawn, therefore, that a clear understanding of the purpose of drawing for designing enabled a more balanced development of the understandings inherent in the Dimensions. References are made back Section 5.3 to give context to the quantified analysis.

In Charts 16-18 on the following pages, separating out the Dimensions Plots for each Assessment Task (from the spreadsheet in Appendix O : AO1.4 Sheet 1) provides a view of developing capability that enables cross-task comparisons to be made. Juxtaposing the plots for Pizza and Frosty gives a sense of the starting points of each class. Then the mid-programme product design tasks (Easter, Card and Suitcase) are shown together and discussed and, finally, the Maze (as a problem scenario) is presented separately.

There is no Basis for Making score for the Card as the children did not make it.

Planning the Look of the Product (decorative features and/or logos) was not relevant to the problem scenario, so that this Dimension was not considered in the analysis of the Frosty and Maze tasks.

***At the Beginning of the Programme :***

*Chart 16 : Dimensions : Mean Scores (a)*

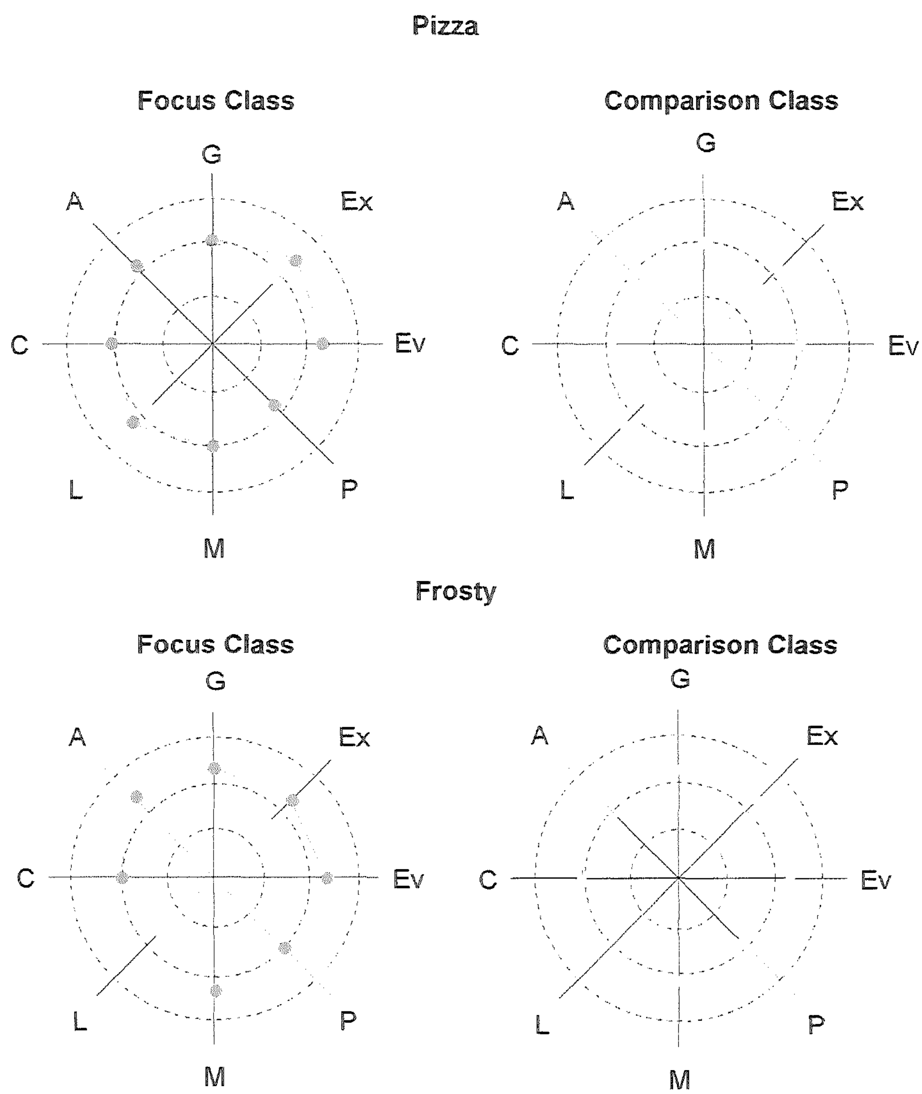
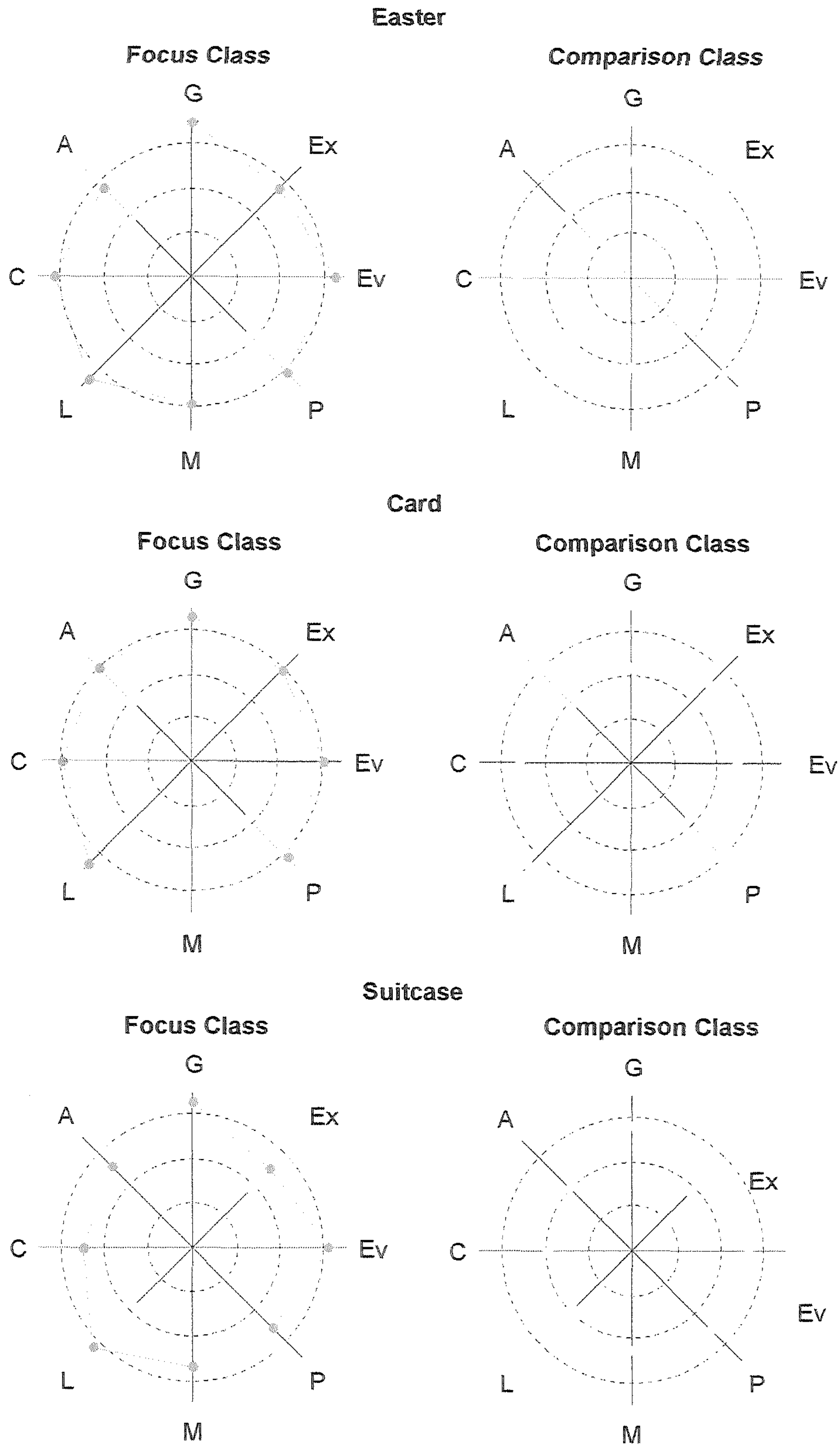



Chart 16 suggests that many children in both classes were drawing a simple, stereotypical sketch of an object to be made, relying on shared meanings for its interpretation. They showed some understanding of the task constraints and exploration of possibilities but little reflection on their ideas or changes made as they drew. The product related to the drawing but it could not truly be said that the drawing had formed a plan for making. Little attention was paid to arrangement of Pizza foodstuffs to enhance the look of the product.

***Mid-Programme Product Designs :***

*Chart 17 : Dimensions : Mean Scores (b)*



***Easter:***

Immediately after the Container / Journey metaphor input, the Focus Class' use of drawing for designing has developed considerably and equally across all Dimensions, as can be seen by the almost circular plot in Chart 17. The Comparison Class used drawing for Planning Construction equally with the Focus Class but this did not translate into the making. This might suggest that, although Comparison Class children knew to how to *record* construction, they were not *planning* construction, whereas Focus Class children were seeing the role of the drawing as a way of recording planning for making.

The Focus Class also showed greater facility in generating creative ideas, which they were beginning to develop towards a design solution (for example, Chicks, Bunnies' ears popping out, etc.), together with an acceptance of the constraints of the task (the egg needed to be supported inside the tube) in contrast to the Comparison Class' simple line drawings and free interpretation the task (for example, discarding the tube and building a tower for the egg to sit on top). The ability to reason creatively within the "rules of the game" emerges as a Key Theme across all strands of the Structured Phase analysis.

The clear differences that emerge at this point in the Programme indicate the immediate effect of the teaching input to the Focus Class through the Container / Journey metaphor. The Focus Class demonstrated a greater use of drawing to support their designing in all Dimensions apart from Planning Construction. One surprising difference was the Comparison Class children's lack of consideration of the Look of the Product. My assumption would have been that less capable designers would focus on this aspect of the task but many children produced single annotated line drawings in pencil which they ignored once they began making.

***Card***

The structured nature of the task enabled many Comparison Class children to give their best performance across more Dimensions than any other task. However, except for the decorative aspects of the task, they were outperformed by their Focus Class peers. Planning the Look of the Product was the most obvious feature of the task and what they were initially told to do. Hence both classes achieved well. However, there were important differences on other Dimensions.

The Focus Class generated a range of creative design ideas (on which they reflected and made changes), containing a surprise element, tailored to the preferences of their client, and conveying a sense of how the card would be made (materials and construction details). Comparison Class children tended to produce a simple drawing which represented a stereotypical response, less closely relate to the preferences of their client or the "surprise" theme (any card, rather than a surprise card for a specific person), yet recorded in my Log Book that the Comparison Class showed much keener interest in the examples they were shown. This lack of focus on specific problem-solving also impacted on their achievement in communicating ideas, planning construction and evaluating.

The similarity in performance of the Focus Class here to that at Easter suggests that they could transfer their learning to a new situation and thus were utilising domain-general knowledge. For the average Comparison Class child this was not so: the two profiles are quite different, suggesting a lower level of domain-general knowledge and that they were engaged in context-specific problem-solving.

***Suitcase***

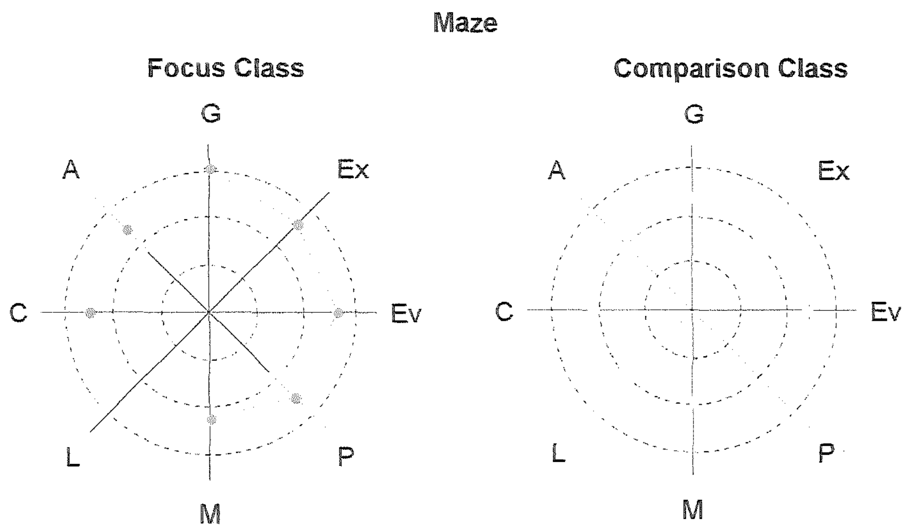
The parameters of this task were much tighter. If the Focus Class found it harder to Address the Constraints of this task, the Comparison Class found it even more difficult. The recording of plans on paper was dislocated from a real understanding of task constraints and was frequently ignored in the making of a product that did not satisfy the task criteria (hold this mac and be able to be held by Pandy).

At this stage the Focus Class children had a working definition of the purpose of the drawing that could be summarised as: it is a means of recording ideas about what they *wanted to make*, what is it going to look like when it is finished and having several attempts at improving and refining ideas. The Comparison Class, viewed the role of the drawing as recording an idea (or perhaps several ideas) of what *might be made*. The creative thought, consideration of decorative features, construction techniques and evaluative decision-making occurred once they were engaged with the materials. This lack of pre-planning ability is typical of children of this age and these comments are not made in criticism of the Comparison Class, rather, it highlights the mature way in which the Focus Class were using the design drawing to plan and refine their ideas before their engagement with the materials.

***Post-Programme Problem Scenario: the Maze :***

The trend continued into the final Assessment Task (as shown in Chart 18 overleaf): the Focus Class generating design ideas related to solving the problem whereas the Comparison Class were simply drawing mazes, as evidenced the higher scores for Generating and Developing Ideas coupled to Addressing the Task Constraints. In the Focus Class drawings, there was an attempt at conveying ideas about an object to be made (even if as simple as the word-label "string") that was absent from the work of their Comparison Class peer.

*Chart 18 : Dimensions : Mean Scores (c)*



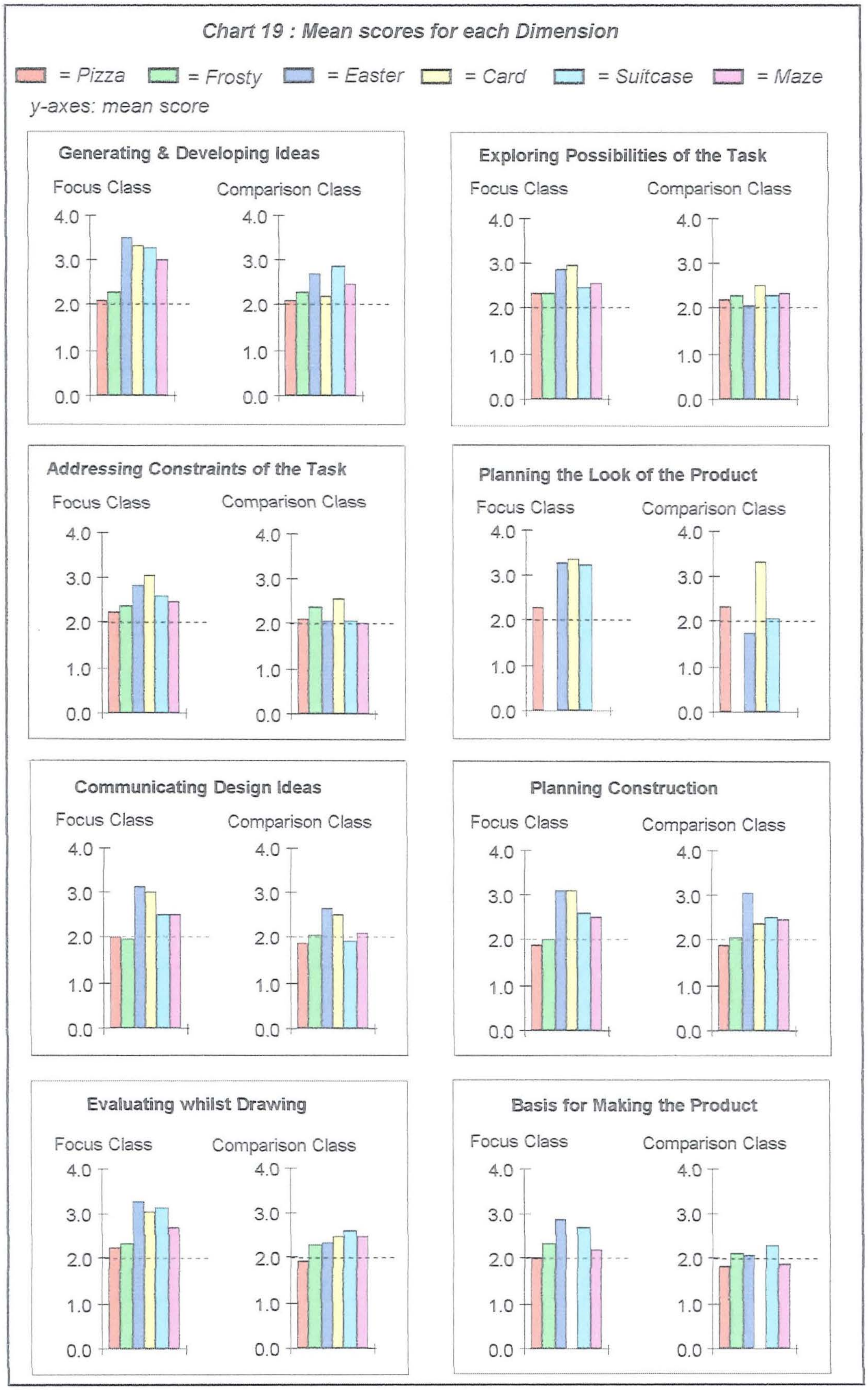

The level of evaluation whilst drawing and subsequent relationship of the drawing to the making shown in Chart 18 is also indicative of this difference between the two classes. Many Focus Class children thought about the product whilst drawing and made changes at the planning stage, so that there was a fairly close match between the plan and the product. The Comparison Class children, however, not only generated less ideas but were relating this to the reality of construction. This accords with my in-context observations (Section 5.3.1f) and the results of analysis on the Purpose of Drawing Continuum (Section 5.5).

Comparing the Dimensions Plots for Frosty and Maze supports my hypothesis that domain-general learning had taken place within the Focus Class (suggested also in relation to the Card), who demonstrated their ability to transfer learning to less familiar territory and to still outperform the Comparison Class. In contrast, in all Dimensions, the Comparison Class' use of drawing to support designing a problem solution is at a similar level to that of both classes for Frosty, near the start of the Programme.

## 5.7.2 Comparing Capability in each Dimension across Tasks

The results of this analysis are displayed overleaf as bar graphs in Chart 19, as this was felt to be a more appropriate display medium for cross-task data. As in the previous section, the unit of comparison is each class' mean score in each Dimension. Empty positions are left on the graphs when a particular Dimension was not relevant to a specific task.

## 5.7.2a Comparing Mean Scores for each Dimension




*Comments on differences between tasks are to be found in Sections 5.7b & c.*

*Generating and Developing Ideas*

The Focus Class appear to have learnt to use drawing more effectively to generate and develop ideas between Frosty and Easter, through being taught the Container / Journey metaphor. The slight slippage in subsequent tasks could be due to the fall-back position as levels of understanding take over from reproduction of recently learnt techniques. The Comparison Class do not reach an equivalent level of capability on any task and their learning profile has increased modestly across the year.

*Exploring the Possibilities of the Task*

Comparing the two classes' exploration of task potentials shows the Focus Class as more capable of making a novel response to the task. My observations of the Comparison Class children freely interpreting the task (for example, Zara playing with the parameters of the Maze task, Section 5.3.1f) and assumption that they were being more creative was not borne out by the analysis of the drawings. The Comparison Class children who produced a divergent response to the task were more often off-task in their making than creatively exploring possibilities whilst drawing.

*Addressing the Constraints of the Task*

This was coupled to the exploration of task potential. As noted in Section 5.3.2, the Comparison Class did not appear to understand that satisfying the task criteria were essential elements of a successful design solution (for example, discarding the card tube at Easter). The Focus Class were much more aware of the need to solve the problem as set (and looked for creative solutions to it).

*Planning the Look of the Product*

The differences between the two classes at Easter and for the Suitcase came as a surprise, as I expected less competent designers to colour their drawings rather than recording material or construction details. However, in seeing the role of drawing as clarifying the task rather than develop design ideas, the Comparison Class were not thinking about finishes, whereas Focus Class children planning a solution were imaging a real product, including its colour or logo. The Card task produced almost identical results because the children were told to draw a picture for the front of the card.

*Communication of Design Ideas*

The peak in both classes' mean scores for Easter and Card tasks, probably has more to do with the emphasis on clarity of communication in view of the impending SATs tests than with teaching in Design and Technology. However, the Focus Class maintained a greater clarity in communication in the later task than did the Comparison Class.

*Planning Construction*

There was a similar development of use of drawing to plan construction in both classes, except for the Focus Class greater use of drawing in this Dimension for the Card. Having the tube on the table helped both classes to address construction issues at Easter.

*Evaluating whilst Drawing*

The Comparison Class' mean score gradually improves across tasks indicating natural maturation, perhaps. The Focus Class' profile shows a change at Easter, which could represent an understanding of the genre of design drawing: that several ideas recorded on one sheet is not just allowable but desirable.

*Basis for Making the Product*

Throughout the Programme, the Focus Class appeared to have a better understanding of the drawing as planning for making. Although the Comparison Class made something that related to their drawing, it could not generally be regarded as a plan for action. In my view, this Dimension most raises the question of the children's perception of the purpose of the drawing.

## *5.7.2b Problems and Products*

Chart 20 overleaf shows the comparison between the children's mean scores across all Dimensions for the Problem Scenarios (Frosty and Maze) and the Product Designs (Pizza and Suitcase) in the same way as the Purpose scores for these tasks were compared in Section 5.5.2, Chart 8. The mean scores across all dimensions were calculated from the individual Collation Grids (Appendix O: AO2). AO1.4 Sheet 2 shows the data from which Chart 20 was created.

Similar conclusions can be drawn from Chart 20 as from Chart 8:

- most progression appears to be made by the Focus Class in the product design tasks, least by the Comparison Class in the Problem Scenarios.
- many Comparison Class children appear to have made little progress in their ability to use drawing to support their Product Designs, whereas considerable progress has been made by most of the Focus Class.

the numbers of Comparison Class who show similar or less use of drawing to support their thinking about the Maze than they did for Frosty shows that there was relatively little progress in understanding of how to use drawing to support thinking about design problems. The Focus Class seem to be able to transfer skills in design drawing to a different context.

*Chart 20 : Changes in Means of Dimensions Scores across Time*

*x-axes = Individual Children*

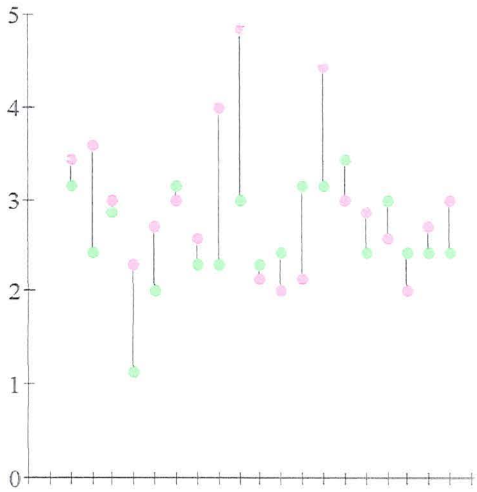
*n = number of children present for both tasks represented on chart*

*y axes = Scalar equivalent of Dimensions Continua as per Table 14*

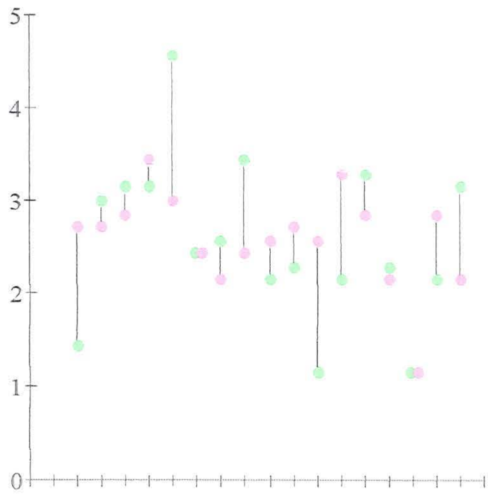
**Problem Scenarios**

*Frosty* *Maze*

**Focus Class**
*(n=18)*



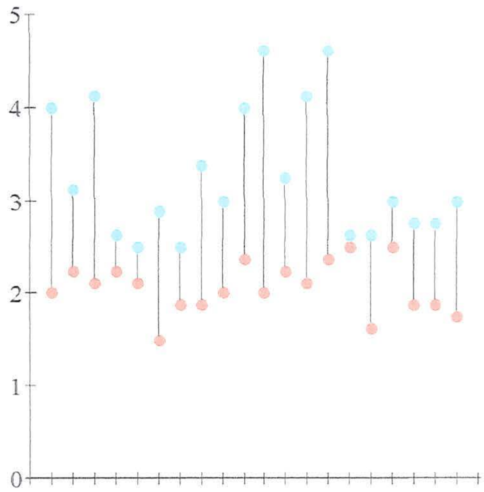

**Comparison Class**
*(n=17)*



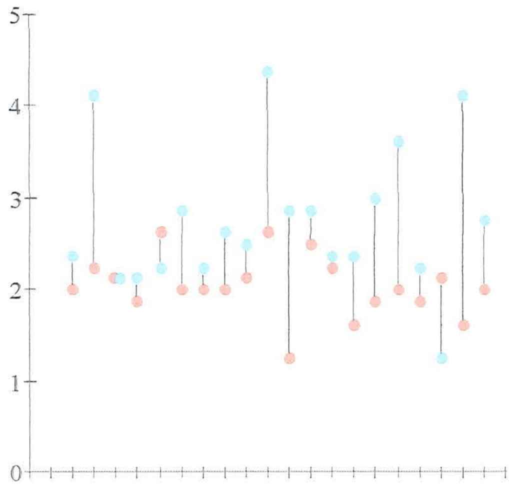

**Product Design**

*Pizza* *Suitcase*

**Focus Class**
*(n=21)*

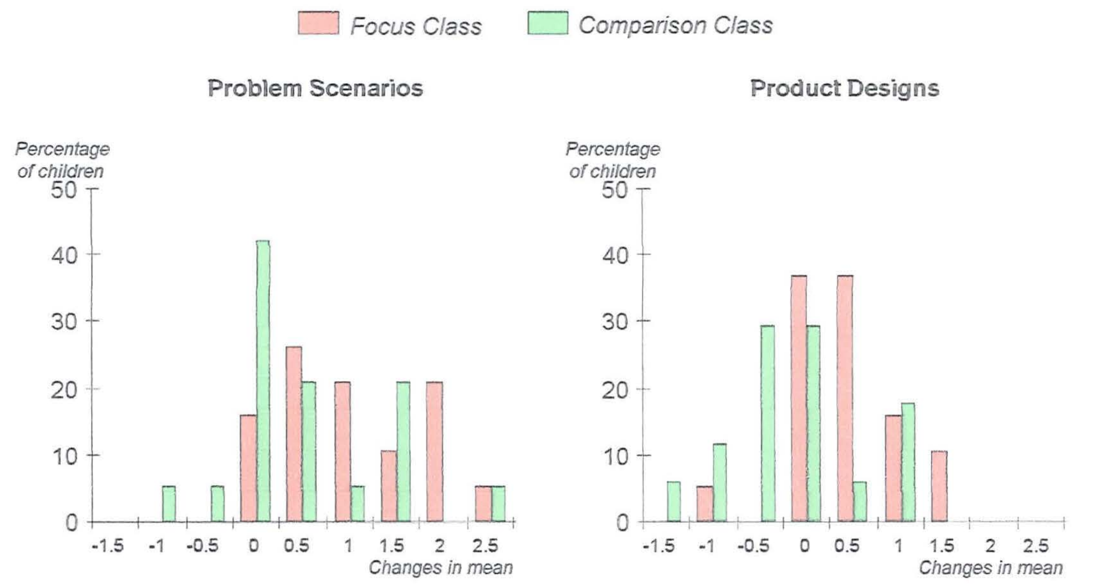



**Comparison Class**
*(n=20)*



As in Section 5.5.2, these figures were collated into bar graphs (Chart 21) to show class profiles for development over time. Unlike the scale on the x-axis of Chart 8, which represented the discrete bands on the Purpose Continuum, the x-axis here represents an analogue scale. Divisions of 0.5 have been used in order to give greater clarity of representation of the data.

*Chart 21 : Progress in Use of Drawing over Time*




The comments made in with regard to Chart 9 in Section 5.5.2 are also pertinent here. In both types of task, the Focus Class display a greater ability to use drawing to support design thinking, regardless of familiarity of task type.

## *5.7.2c Differences in Performance on Dimensions Continua*

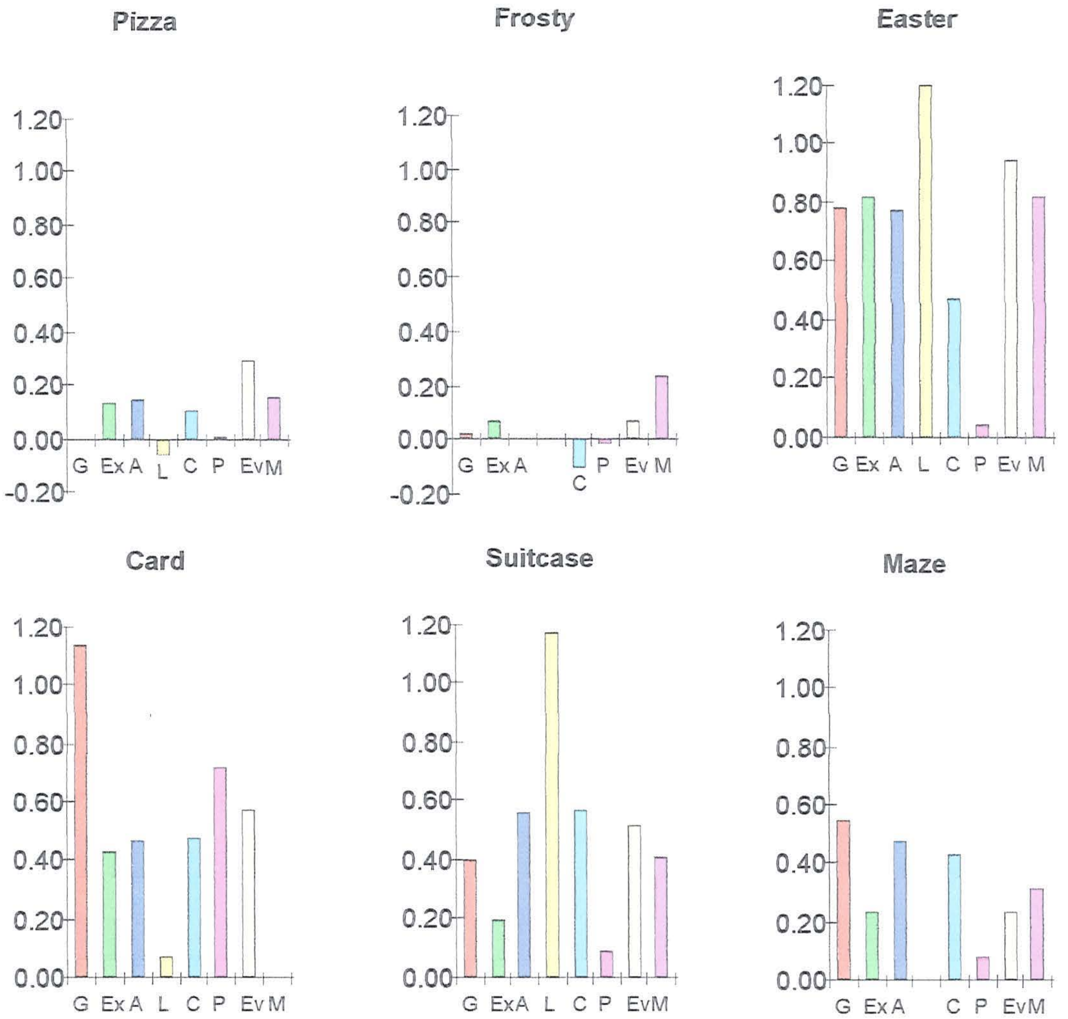
Chart 19 revealed that on many of the Dimensions, the Focus Class appear to make a leap in understanding at Easter, that is maintained into subsequent tasks.

To examine the extent to which this was different from the growth in the Comparison Class' use of drawing for designing, Chart 22 (overleaf) was constructed by calculating the difference in mean score for each class for each Dimension (Focus Class' mean minus Comparison Class' mean). The graphs within Cart 22 represents *differences* between the children's use of drawing to support designing, rather than better or poorer performance. There was little difference between the classes at the start of the Programme.

*Chart 22 : Differences between Performance on each Dimension*

*x-axes = Dimensions of Design Drawing*

*y-axes = Differences in mean scores for each Dimension, calculated as Focus Class mean minus Comparison Class mean.*




The immediate effect of the Container / Journey input to the Focus Class can be seen in the Easter chart. This would appear to suggest that the understanding of the purpose of design drawing came as a result of the specific teaching input of the Container / Journey metaphor. This immediate effect is one of the emergent themes from the dimensions analysis (Section 5.7.4). The Focus Class had not received specific teaching on Planning Construction whilst drawing, as my Exploratory Phase observations had revealed that children of this age find it difficult to do this. Therefore, it was likely that there would be little difference between the two classes on this Dimension.

The greatest difference at Easter is in the use of drawing for Planning the Look of the Product. This reflects the choice of many Focus Class children to make the tube into something (e.g. Easter Bunny), which they recorded as a whole potential product, rather than the Comparison Class' response to use the drawing to plan how to solve the construction problem and leave the decision about how to decorate the outside of the tube until engagement with materials. The same trend can be seen for the Suitcase.

Both Card and Suitcase tasks show a less pronounced difference between the two classes. I think that the Easter scores represent immediate application of recent teaching and that the Card and Suitcase results represent longer term changes in understanding. It would be expected that some children would not be as capable as others to apply their learning to different situations. However, the ability of the Focus Class children to maintain their greater understanding across a range of different tasks would perhaps indicate that real learning had taken place. The great difference between the mean scores for Generating and Developing Ideas for the more structured Card task might indicate that the printed design sheet led the Comparison Class children into thinking in terms of "one right answer."

The immediate and sustained difference between the two classes immediately after the Teaching Input to the Focus Class enshrined in the Container / Journey metaphor would suggest that this teaching had an immediate and lasting effect on their perception on how drawing might be used to support design thinking.

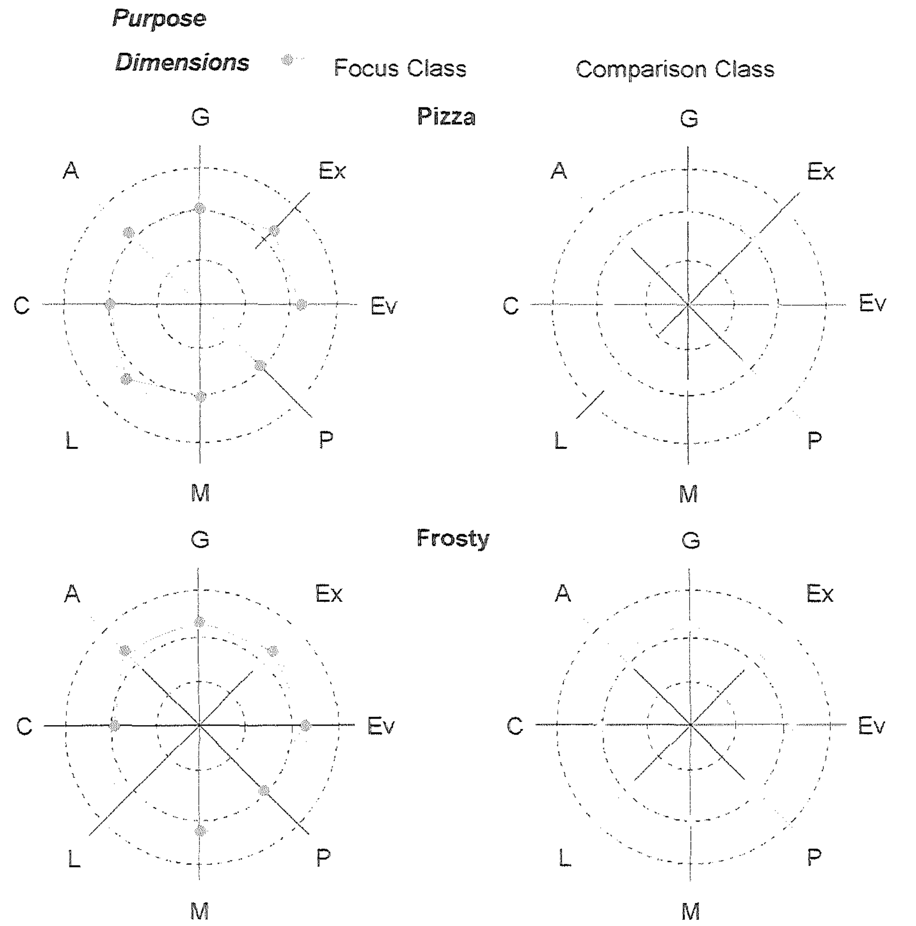
## 5.7.3 Relationship between Purpose Continuum and Dimensions

The Purpose Continuum and Dimensions Wheel form two overlying layers of a holistic view of children's design capability (Section 5.4.3). Superimposing a Purpose Plot on the Dimensions Plots enables analysis of the relationship between the two in the children's responses, both within and across tasks. The charts were created from Appendix O : AO1 Sheet 1 & AO1.4 Sheet 1.

### *5.7.3a Within Tasks*

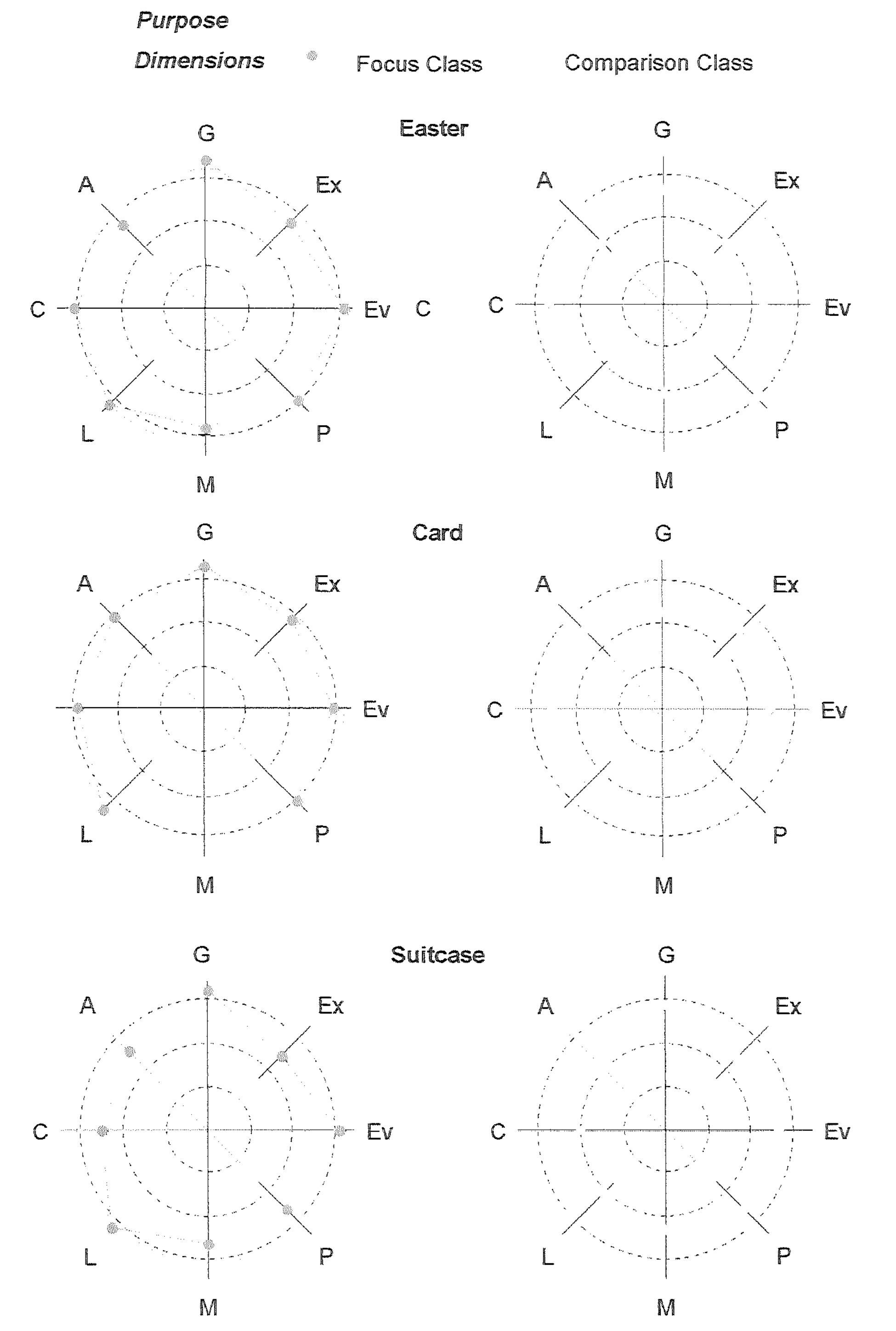
*At the Beginning of the Programme* both classes started from a low level of understanding of the purpose of design drawing (Chart 23), reflected in their limited use of drawing on any of the Dimensions continua:

*Chart 23 : Relating Purpose Continuum to Dimensions Wheel (a)*



*Mid-Programme Product Designs :*

*Chart 24 : Relating Purpose Continuum to Dimensions Wheel (b)*




The sudden expansion in both the Focus Class' Purpose and Dimensions Plots following the Container / Journey input (Easter) shows a strong connection between their understanding of the purpose of the drawing as a design tool and the way that they used it, across all

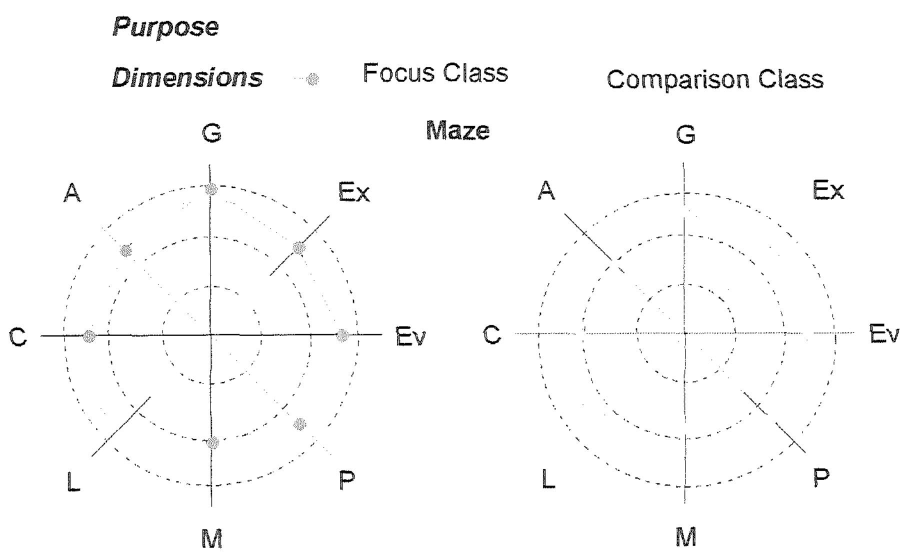
Dimensions. The Suitcase plot confirms that real understanding of the purpose of drawing for designing had been achieved and maintained, this was most clearly expressed in their generating, developing and evaluating of ideas about the overall look of the product.

In contrast, the Comparison Class' Dimensions Plots swing around within and across the Purposes Plot, suggesting that these children were not developing such a holistic understanding of the purpose of drawing and were responding to cues within in the task on each occasion. Hence for the Card task, which guided them through the process and required them to record something that related to each of the Dimensions, their use of drawing relates closely to their understanding of the purpose in all Dimensions. However, without such support and left to their own devices with blank paper at Easter and for the Suitcase, they demonstrated a much weaker relationship between purpose and use of drawing for designing.

At Easter, clarifying and recording possibilities is most closely related to generating, developing and communicating ideas about planning construction, without considering the final external appearance of their product or confronting the constraints and possibilities of the task potential Neither do they appear to view the purpose of the drawing as planning the making of a product. This accords with the observation that many Comparison Class children viewed the purpose of the drawing as clarification rather than solution of the problem. These trends were also true for the Suitcase. However, the children who used the design sheet as part of the product demonstrated minimal understanding of the purpose of the drawing as related to communicating design ideas, bringing down the mean score on this Dimension.

*Post-Programme Problem Scenario: the Maze :*

***Chart 25 : Relating Purpose Continuum to Dimensions Wheel (c)***



In this problem scenario task, there is less difference in the relationship between the Purpose and Dimensions Plots shown by each class. The Focus Class' greater understanding of the purpose of design drawing is reflected in their greater use of drawing across each Dimension, especially Generating and Developing Design Ideas.

### *5.7.3b Across Tasks*

*Points of near contact between the Purpose Plot and the Dimensions Plots:*
Most frequently, one of those points is Generating and Developing Ideas. Thus, even at this young age, children can understand the purpose of the design drawing as a means of generating and developing ideas about the product they have been asked to design or the problem they have been asked to solve. That Evaluating whilst Drawing is frequently another close contact point suggests that at this age children can be reflective about their work and seek ways to improve and refine their ideas.

*Points of greatest distance between the Purpose Plot and the Dimensions Plots:*
These occurred in the Comparison Class' plots. Apart from the Suitcase task, the Focus Class exhibited a close relationship between their understanding of the purpose of design drawing and the way in which they used it in all Dimensions.

Thus it would seem that having a secure understanding of the purpose of drawing for designing enabled the Focus Class children to address each of the dimensions of design drawing with greater success than did the Comparison Class. Smith (2001) asked two questions, which I believe my research has, at least partly, been able to answer:

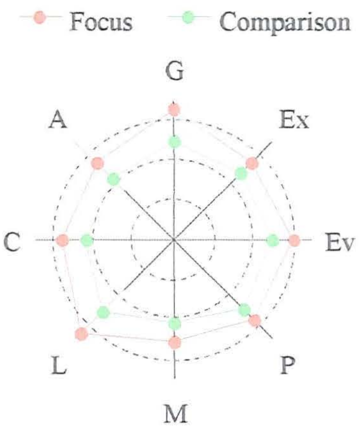
> "What age should learning sketching techniques be started and to what depth? Do pupils understand that one reason for sketching when designing is to assist in the generation of more ideas through the ambiguity of the sketches and the juxtaposition of ideas?"
>
> (pp.8-9)

My answer to Smith's questions would be that the understanding needs to come before the techniques. The Focus Class' understanding of the purpose of drawing for designing appears to have had an immediate effect. Unless children have a secure understanding of the purpose of the drawing, teaching of techniques is futile. The Comparison Class could indicate how to make a product that answered the task, often as a labelled diagram, but their lack of understanding of the purpose of drawing to develop design ideas meant that they did not relate this drawing to the development of a solution to a design problem. In answer to Smith's second question, I would say that even such young children as those in my study can and do understand the purpose of drawing as a means of generating design ideas, but that they need to be taught that this is the *purpose* of using drawing in a design context. The beginnings of reflective interaction with their drawings began to show in tasks in which the Focus Class showed the highest degree of balance across all Dimensions, coupled to (and I believe driven by) an understanding of the purpose of the drawing as planning to make.

## 5.7.4 Emergent Themes from the Dimensions Continua

Throughout the Dimensions analysis, it has been clear that the Focus Class use drawing much more effectively across all Dimensions from Easter onwards. Chart 26 collates these differences into overall mean scores across Easter, Card, Suitcase and Maze tasks (Section 5.7.1a demonstrated the close parity between the two classes responses at the beginning of the Programme).

***Chart 26 : Dimensions' Means***
*from Easter onwards*



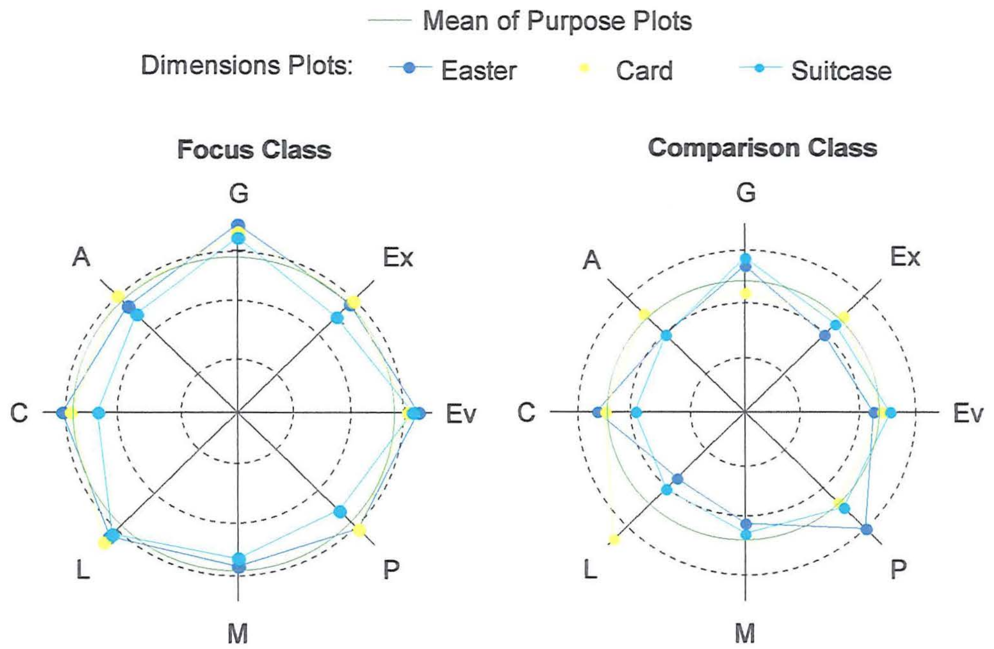

Over time, therefore, regardless of specific individual task effects, the Focus Class had achieved greater long-term learning about the use of drawing for designing after being taught the nature of design drawing through the Container / Journey metaphor.

However, within the analysis of the Dimensions, themes and trends emerged that mirrored and enhanced observations from other layers of analysis from the notes made on the Teaching input to the Focus Class (Section 4.4) through to the analysis of Drawing Types in Section 5.6.4. Reflections upon these emerging themes led to new insights on the way in which the Dimensions relate to the Container / Journey metaphor.

*Impact of Understanding Purpose on Performance in Dimensions*

The immediate effect of the Focus Class' understanding the purpose of drawing for designing is best demonstrated by the superimposition of the mean of the Purpose Plots for the mid-Programme product design tasks onto their Dimensions Plots (Chart 27) :

**Chart 27 : Comparing Purpose to Dimensions**




The Focus Class plot suggests understanding of *purpose* expressed through the *dimensions,* whereas the Comparison Class plots seem to suggest a sense of struggling to come to terms with drawing their design ideas and unsure of the purpose of the activity. The integrity of the Focus Class Dimensions Plots suggest the development of domain-general knowledge which is being transferred across tasks, which cannot be said of the Comparison Class, whose responses appear context-specific. The close matching of the holistic (Purpose) and the discrete (Dimensions Plots) on the Focus' Class' chart would suggest that understanding the purpose of the design drawing is that domain-general knowledge and that the Comparison Class have not yet reached a level of understanding of the purpose of design drawing for this effect to occur.

That the effect on the Focus Class' performance was immediate upon the Container / Journey teaching input would suggest a strong relationship between the two. That it was not caused by maturation or deduction from practice is suggested by the Comparison Class not reaching the same level of understanding or use of drawing for designing across the duration of the

Programme. What had happened within the Focus Class was not simply accelerating a natural process but imparting knowledge that they would not have deduced for themselves within the timespan of the Programme.

*Task Potential*

Throughout the Dimensions analysis it was clear that the ability to Address the Constraints of the Task and to Explore the Possibility of the Task need to be in balance in order to create a successful design. This was identified as an Emergent Theme during observations contributing towards the qualitative analysis (Section 5.3.2).

Both these Dimensions relate to notions of creativity in Design and Technology contexts and to Donaldson's (1992) "this problem and this problem only". I began to call this *"awareness of task potential"*: looking for creative ways to solve the task in hand or to play with ideas within the rules of the game. The Compression Class' divergence from the task constraints showed low awareness of task potential. For example: making the tube into an Easter Bunny shows high awareness of task potential; a unsuccessful Maze did not aid Theseus in his escape.

*Problems and products*

The difference between the way drawing is used in problem scenarios and product design was realised in the course of Dimensions analysis of the Maze task, when it became apparent that the children had not recorded any details relating to Planning the Look of the Product and very little in terms of Planning Construction. It would seem that their perception of the planned object as a "model" rather than as a "product" elicited a different use of drawing for designing.

This realisation led to the analysis of each task type separately and enabled the perception of trends within the product design tasks (for example, that Planning the Look of the Product was an important difference between the two classes' use of drawing). There were common trends across task types, however, especially in the dual aspects of Addressing the Task Constraints and Exploring the Possibilities of the Task.

## 5.8 The Techniques Ticksheet

The re-definition of the analysis instrument in terms of the Dimensions Wheel and the consequent re-working of the Grid's Descriptor Cells into Dimensions Continua meant that much of the information contained in the Techniques Ticksheet was subsumed into the Continua. However, as indicated in Section 5.4.3b, the external evidence for the children's understanding of the Dimensions of Design Drawing was frequently contained in the techniques that they used.

The way that the quantified analysis instrument evolved over time made the to-ing and fro-ing of specific bits of information inevitable. One strength of this was that the four elements of the analysis instrument (the Purpose and Dimensions Continua, the Drawing Types and the Ticksheet) were inextricably interwoven and consequently supported each other rather than clashed. I tried to be vigilant in ensuring that the same information was not recorded twice. The causes were frequently due to closer correlations in the data than I had anticipated The result was frequently a re-thinking of definitions, categories and meanings.

The full Techniques Ticksheet list can be found in Table 15 in Section 5.4.3b(ii).

### 5.8.1 The Role of the Techniques Ticksheet

Although far less time was spent re-working and moderating and re-defining the Ticksheet than was spent on any of the other layers of the Analysis Instrument, this does not imply that the role of the Ticksheet was just as supporting cast.

It evolved into contributing clarification and definition to the Dimensions Continua and supporting information to the Purposes Continuum, yet it also had its own contribution to make about children's designing. Through teasing out the techniques the children used, I was able to get a much firmer grasp on what I meant by my more global categories. For example, the combination of addressing task requirements and client's needs into a single Dimension as Addressing the Constraints of the Task was decided whilst analysing the drawings using the Ticksheet, as it became clear that these were inter-related.

The Ticksheet categories were refined over the course of time, in line with the development of the rest of the quantified analysis instrument. However, from the start its structure had a hierarchy that implied progress, which enabled the information recorded in the Ticksheet to relate directly to the Dimensions Continua. This was really useful for determining the placement on the Continua of work for which I felt uncertain.

For example, Table 17:

| PLANNING CONSTRUCTION |
|---|
| indicates materials by list |
| indicates materials by labelling drawing |
| materials indicated are suitable |
| materials indicated are available |
| indicates cuts, folds &/or fixings |
| indicates measurements |
| indicates equipment needed |
| indicates parts to be assembled |
| can be made in time available (roughly) |
| technically realistic (child can make it) |

*Table 17 ; Ticksheet Example to show Progression*

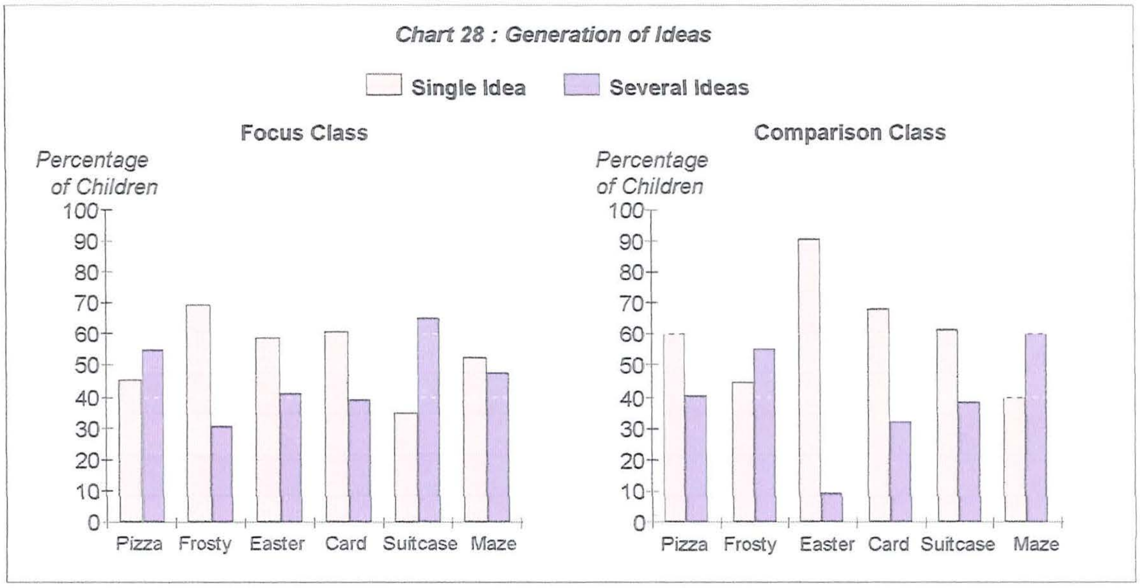
## 5.8.2 Information from the Techniques Ticksheet

There were two aspects to "progress" which I hoped that my Focus Class would acquire in terms of facility and confidence with using drawing to support design thinking. As well as using the drawing to record and develop their design ideas, I also wanted them to be able to choose the technique which best suited their purpose. I was hoping, therefore, that one thing which would emerge from the Ticksheet analysis would be that the richness and diversity of techniques used by the children, and that the range of such techniques would prove to be considerably greater amongst the Focus Class children.

The reporting of the Ticksheet findings in Section 5.8.2, which follows, is designed to illustrate that richness. The subheadings under which this is discussed relate the Ticksheet to the Dimensions.

### *5.8.2a Generating and Developing Design Ideas*

The ratio of single to several ideas recorded by the children seemed worth examining, regardless of how developed the ideas were. This was not the same as number of drawn items on the paper. Several iterations of the same idea counted as one idea. The 40% - 60% band is indicated on Chart 28 to add emphasis to the difference in the two classes in this respect:



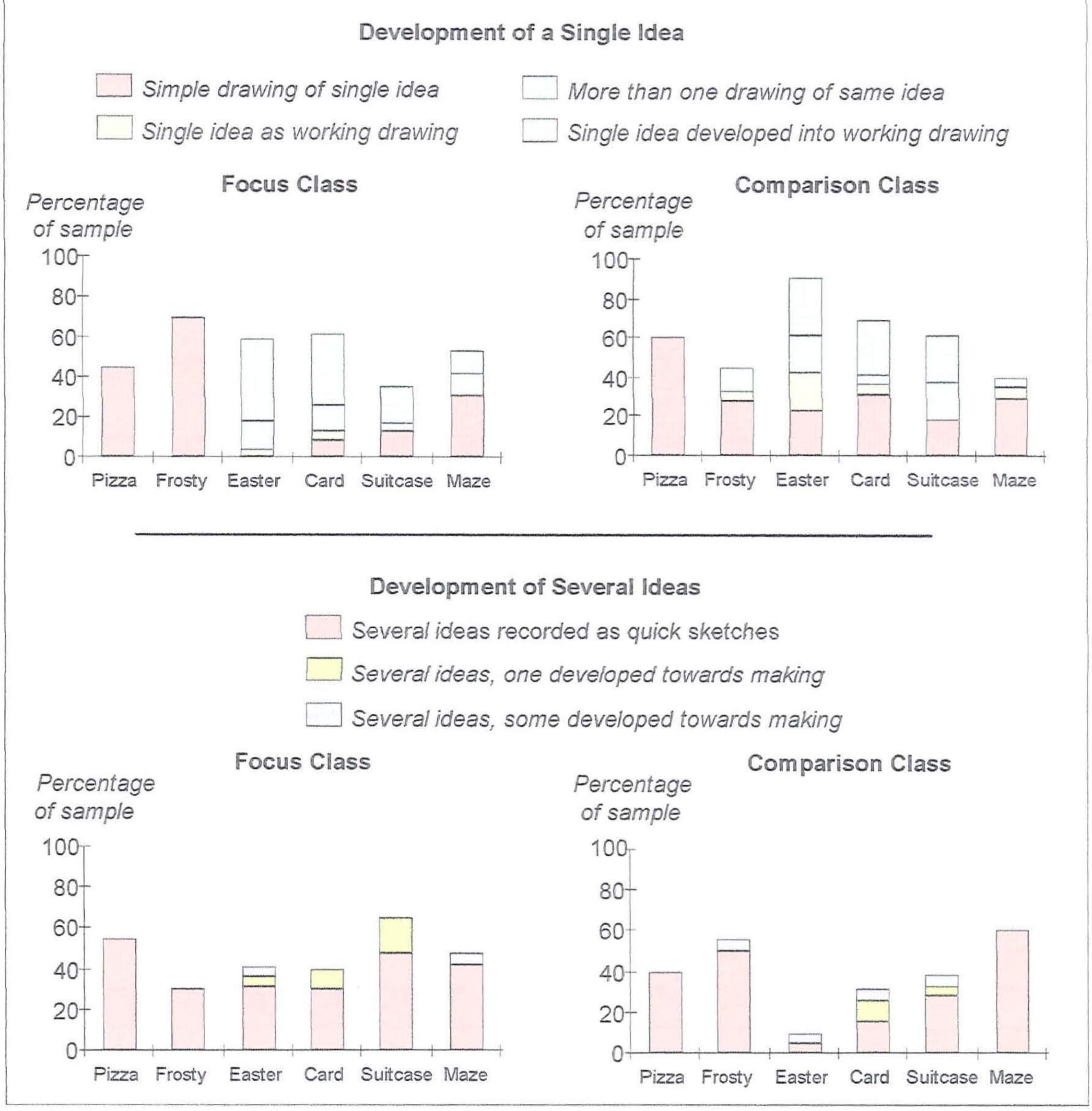

In the Focus Class, almost equal numbers of children (and by no means the same children each time) took either option for each task, suggesting perhaps that they felt comfortable using drawing to record that which they felt to be personally useful.

The Comparison Class show a strong preference for single ideas for product designs but several ideas for problem scenarios. My Log Book records that they were calling out "I know what I'm doing" almost before I had finished explaining the Easter task, which would corroborate the high incidence of single drawings for this task. This impulsive recording of the first idea may, therefore, be a factor in their continued recording of single ideas for the Card and Suitcase. The use of drawing for clarification for the Maze task has expressed itself in several drawings, as they had more than one attempt at defining a maze to themselves.

The development these ideas was then considered. The two kinds of response (Single or Several ideas) are considered separately. The range of responses for the whole class is, therefore, split across the two charts, e.g., for the Focus Class response to the Suitcase task, half of the single idea children produced a simple single drawing, but 65% of the class produced several ideas and the same proportion of these developed one towards making as produced simple singles.

As can be seen from Chart 29 overleaf, the development of design ideas from a single starting point is much higher than for the production of several ideas, to the extent that this seems to be an either/or option on how to use drawing to support designing. In terms of Drawing Type, the developed single idea would include all the Multi-Draws and Progressives. The lower incidence of development across several ideas are the Multi-designs. It would appear that children at this age tend either to record one idea which they develop towards making or record several options from which they choose to make one. The incidence of "draw several and develop one / several" is very low and the "several" is frequently two: a first idea is adapted then discarded and a second idea developed.

*Chart 29 : Development of Ideas*




The continued higher incidence of simple single drawings amongst Comparison Class children accords with Purpose Continuum analysis that many were not using drawing to develop a design solution but to define the problem to themselves. The Focus Class moved to the recording of several ideas for the Suitcase. Perhaps they felt confident in their ability to make the product and so were using drawing to place-mark a range of ideas as possible solutions.

## *5.8.2b Satisfying Constraints vs. Exploring Possibilities*

The original Ticksheet was tautologeous and the distinction into "task requirements" and "client needs" unnecessary, since there was negligible difference between the results on all tasks, leading to the definition of one of the Dimensions as Addressing Task Constraints, which combined both client and task requirements. The original criteria list on the Ticklist was collated into the following shortlist (Table 18):

| ***as required by task or client/user*** |
|---|
| using drawing to model the product specified |
| aware of possibilities |
| aware of constraints |
| considering construction of product |
| product satisfies task / client criteria |

*Table 18 : Task Constraints (a)*

In tandem with this change, I realised that *awareness of possibilities* was essentially a measure of creative response. Children who produced a single stereotypical response scored low and those who produced a range of interesting and different ideas scored high on the Dimension of Exploring the Possibilities of the Task. Thus, a child who produced a chicken laying eggs into the tube was thinking of a more creative solution than those who drew six slightly different patterns for the outside of the tube. Exploring the Possibilities of the Task became one of the Dimensions of Design Drawing. These considerations led to a clarification of my task criteria (Table 19) to ensure equivalence of application to inform decisions regarding placement on the continuum for the Addressing Task Constraints Dimension:

| **Task** | **Using drawing to model the product specified** | **Aware of task constraints** | **Product satisfies task & user requirements** |
|---|---|---|---|
| Frosty | A drawing of something to be made; No snowflakes, clouds or fish in the lake. | Drawn as if made from materials provided. | A model of a viable solution to the problem |
| Easter | The tube must be included in the drawing. | Drawing indicates how egg will be held inside tube. | The egg is held firmly inside the tube |
| Card | There must be a drawing of a card, which must match the likes of the client. | There must be a surprise element to the design | N/A |
| Suitcase | More than just a picture of a suitcase: evidence of considering range of travel bags, or thinking about size, or how to make it. | Evidence of grappling with both construction issues and size. | Suitcase is: big enough to hold mac; small enough to be carried by Panda; handle fits over paw. |
| Maze | Must have top-down view of the maze, indicating route into & out from Minotaur | No irrelevant detail, not too complicated to make: i.e. constructionally viable. | Model is 3D; must have internal walls. |

*Table 19 : Task Constraints (b)*

This greater clarity gave awareness of finer details of children's work that I might otherwise have missed. For example, so many children had provided a "way in" and a "way out" with a string going between the two, passing the Minotaur on the way, that I began to wonder if I had accidentally implied this in my task introduction.

### 5.8.2c Communication Techniques

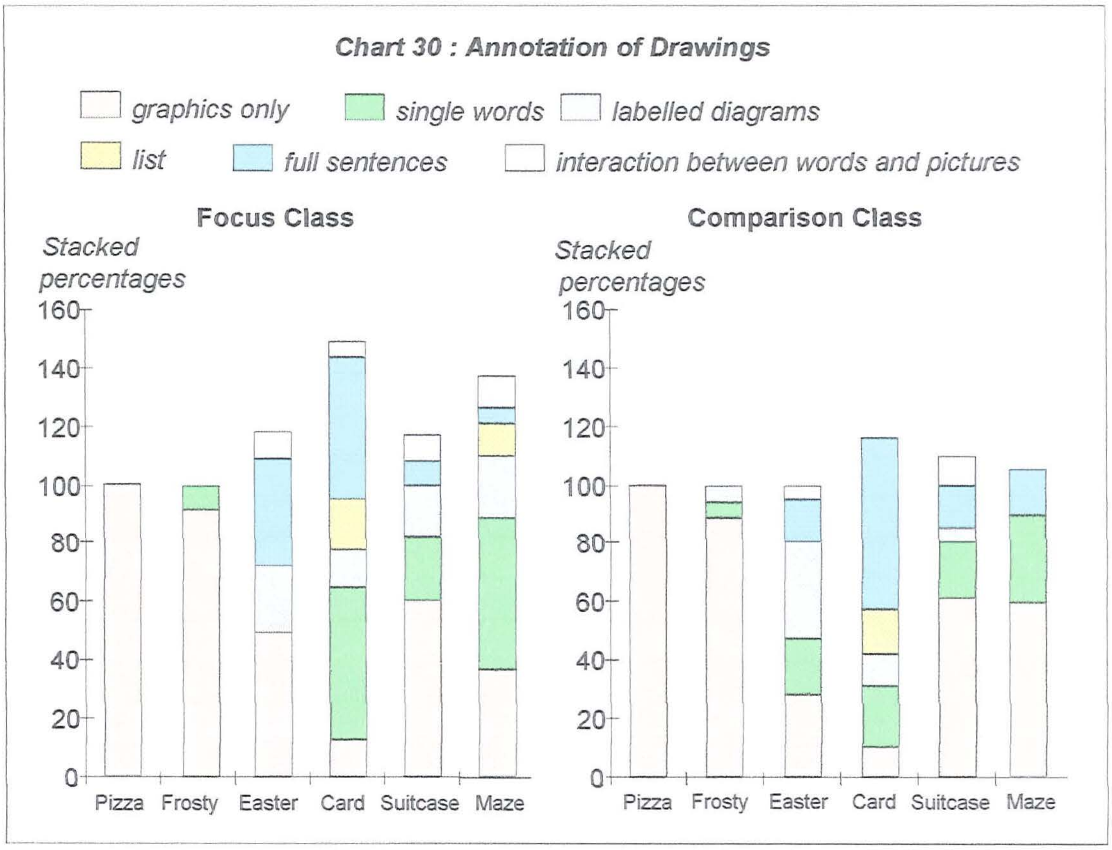
The surface features of the drawings (annotation, level of detail, decoration, recording of materials and construction) provided the information for judgements about the child's placement on the Communication of Design Ideas Continuum. The level of annotation was much higher than in the drawings analysed in the Exploratory Phase but I was careful not to simply give annotated drawings higher status than graphics only, simply because I could understand their intentions more quickly. The level of detail and decoration might indicate how clearly the children were imaging their solution and the recording of materials and construction details, although muddled, might indicate their thinking through the practical problems of making their idea.

#### 5.8.2c (i) Annotation of Drawings

Prior to Easter, few children annotated their drawings, in line with all Year 2 and many Year 3 children in the Exploratory Phase studies, which might suggest that the study and production of non-fiction texts in Literacy Hour was having an improving effect on recording techniques in other areas of the curriculum. This observation is re-inforced, perhaps, by the highest level of annotation used for the Card, which was conducted immediately after the completion of the SATs tests, suggesting that the combined effects of the National Literacy Strategy and the run-up to SATs testing was increasing the use of writing as a recording medium across all areas of the curriculum.

Rogers & Stables (2001) reported similar mutually enhancing effects within the "Enriching Literacy through Design and Technology" project. I seem to have parallel findings here, despite focusing on drawing and not aiming to improve literacy. Mantell (1999) recommends the introduction of "potential designing techniques" from other areas of the curriculum (mapping, listing etc.) since children appear to be able apply such techniques from other curriculum areas, even without specific teaching.

A range of annotation was in evidence, as can be seen from Chart 30 overleaf, from single word or phrase used as title for the drawing ("A Suitcase for Pandy") to a full account of the task in hand. Since many children used more than one annotation techniques, the results are shown as stacked percentages which allows for totals exceeding 100%:




I was relieved to find similar levels of graphics-only recording, since this meant I had probably not valued heavily annotated (and, therefore, perhaps easier to interpret) drawings above graphics-only in my Purpose and Dimensions analyses. This is especially apposite at Easter, where the percentage of graphics-only Focus Class drawings was higher than for the Comparison Class and yet it was in this task that they suddenly demonstrated a growth in understanding on all Dimensions.

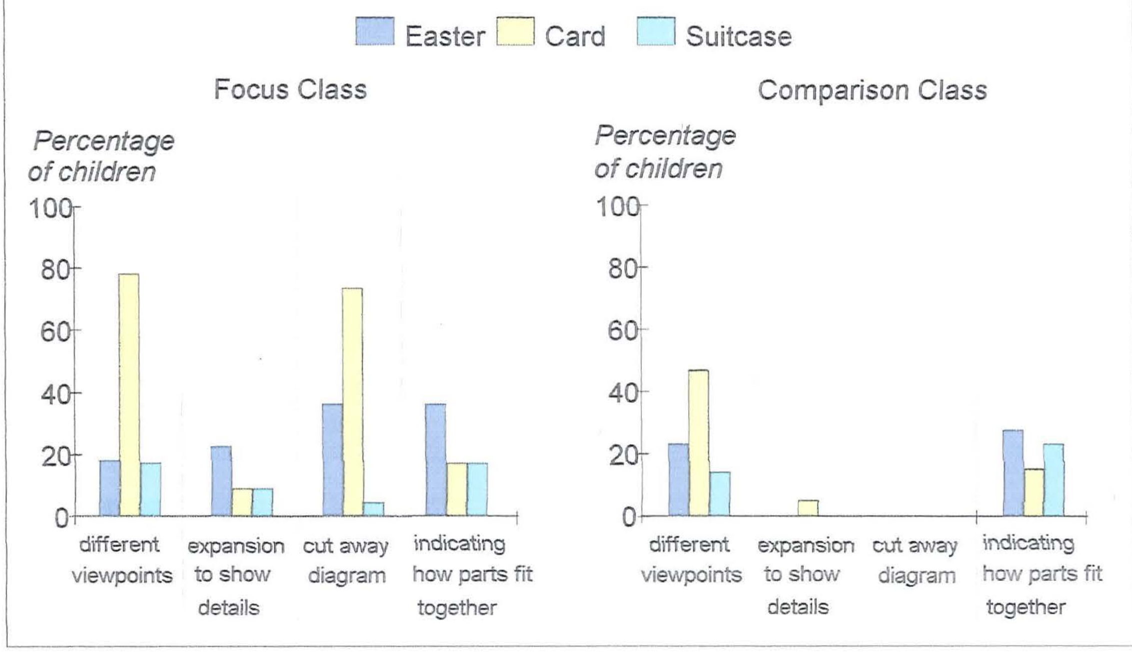
I attempted to look at all drawings holistically and see annotation as part of the child's communication, seeing it as a proxy Multi-draw where words repeated drawn information and give credit where words were used to enhance the information given (e.g. specifying colour in words rather than colouring in). I felt that this was fair. I had not told the children that they must draw (rather than write) everything and there were many occasions when words were the most sensible communication option, especially with regard to recording materials.

One child, Peter (a very bright boy in the Comparison Class ) did not draw for either Easter or Card but defined the task in words. Despite attempts to be as fair to him as possible and look for features of design skills within his writing, his inappropriate choice of medium meant that there was little and he is among the lowest achievers of the cohort. However, his use of writing for task clarification gave insight into the design intentions of children whose drawings were a static recording of the task. His case also highlighted the limitations of words and the importance of drawing for imaging, manipulating and adapting possible design solutions.

### *5.8.2c(ii) Level of Detail*

Details such as different viewpoints, expansions to show small details, cut away diagrams and indicating how parts would fit together were features of product designs but absent from problem scenarios (Chart 31). This further re-inforces the view that children saw a different use for drawing for each task type.

*Chart 31 : Level of Detail*




The differences appear as strongly between tasks as between classes, indicating that all the children used a level of detail which they felt was appropriate to the task. However, it can immediately be seen that the range of techniques employed by the Focus Class is much greater, despite not having been specifically taught to do any of these. Despite the Card task being strongly structured towards recording different viewpoints (inside as well as the front of the card), I was surprised how few Comparison Class children did so. Prior to analysis, I deliberated whether inside and outside counted as "different viewpoints" since I assumed nearly all children would do both.

The Suitcase task prompted a range of ideas rather than detailed working out of how it would fit together. Perhaps they were aware that they would be pretending these parts when they made the suitcase and so felt little need to be specific about them whilst drawing. The fantasy element of the task would encourage children to record a range of possibilities rather than develop ideas towards making. Perhaps the greater clarity of design ideas at Easter and the Card was attributable to the children believing they were planning a real product for a real client and so they were being real designers, whereas pretending that Pandy was going on holiday encouraged them to role-play at designing.

***5.8.2c(iii) Patterns, motifs and logos***

The observation that such details (even colour) were missing from the Frosty and Maze tasks informed the realisation that problem scenarios were treated differently to product designs and hence the non-assessment of Frosty and Maze for Planning the Look of the Product in the Dimensions analysis. Only the product design tasks are considered here, therefore, and, since all children except Peter drew a picture of the front of their Card, only Easter and Suitcase are compared for recording of decorative features.

*Chart 32 : Decorative Features*

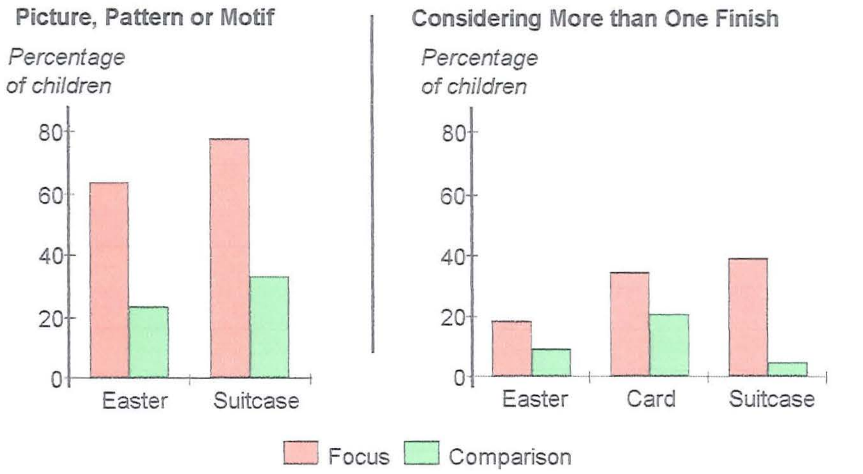



Chart 32 illustrates the Focus Class' increasing ability to image and record several design possibilities. This was re-assuring at a time when I was still thinking in terms of Progressive automatically being better than Multi-Design and considered such aesthetic features as colour or pattern as peripheral add-ons. This analysis enabled me to realise the role of Planning the Look of the Product in conceptualising a whole possible solution to task requirements.

### *5.8.2c(iv) Recording materials*

Choice of materials available :

Pizza : card, coloured paper and small items such as seeds, matchsticks etc.

Frosty : newspaper (to roll), string, wide range of recycled materials

Easter : the tube, coloured cord and wide range of recycled materials

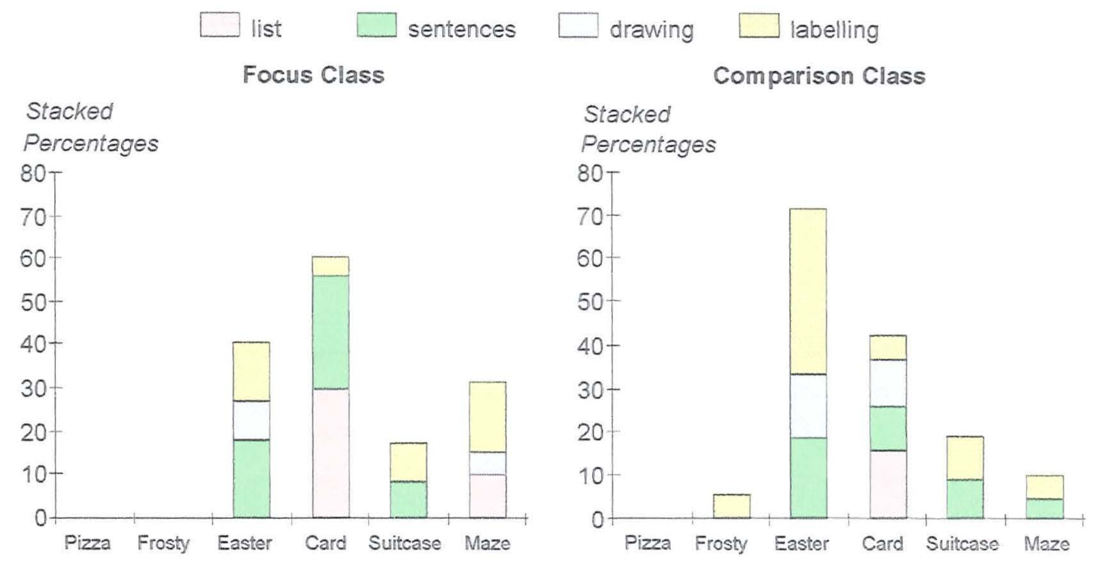
Card : none provided

Suitcase: Card, cord, treasury tags, paper clips, paper fasteners etc.

Maze : Thick and thin card, string, small sticks, range of fastenings, etc.

These were shown to the children during the introduction to the task and laid out on side table (except the tube for Easter, placed on work tables).

*Chart 33 : Recording Materials*

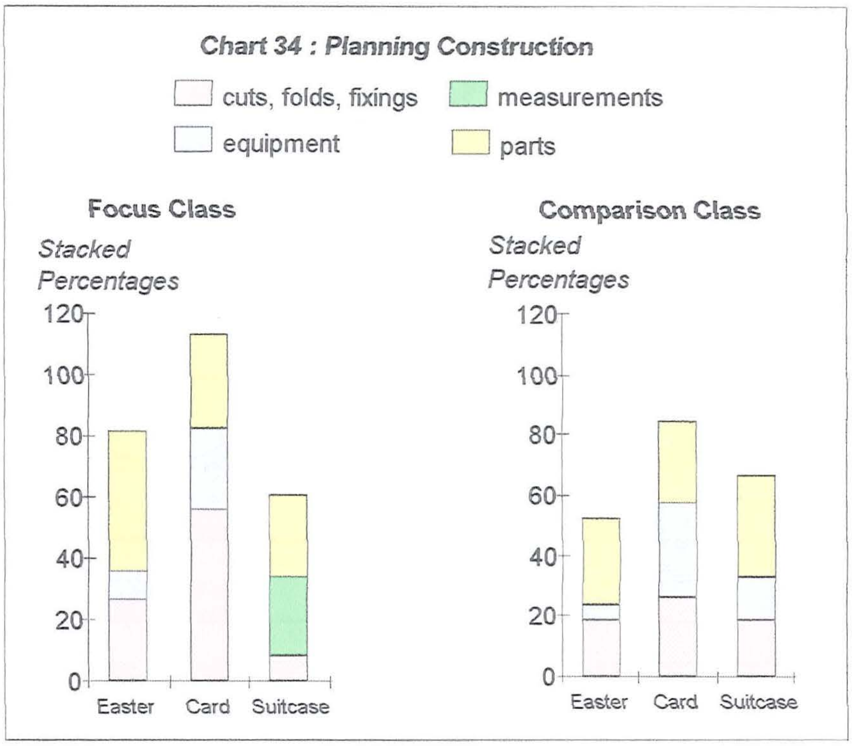



The Frosty task had high potential for recording materials, as a large range was available, and so the sudden increase in doing so, shown in Chart 33, must be attributable to teaching during the Spring term. This could also be a Literacy Hour effect, as most indications of materials is by writing, not drawing. The children were not drawing their idea as if made from the materials provided, suggesting that this was not the image they had in their heads but that consideration of what the object would be made from came with the recording the inner image as a drawing and so was added in writing.

The high incidence of recording materials (especially by labelling) among the Comparison Class children at Easter correlates with their high score on the Dimensions Continuum for Planning Construction. Despite specifically being told to record materials in Box 6 on the Card design sheet, about half the cohort did not do so. The low incidence of recording materials for Suitcase in both classes may be due to the fantasy elements inherent in the task (as observed with regard to level of detail, Section 5.8.2c(ii)). For the Maze, the incidence of recording materials is much higher in the Focus Class, reflecting their overall greater sophistication in using drawing for designing; some children even used legends:


## *5.8.2d Planning Construction*

The Ticksheet list was not the instrument to capture the holistic "intent to make" sense that I was looking for in order to place children's drawings on the "Planning Construction" Dimension, but usefully recorded specifics for product design tasks (but not problem scenarios).




Despite my intuitive feel that the Comparison Class tended to be drawing a labelled diagram of how to make a product, this more detailed analysis reveals that it was the Focus Class who did so for both Easter and the Card. Consideration of the designs reveals that the Focus Class had more complicated ideas which required parts to be detailed, along with their construction (the Easter Bunnies had ears or the Chicks had wings and beaks, for example). For the Suitcase, the Focus Class' frequently recording measurements on a simple diagram, indicating that they were grappling with the realities of the size of the product, rather than production techniques. No measurements were taken by the Comparison Class.

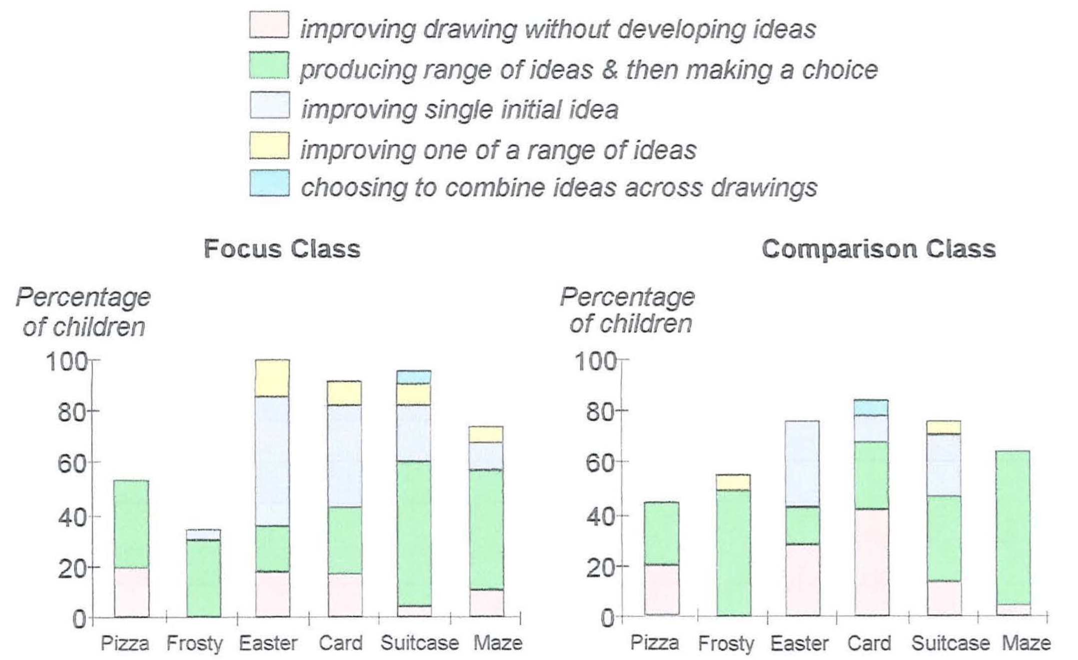
## 5.8.2e Evaluating Ideas whilst Drawing

This analysis examines just those drawings for which there was more than one item on the paper. For the Card, both Boxes 5 & 6 were considered but Box 7 (for reflection once finished) was not. My focus was on evaluation *whilst* drawing rather than on completion of the work.

Evaluation whilst Drawing closely reflects the differences between the Drawing Type categories: *improving the drawing* is essentially Multi-Draw, *producing a range of ideas and then choosing* is essentially Multi-Design, *improving ideas* (whether starting from an single initial idea or a range) is Progressive and *combining ideas* is Interactive. This in tern reflects my perception of the centrality of evaluation within designing rather than seeing it as something that happens at the end. This is the view of Kimbell et al. (1991) as expressed in the model cited in Section 2.4.1, as it is also central to Rogers and Clare's (1994) model (cited in the same section).

Since the aim of this analysis was to examine the results of evaluative action, the simple single drawings with no evidence of evaluation are not included on Chart 35.

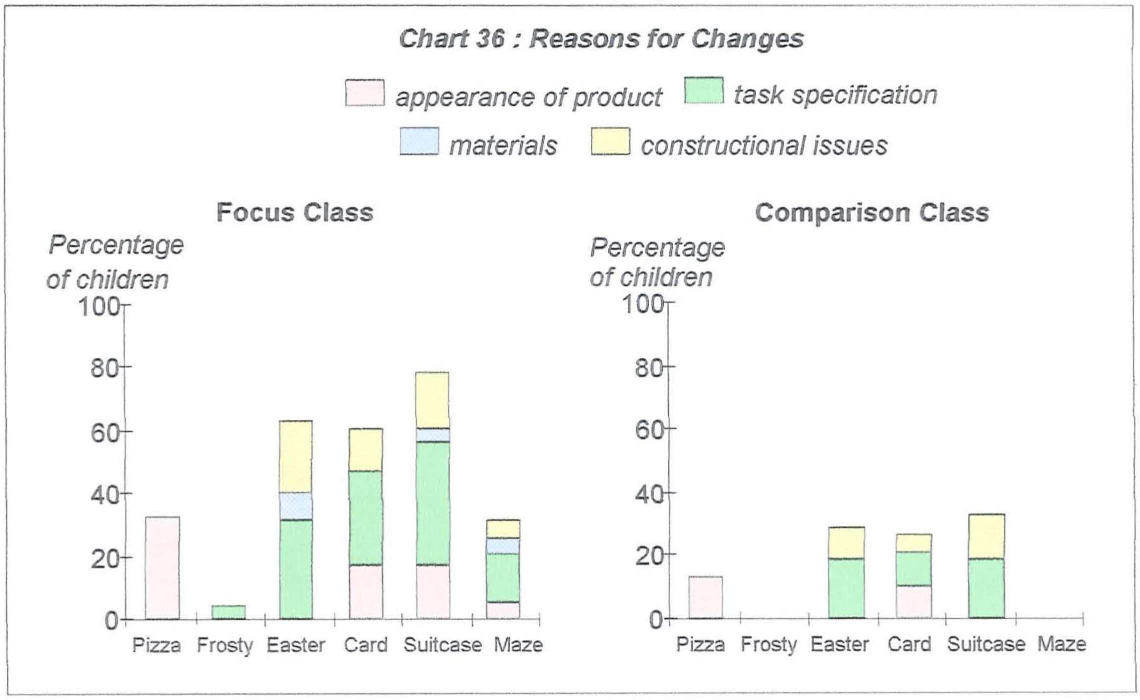
***Chart 35 : Evaluating whilst Drawing***




This analysis confirmed my belief in the close relationship between Generating & Developing Ideas and Evaluating Whilst Drawing. The adaptations, additions and multiple drawings on the paper are the result of an evaluative response to the first drawing. It may be that several other ideas tumble out of their minds onto the paper (Multi-Design) or that they want to make improvements to the one idea which seems to have answered the problem (Multi-draw, Progressive).

Different kinds of tasks seem to promote different responses: problem scenarios seem to promote the recording of a range of possibilities whereas product designs tend to promote the development of one good idea (except for Focus Class Suitcases). Choices were often indicated by tick or crosses against sketches of ideas (or occasionally the word "best") but the reasons were rarely recorded. In debriefing interviews, children could often recount the whole of their design path and justify choices and changes but these were not recorded on the paper.

The things that were changed across drawings were then examined. The drawings that fell within the category *"improving drawing without developing ideas"* from the first analysis (above) have been excluded. Chart 36 shows a much higher incidence of changes made by the Focus Class overall, and this is most frequently related to task specification, providing evidence for the Focus Class being more likely than the Comparison Class children to be reasoning within the parameters of the task potential.




The category *"appearance of the product"* denotes re-drawing the same idea but simply changing the decoration or colour. The low level of even these minimal changes amongst the Comparison Class children show that evaluation of design ideas were not really occurring whilst drawing.

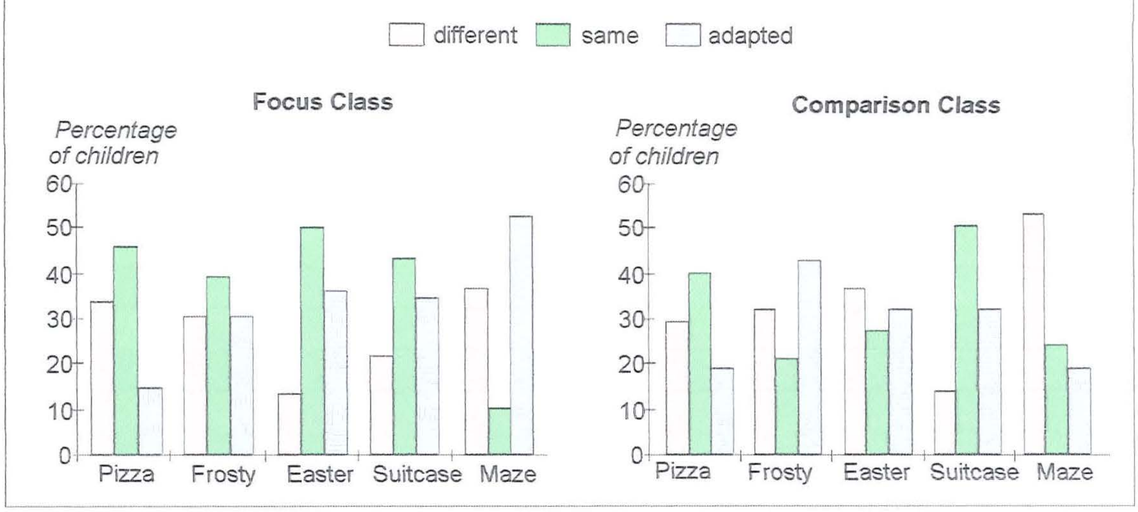
## 6.6.2f Relating Drawing to Making the Product

These data were obtained by comparison of photographs of finished products with the drawing and also through interview data. My first reaction to this analysis was that it overwhelmingly shows that children at this age can and do make what they draw, despite the folk myth to the contrary.

I was also aware of the possibility of judging more developed drawings more harshly than simple ones. There would be no parity of judgement if an unlabelled line drawing with a product of the same proportions were to be deemed *"same"* whilst a development of design ideas including materials and construction techniques was judged to be *"adapted"* if different materials were used. Similar decisions need to be reached about the point at which adaptation became *different*.

The reasons for changes between drawing and product were queried and noted as I took photographs of finished products. If the reasons for change were justified within the remit of the child's own planning (e.g. materials were no longer available) then this was taken as adapted. If reasons were external to their remit *("I just did this one", "We worked together"; "Natasha had that idea")* then such changes counted as *different.*

*Chart 37 : Relationship to Product*




The most common adaptations to drawings were proportions, size or colour. Considerations of size, especially where this was important to solving the task, were more frequently dealt with at the making stage, especially of the Suitcase. Children who produced a generic picture of "a suitcase" rather than a detailed drawing of "this suitcase" were more likely to produce an object of different proportions since they were not, at drawing stage, imaging a specific solution to the problem.

The role of the drawing for the Maze task was demonstrated in its relationship to the object made. The ongoing flow of ideas from planning into making within the Focus Class shows in the number of adaptations of recorded ideas. They have apparently continued to design a solution but fetched the materials at the point at which they were ready to model their ideas in card. The Comparison Class abandoned their drawn ideas because they were only clarifications of the problem and not solutions it.

## 5.8.3 Emergent Themes from the Techniques Ticksheet

The Ticksheet has provided supporting evidence for many of the themes identified from other layers of the analysis. These will not be repeated here, although reference will be made to Ticksheet evidence in the discussion of these themes within Section 6.

*Drawing and Writing for Designing*

Many of the techniques used by the children for recording design ideas involved writing and so "Annotation of Drawings" was chosen as the first sub-heading of Section 5.8.2 as my list of features for Communicating Ideas specifically examined the relative use of text and graphics. Ideas about colour, materials, size and construction could all be in writing. These were frequently sensible choices, showing that children could use both drawing and writing interactively as tools to express their ideas. Drawing seemed to be used for developing whole images or ideas. Annotation was added afterwards. Peter was the only child who began by writing. Everyone else drew first and then wrote. The purpose of the writing was initially an aide memoire (labelling the parts, perhaps, where the drawing was unclear) and then further thoughts about their idea (for example, sentences below the drawing) were added upon reflection.

*Reality / fantasy*

Examining the level of detail on the different drawings led me to conclude that choices about use of drawing were being made partly on the basis of the perception of the reality of task. This would accord with my observation of the Focus Class making very clear drawings throughout the kit-making task where their client was a younger child and then appearing to perform much more poorly on the Maze. Perhaps knowing that this was a school exercise and that we were all role-playing the status of the model as "helping Theseus to escape" meant that they invested the whole activity with less importance.

*Generation, Exploration and Evaluation*

Devising the Ticksheet raised issues of the inter-relationship of these three key skills in designing, which impacted on the development of other parts of the analysis instrument.

The reflective journey into the relationship between generation, exploration and evaluation began when my blind-markers reported that they were recording the same thing in several places. A child who produced a row of four different Suitcases could not get a tick in three different Ticksheet categories and then appear to score well on three different Dimensions Continua. They would score well if, and only if, at least one of the ideas were developed towards making, the ideas were basically different or had some novelty value that was being explored, and that a clear evaluative path could be seen across the drawings. Despite the holistic view of designing that the analysis model expressed, the Dimensions could not be allowed to blur into one another.

*Relationship to Making*

Children who produced well-developed drawings and who subsequently changed their ideas when they made the product frequently did so because they felt their ideas "didn't work." On further questioning it emerged that this often meant that once they had the materials in their hands they would re-image their ideas. However, children who did not develop their recorded ideas and designed something new once they had the materials in their hands would frequently tell me that they were making just what they had drawn. There was a kind of tokenism about their use of drawing, which was quite different from those who had attempted to record an idea which they intended to make.

The sharing and swapping of ideas, adapting someone else's better idea to one's own purpose is such a feature of normal life (and that of design professionals) that it goes unremarked. Lave & Rogoff (1984) contrast this with school life where such helpfulness, especially in test conditions, is forbidden. In Design and Technology, where team-work is part of the overall skill-base to be encouraged, it is anomalous that once an activity is deemed a "test", ideas gleaned from others become "cribbing".

*Diversity and richness*

Section 5.8.1 set out my hopes for the Ticksheet that it might reveal the diversity and richness of techniques within children's responses to the tasks and, hopefully, that this was more so for my Focus Class. To have explicitly indicated this at every turn along the way would have been wearisome but a glance back across the techniques produces the summary shown in Table 19 overleaf.

| | Prevalence | Range |
|---|---|---|
| Annotation | greater | same |
| Level of detail | greater | greater |
| Look of the product | greater | greater |
| Recording materials | same | same |
| Construction details | greater | same |

*Table 20 : Diversity & Richness?*

Put succinctly, more Focus Class children were using a wider range of techniques to generate and communicate their design intentions.

# 5.9 Gender Differences

Recent concerns about boys' poorer performance than girls' in school assessment creates the expectation that gender differences in capability be explored in any research into children's learning. Whether there were gender differences in the Exploratory Phase, I do not know, as I was not looking for them. The ethos of the school is of respecting all children equally and as a teacher, I have aimed to promote this by using non-gendered vocabulary. Thus when asked if there was a gendered difference in response to the activities, my immediate answer was "I don't know, they are all just children." So, although perhaps masked by my professional gender-blindness, some differences between boys and girls designing skills were likely to exist.

In both class samples the number of girls to boys was almost a 2:1 ratio (15:9 in the Focus Class and 14:7 in the Comparison Class) as shown by Table 21:

| | **Focus** | | | **Comparison** | | |
|---|---|---|---|---|---|---|
| | Girls | Boys | All | Girls | Boys | All |
| Pizza | 12 | 7 | 19 | 13 | 7 | 20 |
| Frosty | 14 | 9 | 23 | 11 | 7 | 18 |
| Easter | 13 | 9 | 22 | 14 | 7 | 21 |
| Card | 14 | 9 | 23 | 12 | 7 | 19 |
| Suitcase | 14 | 9 | 23 | 14 | 7 | 21 |
| Maze | 11 | 8 | 19 | 14 | 6 | 20 |

*Table 21 : Numbers of Children by Gender*

To generalise about boys' and girls' design styles on the basis of so few individuals (especially the seven boys in the Comparison Class) would not be appropriate nor would separating out the results for each layer of the quantified analysis into gender groups. Such low numbers are too small to support the validity of such an exercise (Tversky & Kahneman, 1982). Comparing results on the Purpose Continuum, however, might reveal differences that were less methodologically problematic. As discrete categories, the Drawing Types could also have potential, not being subject to the effects of a few low achievers pulling down an average. My Log Book notes included reflections on gender differences and I had clearly identifiable main boys' and girls' friendship and working groups within the Focus Class.

As I set about the gender analysis, I was curious to know whether, perhaps, some of the anomalies in the data (or even the different routes through the Drawing Types) were gender related. Perhaps Multi-design was more common among boys, or Progressive among girls? It was a possibility that I had not considered.

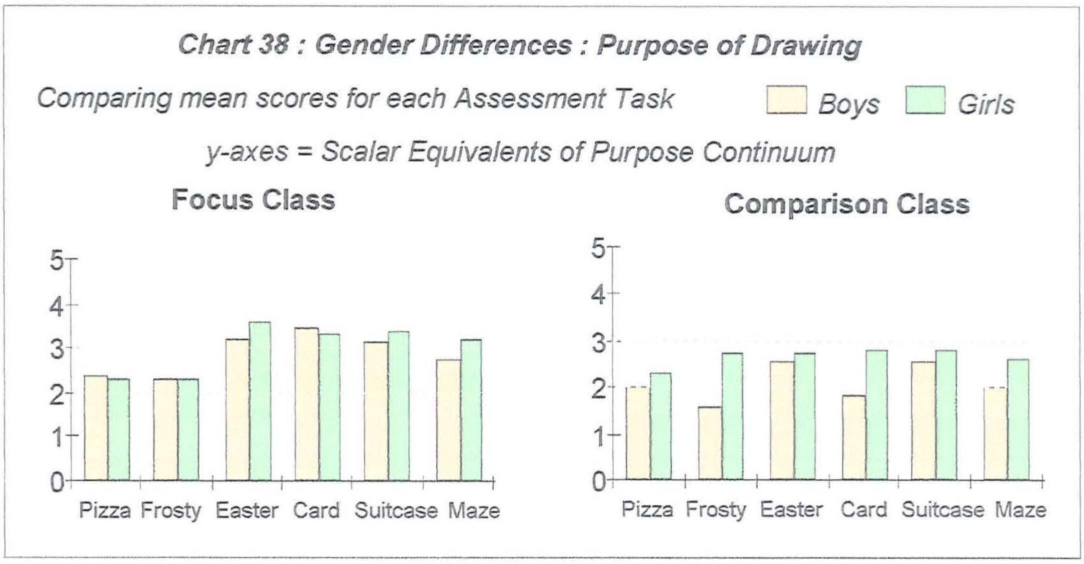
## 5.9.1 Quantifiable Differences

Checking the SATs results confirmed that the boys and girls in each class had very similar academic attainments (Table 22). By substituting a 0-5 scale for the SATs scale of "Working Towards" through Level 3 (so that 2C = 2, 2B = 3, 2A = 4 & Level 3 = 5) class averages could be calculated:

| | | Reading | Writing | Maths |
|---|---|---|---|---|
| Focus | Boys | 2.56 | 2.00 | 3.00 |
| | Girls | 3.57 | 2.93 | 3.57 |
| Comparison | Boys | 2.57 | 1.57 | 3.29 |
| | Girls | 3.43 | 2.86 | 3.79 |

*Table 22 : SATs Scores by Gender*

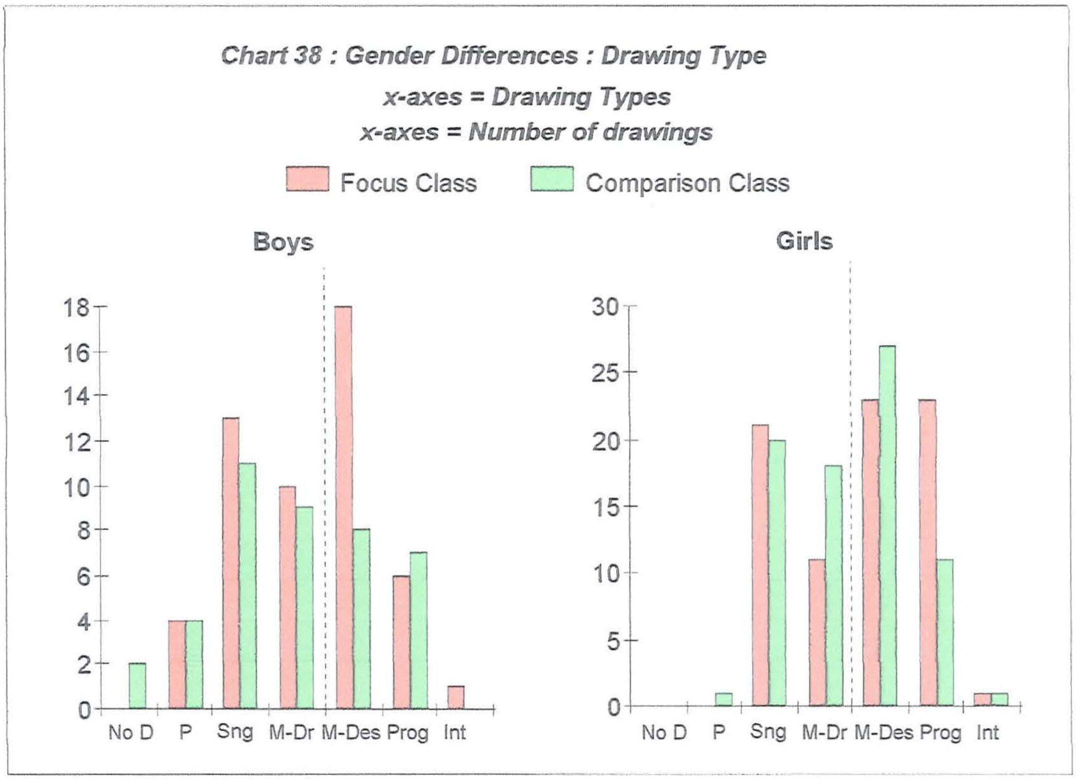
The Comparison Class boys' average is low for writing because the child with muscular dystrophy did not achieve Level 1. He was, however, a good designer.




The following observations of Chart 38 can be made:

- There is very little difference between the Focus Class boys and girls, whereas there is a marked difference between the Comparison Class boys and girls;
- There is a greater difference between the Focus Class boys and the Comparison Class boys than between the Focus Class girls and the Comparison Class girls;
- The Focus Class boys out-perform the Comparison Class girls.

Thus, the Focus Class, both boys and girls, developed a better understanding of design drawing as a result of receiving the Programme.




*The difference in numbers between each gender sample in Chart 38 has been accommodated by making the display the same size but indicating the difference in numbers in the y-axes scales.*

Observations:

- There is a high number of Multi-design drawings produced by Focus Class boys. The number of girls' Multi-designs is roughly equal across both classes.
- The boys in both classes produced roughly the same number of Progressive drawings as the Comparison Class girls. The number of Progressive drawings by Focus Class girls is much higher.
- Roughly the same number of boys and Comparison Class girls use Multi-Draw. The Focus Class girls have used more Progressive drawings and less Multi-Draw.
- The number of Single-draws is roughly the same for both genders in both classes, although lowest amongst Focus Class boys.

The line between Multi-Draw and Multi-Design has been marked to indicate the division between design drawings that are static and those in which ideas are travelling. This shows that similar numbers of boys and girls in the Focus Class have ideas on a journey across their paper, whilst this is true only of Comparison Class girls.

## 5.9.2 Accounting for Differences

My search for reasons for these results led to conclusions drawn from observations of children working and reflection on reading of the literature of gender issues which meshed with understandings established through the literature in the Exploratory Phase.

### *5.9.2a Discussion whilst Drawing*

My de-briefing conversation with Randal after the Flat Stan input (Section 4.4.2c) illustrates the extent to which the Focus Class boys discussed their ideas as they drew. Such design conversations led me to understand that this was not "copying" but co-operation and that the apparent randomness of some of these boys drawings was due to swapping ideas. Craig was always full of helpful suggestions to others. He was observed several times discussing what others could do to develop their ideas and so his input appears in several other children's drawings.

I think this particularly helped Noel who was a slower learner across the rest of the curriculum but included in this friendship group because of his football prowess. His friends' support scaffolded his learning and enabled him to develop into a successful designer.

The main girls' group in the Focus Class tended to chat less whilst they were drawing, but their occasional comments to each other denoted awareness of each others' good ideas. For example, this brief exchange seems almost meaningless:

> *Natasha (to Ellie) : I'm doing a rabbit.*
> *Ellie: That's a good idea.*

However, Natasha had developed a detailed plan of how she will have pop-up rabbit's ears coming out of her Easter Egg Holder as it opens. Once this girls' group started making, several (including Ellie) included Natasha's rabbits' ears in their own product. The idea also appeared in some of the boys' work via the itinerant Craig.

Although my observation time in the Comparison Class was limited to the Assessment Tasks, I recorded few instances of co-operative working whilst planning, reaching its most extreme in their almost silent working whilst drawing their Mazes. The effects of this lack of discussion on their ability to Address the Constraints and to Explore the Possibilities of the Task was discussed as an emergent theme from the Dimensions analysis in Section 5.7.4. They did not act as checks on each other when mistakes were made. They did not share good ideas or suggest things to each other to extend each others design thinking whilst drawing. In the Focus Class I frequently heard children, especially boys, saying *"What you could do is.."*

This discussion of design ideas whilst drawing was a consistent feature across Teaching Input activities and Assessment Tasks could, therefore, be seen as a factor which enabled the Focus Class boys to outperform the Comparison Class boys and girls.

## *5.9.2b Designerly Play*

Browne & Ross' (1995) typifications of young children in free play activities resonate with my own observations in my Year 1 classroom. Girls tend to gravitate towards drawing and making small items at tables; boys sprawl across the floor playing with construction kits. Missing from the account, however, is the talk that accompanies play.

Browne & Ross typified boys as building models with construction kits, brmm-brmming them around briefly and then taking them apart to make something else. What Browne & Ross missed was that boys play and talk through the construction of complex structures, creating the fantasy and its vehicle together, integral with the social action. Browne & Ross typify girls as tending to make simple structures to support social interaction. My observations of girls at play is that they will create just sufficient play-props to maintain the story line. Whilst sitting making things as a group, they keep a weather eye on what each other are doing, monitoring each others output and appropriating good ideas without comment, often whilst talking about something else.

Both play styles were observed within the design styles of the Focus Class. The outgoing sociable main boys' group talked their way through every activity. They freely shared and commented on each other's ideas in the same way as they would play with a pile of Lego. Such design by discussion facilitated co-operation and sharing of ideas and through peer support enabled boys such as Noel (who had limited language and academic skills) to succeed as a designer. The main girls' group talked less, usually on the practical (sharing pencils or sellotape) or apparently superficial (colour, decorative features) yet shared good ideas appeared within each others' work, whether rabbits ears or mosaic floors.

I had made connections between children's play activities and designing in the Exploratory Phase (Section 3.2.6), having made many observations of Baynes' (1989) "designerly play" in my Year 1 classroom. The truth of his insights were confirmed at a In-service Training Course on using role-play for literacy development which included "designerly" skills such as negotiation, imagination, communication and so on. My observations of children at play had fed into my developing understanding of drawing as metaphor which had in turn led to the recognition of the potential of Lakoff & Johnson's (1980) theories and the adoption of the Container / Journey metaphor to teach design to young children. Thus the holistic at the heart of the Programme delivery was able to tap into children's personal play styles and enabled them to experiment and be creative with ideas on paper.

The Comparison Class were also playing with ideas in the Assessment Tasks but my comments on their playing have not been complementary, since they frequently ignored the rules of the game: the Constraints of the Task. Both gender play styles were there, typified perhaps by the boys snake pits and the girls' cards *"for Mummy because she doesn't like her new job"* (Kathy). But they did not harness these play styles whilst drawing. Experimenting and playing with ideas began in contact with the construction materials, leaving on the paper a static, first reaction to the task. The girls were happy to draw and write about something they might make (Browne and Ross (1995) record drawing as a favoured girls' play activity). The boys, quite simply, failed to see the point of the drawing.

### 5.9.2c Accessibility of the Container / Journey Metaphor

The results of the quantified analysis suggest that the Container / Journey metaphor was equally well understood by both boys and girls in the Focus Class and that the freedom given to explore ways of using drawing to record that journey was not prejudicial to either group.

The Programme was geared towards teaching for understanding of design in terms of this metaphor, not towards teaching of techniques which might have been more accessible to one gender group than the other. A range of drawing styles were encouraged and celebrated, since I wanted children to use drawing flexibly to support thinking and to develop their ideas. When children's work was shared with each other, I praised and publicly valued designs that showed elements of journeying. I did not attempt to change the way children recorded their ideas in terms of techniques used, nor did I endorse specific recording techniques.

There was no pressure to annotate drawings or add measurements, although many children did so. The teaching was about using drawing to support thinking. This allowed children's understanding to develop, whilst giving them freedom to express that understanding as they felt fitted the task in hand. Secure in my understanding of the role of drawing in designing and in aiming to impart that holistic understanding, I was able to accommodate a wide range of learning styles, which, as a by-product, supported boys and girls equally.

## 5.9.3 Reflections on Gender Issues

Kimbell et al. (1991) reported that gender differences in attainment were lower within classes of children who had opted to study Craft, Design and Technology than amongst those who had not, thus suggesting that direct teaching of design skills can enable all children to achieve equally well. Recent GCSE examination results, however, appear to suggest that perhaps girls are ahead in the subject. My observations of the social way in which boys design, compared to the way in which girls record their own ideas in greater detail, might suggest that it is the structure and organisation of the 16+ examination itself which is causing the effect, rather than differences in boys' and girls' capabilities.

As stated at the beginning of Section 5.9, gender issues did not feature greatly in my original thinking. However, reflection on Browne & Ross (1995), in pursuit of an answer to the results of my analysis, led to conclusions about the way that designing keys into play styles which connected back to observations and reading during the Exploratory Phase.

That the aim of my Programme was to impart understanding rather than to endorse any particular choice of recording technique, together with public praise of any means of moving design ideas forward, may have contributed to the equal success of boys and girls within the Focus Class.

## 5.10 Reflections on Analysis of the Assessment Tasks

At four points in Section 5, there has been a summarising section in which emergent themes were identified and discussed (Sections 5.3.2; 5.6.4; 5.7.4 and 5.8.3). This will not be repeated here since these are brought together in Section 6.2. The purpose of this section is to reflect on the aspects of the research that developing the analysis methodology for the Structured Phase brought to light, especially in relation to validation of results.

*Assessment Tasks*

The Assessment Tasks enabled children's understanding and use of design drawing to be examined in a range of Design and Technology contexts. The tasks represented a range of opportunities for observing and assessing performance.

I discovered that children can be task-sensitive in the way that they use drawing to a greater extent than I realised ahead of analysis of the Assessment Tasks. Product design and problem scenarios elicited a different use of drawing and so it was decided to analyse these separately.

Since I was not aiming for a positivist, pre-input/post-input testing regime, the differences between the Assessment Tasks were able to add richness to the data, rather than detract from it. My sample of children was too small to aim for a true quantitative methodology and, by the very nature of designing as a "wicked" problem (Rittel & Webber,1976), as well as the unpredictable complexities of working with small children, this would not have been a suitable paradigm in which to work.

My teaching experience enabled me to match the tasks appropriately to the maturation of the children, to design activities that would be suitable for the stages along the way through the Programme. I discovered more about children's use of drawing for designing from the diversity within the tasks than if they had all been alike.

*Balance between qualitative evaluation and quantified analysis*

A major step forward in my conceptual understanding came in realising that the child's understanding of the purpose of drawing for designing was the determining factor in how they chose to use it to support their thinking. Discovering Pascal and Bertram's (1989) evaluation model at about the same time, enabled me to combine the insight and the model to create a representation of my holistic view of the child's experience, which could also function as an analysis tool.

Placing the child and their learning at the centre of the process gave me a way of integrating the data that I collected across the course of the Programme. It enabled me to re-establish my belief in the holism of experience and learning as a means of exploiting both qualitative insights and quantitative methods as mutually enhancing views on the whole. The video and audio recordings, observations and reflections in my Log Book, sketches and notes about children's work in progress all gave reality and context to the percentages and radial plots produced through the quantified analysis. At the same time, trends and issues emerged as important that would have passed unnoticed had it not been for the quantification of judgements made about the drawings.

### *The Multi-layered Analysis Instrument*

At the start of the Structured Phase the pragmatics seemed straightforward: the Programme was written ahead of time; and I would deliver the Teaching Input; the drawings would be collected from each Assessment Task and I would assess the results. However, the refining and re-defining of the instrument in the light of developing theoretical understandings was the greater part of my research journey during the Structured Phase.

The re-definition of the quantified analysis instrument in terms of a holistic view of learning and understanding meant that genuine roles for both qualitative evaluation and quantified analysis could be found, with no sense of artificial bonding. Both contributed insights and ways of seeing the children's achievements and their processes.

The range of criteria on which the drawings were evaluated, both between and within the layers of the analysis instrument, enabled a multi-faceted picture of the children's capability to emerge. The inter-relationship of the layers of the instrument, that had evolved as it had been refined and developed, ensured that these layers were mutually supporting and the between-layer relationships within the results explored (for example, relating the understanding of the Purpose of the Drawing to the Drawing Type used).

### *Developing Theoretical Understandings through Analysis*

In the course of devising, refining and re-defining the analysis instrument, I was also reflecting on the way that aspects of designing fit together. This was especially true of the insights that emerged during the development and analysis of the Dimensions of Design Drawing. Across the various iterations and refinements of the instrument, my reflections on observations, reading and analysis enabled me to take apart and piece together a personal belief-system about the nature of design and about design education.

# SECTION 6 : Conclusions and Reflections

# 6.1 Overview Summary of my Research Journey

I began my research with questions about young children's designing at a time when the linear view of the design process, implied by the layout and wording of the National Curriculum documentation, was all that many teachers (including myself) knew. As Kimbell et al.'s (1991) conclusions indicate, the way that the Attainment Targets are viewed (either as sequential steps or domains of capability) makes a significant difference to the way they are interpreted and hence how teachers teach Design and Technology. The application of industrial project management systems to Secondary School practice, which were then extrapolated downwards to Primary Schools, did not fit with the theories of child development of Piaget-steeped Primary practitioners that were coming up to meet it. There was minimal research on what Key Stage 1 could do.

My questions centred on what could (should?) children aged 5-9 be doing in terms of using drawing to support designing.

However, as the research evolved, it was not enough to observe what they could already do. As a teacher, I was keen to discover what more they could be taught to do, and how. Hence the change of emphasis partway through the research from the Exploratory (descriptive, mapping out the field) to the Structured Phase (with hypothesis in hand, attempting to make improvements in performance, "raise standards").

During the Exploratory Phase (described in Section 3), I changed from thinking that Key Stage 1 children would find it very difficult, if not impossible, to use drawing to support their designing to a position of believing that Year 2 children could be taught to use drawing to develop design ideas and that I knew how I could do so. This change came from related literature on cognitive and language development, where I could see parallels with the development of graphic skills, as much as from the literature on children's drawing or designing (Section 3.4)

Early in my research, I became interested in the role of symbolic manipulation in design capability. This threaded through the Taxonomies and the related Concept Webs (Section 3.4.1) and on into the perception of drawing as metaphor, with the belief that when children understand that drawing is symbolic and can manipulate it as symbols, then they can use it powerfully as a design medium.

I increasingly focused on extrapolation skills and the understanding of analogy and metaphor and realised how much teachers rely on children possessing these skills in order to make personal sense of teaching input. I discovered a metaphor for designing which I believed I could make work in a Year 2 classroom: the Container / Journey metaphor, as a way of seeing the drawing as product or process, taking ideas on a journey. (Section 3.4.2).

The transition to the Structured Phase (Sections 4 & 5) was the point at which I felt most daunted at what I had set out to do: how to prove the "big idea" about drawing being metaphorical and that this could be used to teach children to access the genre. I was happy trying things out and seeing what happened, almost on an ad hoc basis. To put together a long-term Programme in the belief that it would enhance children's learning, based only on what I believed I knew, was an act of faith in which I did not always feel very confident.

Perceiving the potential application of Pascal & Bertram's (1989) holistic model for transforming the quantified analysis instrument into a viable tool to assess children's drawings put the purpose of the drawing centre stage (Section 5.4.3). It transformed the elements of the research into an integrated whole. The Container / Journey metaphor taught the children what I believed was the purpose of design drawing (to take ideas across a page and off into the making) and the assessment model placed centrally the children's perception of that purpose. Relating this to the Dimensions of Design Drawing to create discrete Continua (and discovering that I could display these as radial plots from my spreadsheets) enabled a second layer of the integrated analysis system.

The results of the Structured Phase analysis did not just confirm what I had already learnt at the Exploratory Phase. New information came out of the data. For example, the degree of task dependency of drawing use, through comparison of product design tasks to problem scenarios (Sections 5.5.2 & 5.7.2b). New insights emerged, especially the importance of discussion whilst designing and planning to make, both for creativity and addressing the task criteria (Section 5.3.2 & 5.7.4).

The results of both the qualitative and quantified analyses demonstrated that the Focus Class' design capability considerably exceeded that of the Comparison Class, suggesting that specific teaching of the role of drawing for designing via the Container / Journey metaphor was contributory to this success. This suggests that children's ability to learn through metaphorical inference to be quite finely tuned at an early age. Children appear to move from the symbolic towards the realistic, rather than the other way around. In the Exploratory Phase, I observed that the younger children were more likely to pretend that the things they made could work or answer a need. In the Structured Phase, the Comparison Class maintained this pretend way of working to the end of the Programme. The Focus Class did not. They were able to reason within a fantasy scenario yet produce solutions which satisfied the reality of the task.

# 6.2 Key Themes that Emerged from the Research

At several points along the way, Emergent Themes have been pulled together, from the qualitative evaluation of the Teaching Input and Assessment Tasks and from the results of the quantitative analyses of the Purpose of Drawing, Drawing Types, Dimensions Continua and Techniques Ticksheet (Sections 4.5.2, 5.3.2, 5.5.3, 5.6.4, 5.7.4 and 5.8.3). The aim of this final "themes" section is to pull together the reflections that have been woven throughout these reflective summaries from the major sections of the Structured Phase, whilst also paying more than lip-service to the work in the Exploratory Phase that provided the foundation on which the Structured Phase could be built.

## 6.2.1 Children can use drawing to plan what they want to make

The Exploratory Phase of the research revealed that, although many design drawings by Key Stage 1 children were rudimentary, there was sufficient potential in them for me to believe that Year 2 children could be taught to use drawing as a design tool (Section 3.3). This view was supported by my reading of parallel literature on language and cognitive development.

The results from both classes in the Structured Phase showed that it is possible for Key Stage 1 children to record their design ideas and to begin to develop them towards a plan for making a product. The far greater capability of the Focus Class demonstrated that with appropriate teaching, such young children can access the genre with considerably greater success.

I believe that being able to use drawing for designing is linked to the development of children's facility with symbolic manipulation and that this was the skill that Piaget identified as emerging around age 7 years. Piaget's critics (e.g. Donaldson, 1978) have linked this skill to the effects of formal schooling rather than innate development and my research would appear to support this position. The Focus Class, who received the teaching input, were able to manipulate a symbol system (drawing) in a way that the Comparison Class could not. This was evident across the ability range. There were more highly achieving Focus Class children and the least able demonstrated greater capability than the lowest achievers within the Comparison Class. Only Emma in the Comparison Class could hold her own with the high achieving group in the Focus Class but she was almost the oldest child in the sample and one of the only two children in the year group (of 95 children) to attain Level 3 on all SATs tests.

### 6.2.2 The Programme was Successful

As a result of the Programme, the Focus Class learnt to use drawing to support the development of their design solutions and to value drawing as a means of scaffolding ideas and communicating with peers and with me as teacher. They learnt that designing is an iterative process in which ideas change and develop and that the process itself is important and that first ideas are not "wrong" but a staging-post towards a better idea. They learnt the vocabulary of design (sketch, diagram, labelling, develop ideas, etc.), which enabled them to access, use and discuss design techniques.

The observations of children working recorded on video and audio-tape together with Log Book notes (Section 5.3) suggested a greater level of understanding amongst Focus Class than amongst Comparison Class children. These observations were supported by the quantified analysis. The Purpose of Drawing analysis (Section 5.5) showed that the Focus Class children had a clearer *understanding of the role of drawing* to support design thinking as a result of the Programme when compared to the Comparison Class children who had no such input. The Drawing Types analysis (Section 5.6) suggested that the Focus Class used *more sophisticated* Drawing Types earlier and more frequently throughout the Programme than the Comparison Class. The Dimensions Plots (Section 5.7) suggested that the Focus Class had a more overall understanding of *how to use* drawing for designing. The Ticksheet analysis (Section 5.8) showed a *greater range* of techniques in use in the Focus Class.

The differences between the two classes would suggest, therefore, that the Programme had successfully enabled the Focus Class to understand the *usefulness* of drawing to support designing and that the Container / Journey metaphor had been a successful medium by which to teach them to do so. The Comparison Class lacked a central understanding of the purpose of drawing for designing and so could not use it to support their planning in any personally meaningful way, which was evidenced by the lack of connection between the drawing and the making. Where Focus Class children departed from their own plans, it was frequently to incorporate features of someone else's.

### 6.2.3 Why Children Choose to Draw As They Do

The Exploratory Phase of the research led to the identification of the Drawing Types as a classification system of the drawings produced by the children across the 5-9 age range (Section 3.3.4). There was clearly a progression of some sort within Drawing Types: the youngest produced Pictures and Single-draws, the older children Multi-design and

Progressives, with the occasional Interactive features. However, it was also clear that this was not a simple linear progression.

Through my reflection and observation, I came to the conclusion that there was a competence level inherent in both Multi-design and Progressive drawing ability, in terms of symbolic manipulation skills, which once reached could be exploited at will. Both Multi-design and Progressive Drawings demonstrated an understanding that drawing could be used to represent ideas that could be changed and developed, "seen as" the real object as imagined in the mind's eye, a place-marking from which a design journey could be continued. This related to the Purpose Continuum categories *Using drawing to record design possibilities, Developing design possibilities* and *Working out what will be made and how.* Prior to this realisation, the recording of design ideas is static. A possibility is drawn but does not represent or support the flow of ideas about design possibilities or solutions (Section 5.6.2).

Such understanding enables children to choose to record multiple possibilities if they are swamped with ideas (Multi-design) or to develop their instant "I know what to do" reaction towards a design resolution to see if it would work (Progressive). Understanding of the purpose of drawing for designing as being the recording and development of design ideas , sets children free from having to produce any particular sort of drawing, even to the extent of knowing when not to draw (for example, writing a list of materials). The possibilities recorded as quick sketches (typical of Multi-design) are multiple possible directions the design could go (like roundabout exits). The Progressive drawings, the developments of a single idea towards making is more like the unfolding of a route with few side-turnings.

Multi-draw forms the bridge between Single-draw and these design journeys. However, once the journeying stage was reached, children would also use Multi-draw as a short-hand for situations where they did not feel the need for the support of the drawing. They did not, however, revert to Single-draw.

The round-cornered rectangle in Fig.59 (overleaf) represents this plateau of realisation. The arrows are double-ended to indicate the by-directionality of choice of Drawing Type that the freedom of this cognitive plateau allows. Children who produce Single-drawings have not begun to understand how drawing can be used to develop design ideas. They have learnt the genre (no background, clouds in sky, etc.) but have no grasp that drawing can be used as a tool for the development of design ideas, cut free from its ground anchor and used as the supporting structure for free-flowing ideas.

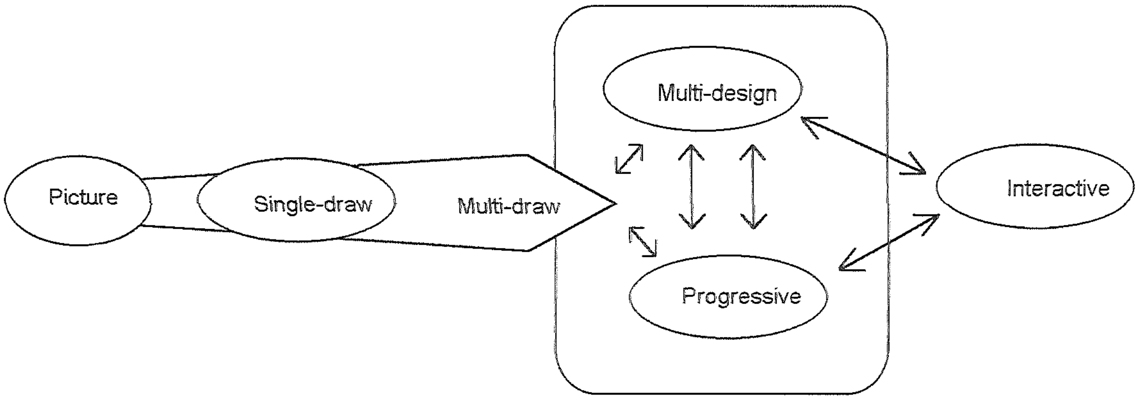



*Fig. 59 : Developing Understanding of Design Drawing (a)*

Relating this to the children's understanding of the purpose of the drawing to support designing, Fig.60 demonstrates the way this plateau of realisation allows children to become far more fluid in their use of drawing to support designing.

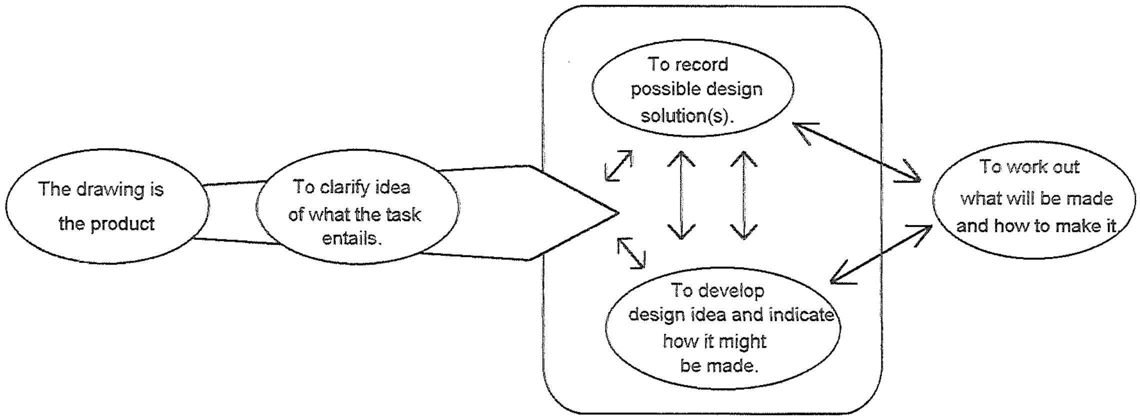



*Fig. 60 : Developing Understanding of Design Drawing (b)*

Crossing the bridge between clarifying the task and designing solutions means that children can then choose the recording technique that they feel most appropriately fits their level of clarity about the task in hand. If they have a rush of ideas but are not sure which to choose, then they use Multi-design. If they settle quickly on one idea but need to develop ideas about its viability for making, they use Progressive drawing.

Arriving on this plateau indicates arriving at an understanding of the Journeying aspect of the genre of design drawing. I think that the Container / Journey metaphor cannot be accessed until some understanding of the purpose of drawing for designing has developed. This process is frequently evidenced by the use of Multi-draw. Chart 12 in Section 5.2.2 shows two different scenarios for Multi-draw. In the Focus Class, its occurrence is divided between the static and journeying categories of purpose perception. In the Comparison Class, its occurrence is almost all in the static category. I think that this difference of function of the same Drawing Type is evidence of the difference between the two classes in their understanding of the design drawing as a vehicle for developing design solutions.

During the course of conducting the quantified analysis of the Structured Phase, it became clear that children were using drawing differently in problem scenarios to product design tasks. For product design tasks, the Focus Class, particularly, were using the drawing to think through materials, decorative features and construction. For the problem-scenario tasks, the children did not record materials or construction techniques. The priority was to develop a solution. It would seem that they had an awareness of the different status of the 3-D resolution (as product or model) and were able to adjust the level of detail in the drawing accordingly.

## 6.2.4 Understanding the Purpose of Drawing for Designing

I came to realise that *understanding the purpose of drawing for designing* is the determining factor that allows children to cross the "bridge" into fluency with the genre of design drawing. Once children understand that drawing can be used to develop initial ideas and work out how to make a product that satisfies the design brief, then they are able to choose the kind of drawing that suits their response to the task. That this would not become clear to me until part-way through the process of devising an analysis instrument for the Structured Phase drawings (and after the completion of the Programme) is one of the ironies of my research journey.

By being constantly reflective and maintaining dialogue with those whose research was parallel to my own, I was able to identify and make explicit this underlying, implicit, construct. The appeal of the Container / Journey metaphor was that it answered for me the question *"What is the function of drawing for designing?"* as *"To contain ideas to take on a journey"*.

That this reasoning was commutative (that teaching children that drawing is a container for ideas that can then be taken on a journey would lead them into understanding the purpose of using drawing for designing) was to emerge in the analysis process, rather than preceding the design of the Programme. This was probably no bad thing in terms of the teaching: the children were able to construct their own understanding of the role of drawing in designing. If I had been too explicit it could have hindered rather than aided holistic conceptual development and understanding. My Container / Journey metaphor gave the children an explanation for what they were being asked to do that they could understand and work with.

It was this understanding that distinguished the work of the Focus Class from that of the Comparison Class. Even on the final Maze task, many Comparison Class children were still using drawing to clarify meaning, rather than to develop a design solution, which led to a much lower level of success in terms of design resolution (Section 5.3.1f & 5.7.1). They were less likely to have satisfied the task criteria or to have produced a creative response (Section 5.7.2). This trend was evident also in earlier tasks, surfacing at Easter, immediately after the sharing of the Container / Journey metaphor with the Focus Class (Section 5.7.1).

I think that the Comparison Class saw the drawing as a prelude to the real business of task resolution, whereas the Focus Class saw it as integral. The Comparison Class spent only a short time on their drawings and quickly abandoned drawing once others started making. In the Focus Class, children saw no need to stop discussing and drawing if others had moved on to making. Some children even sat and completed their drawings after all other children around them had come back from collecting their materials and begun making. This would indicate that the Focus Class children saw the drawing as an important part of the whole process.

## 6.2.5 The Container / Journey metaphor

In reaching the conclusion that this would be suitable to explain design drawing to young children, several metaphorical leaps of my own had been made. It assumed, based on Lakoff and Johnson's (1980) understanding of the role of metaphor in concept construction, that all new knowledge is built by metaphorical connection with previous knowledge. It assumed that all people, including young children, can access metaphor as a concept-building devise and that teachers frequently uses this assumption in practice. It was metaphorical leap (Fig. 61) and not a logical connection between "drawing is a metaphor" and "a suitable metaphor can be used to explain design drawing to young children."

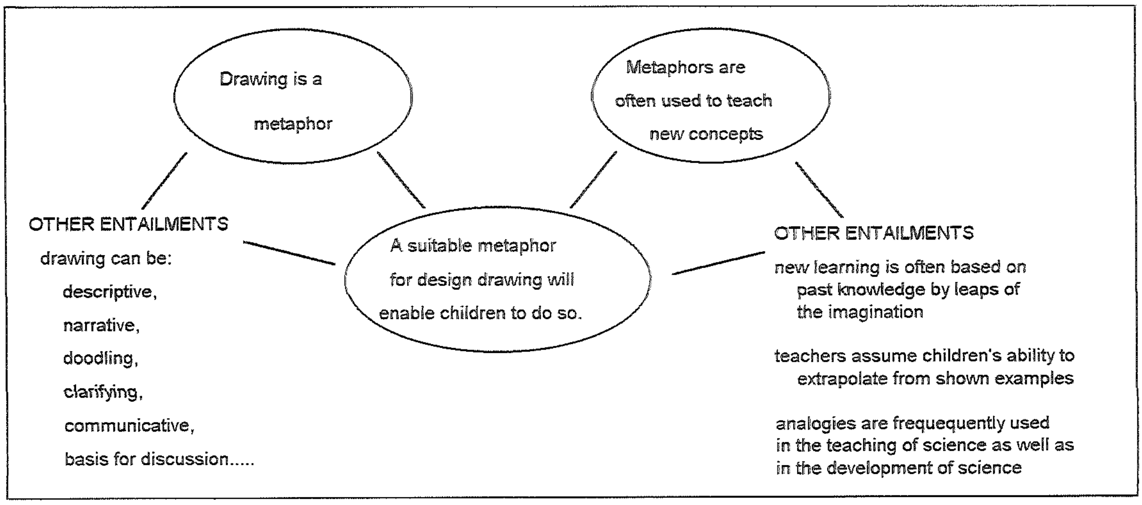



*Fig. 61 : Metaphorical Reasoning about Design Drawing*

The Container / Journey metaphor was couched in story form, complete with mime, to demonstrate putting ideas into an imaginary carrier bag which was then carried along on the journey to the next stopping place, unpacked and each imaginary item examined and put down and then the bag repacked and other useful objects found and the process repeated. The way this related to design drawing became part of the seamless narrative explanation, complete with appropriate hand actions between brain and imaginary piece of paper. I think the children appreciated the idea at a sub-linguistic level.

The Focus Class were able, immediately upon being taught this view of designing, to produce drawings that expressed their design intentions more fully than any I had seen before amongst Year 2 children (they outperformed most on my previous Year 3 examples) and since the Focus Class' work continued to exhibit a greater degree of design success than that of the Comparison Class, it must be argued that the metaphor was an appropriate vehicle for conveying understanding of design drawing. The effect on their use of drawing was immediate. It did not grow gradually, indeed some regression occurred amongst those who had not completely understood. It was not a skill that they developed; the Comparison Class did not come to this conclusion about the use of drawing or use it effectively to develop design ideas throughout the course of the Programme.

An additional factor in the success of the teaching of the metaphor was that it was visual as well as aural. Viewing the Snook's Animals PowerPoint presentation set the scene for understanding the features of a design drawing. Reviewing this by starting the Stan cycle by showing the children examples of other children's planning drawings and pictures gave them the information needed to make sense of the explanation and the diagram.

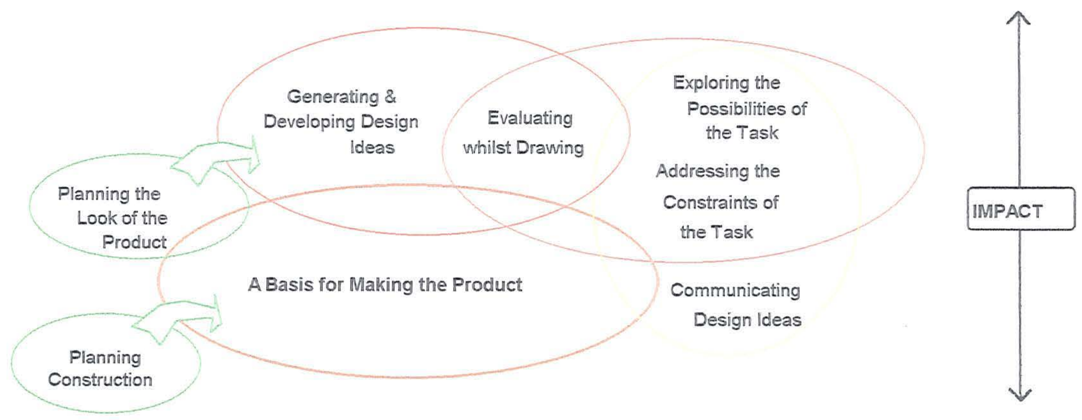
## 6.2.6 Dimensions of Design Drawing on a Journey

If the endpoint of designing as a teleological act is its realisation as a finished product, then the relationship of the other Dimensions of Design Drawing to "Basis for Making" should reveal something about their relative importance in design journeying and impacts on questions about the Dimensions which had been below the surface throughout the analysis:

- Is there a hierarchy or are all equally important?
- Are some more closely related to each other than others?
- Are some dependent on others / are some independent of others?
- Are any more / less important?
- Which are the ones to stress to get good results?

To address these questions in relationship to taking ideas on a journey, I created a concept map (Fig. 62) based on the emergent themes of Section 5.7 :

*Fig. 62 Relating the Design Dimensions to Making the Product*

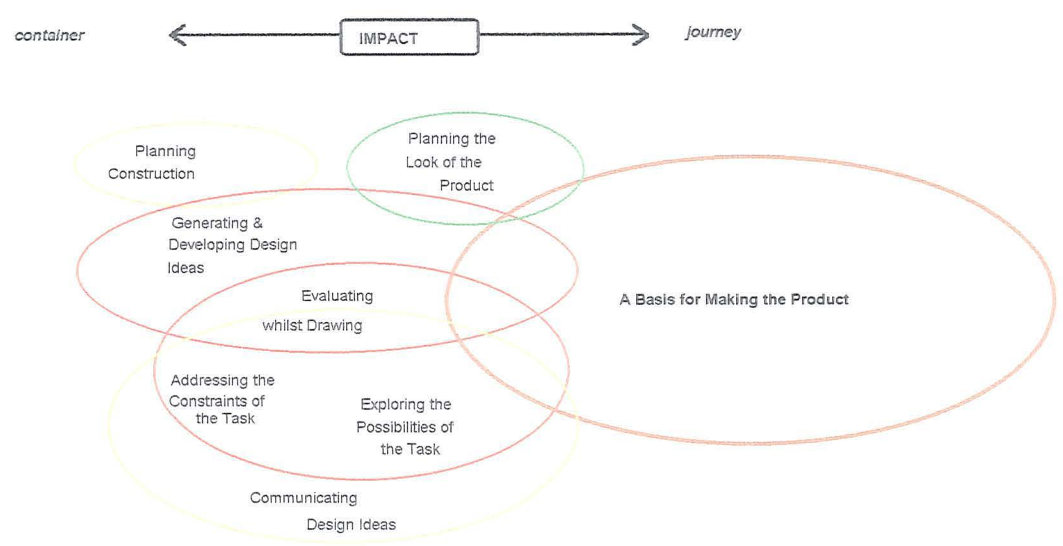



The key Dimensions, which have the strongest impact on each other and appeared to be most important for the successful use of drawing for designing are : Generating Developing Design Ideas, Exploring Possibilities, Addressing the Task Constraints and, central to these three, Evaluating whilst Drawing. This has close similarities with Rogers and Clare's (1994) design model (Fig.22 in Section 2.4.2). Planning the Look of the Product is placed at the side. It is either an essential in product design (indicated by arrow) or irrelevant to problem scenarios. Communicating Design Ideas with each other was important for Exploring the Possibilities of the Task and for Addressing the Constraints of the Task (Section 5.7.4). Conversely, a drawing that was easy to understand (perhaps because well-labelled) was not necessarily an indicator that high quality design thinking had taken place.

The Dimensions that have the least impact of the use of drawing for designing are those which can be achieved without the child using the drawing to move the design forward. Many Comparison Class children produced clear construction plans which were subsequently ignored. It was this kind of work that McCormick et al (1994) accused of being ritualistic. For example: Holly produced a single drawing at Easter of a clearly-labelled, lidded cup with no tube in drawing or product; Nicola drew two sets of well-labelled Suitcase instructions neither of which were followed when making. Both of these Comparison Class girls clearly communicated their ideas for construction but did not moved their ideas towards satisfying task criteria (Holly) or connecting the designing with the making (Nicola).

The grappling with design ideas happens within the generating and evaluating of developing ideas within the potentials of the task as set. For example: Hayley's Easter chick, with her attempt to indicating yellow card wings that would flap or Damian's combination of ideas for his Card which culminated in a pop-up bomb when the card was opened. These Focus Class children had understood design drawing as useful for developing creative ideas about how to solve a specific design problem. Rearrangement of the concept map links the Dimensions more explicitly to taking design ideas on a journey across a sheet of paper and off into making a product:

*Fig. 63 : Moving Forward Design Ideas*




As the analysis of the Comparison Class' drawings revealed, Planning Construction may not necessarily indicate that ideas are moving towards making the final product (Sections 5.7.1-2). Likewise, Planning the Look of the Product can be a major driver in moving ideas forward but it can equally be a token recording of identical products with different patterns. It is less relevant, of course, to solving problem scenarios.

It does not necessarily follow, however, that a wonderful design journey across a sheet of paper will result in the production of a product to match or that the plans are not abandoned once the materials are to hand and a friend is seen to have had a more appealing idea. However, plans that are well-developed and that represent ideas shared and discussed with peers are more likely to be followed through in the making.

If Addressing Task Constraints and Exploring Possibilities are pulled together as *"Awareness of Task Potential"* and if Planning the Look of the Product is considered as part of Generating and Developing Ideas about a product, then the Dimensions essential for design journeys through drawing appear to be as shown in Fig.64, overleaf:

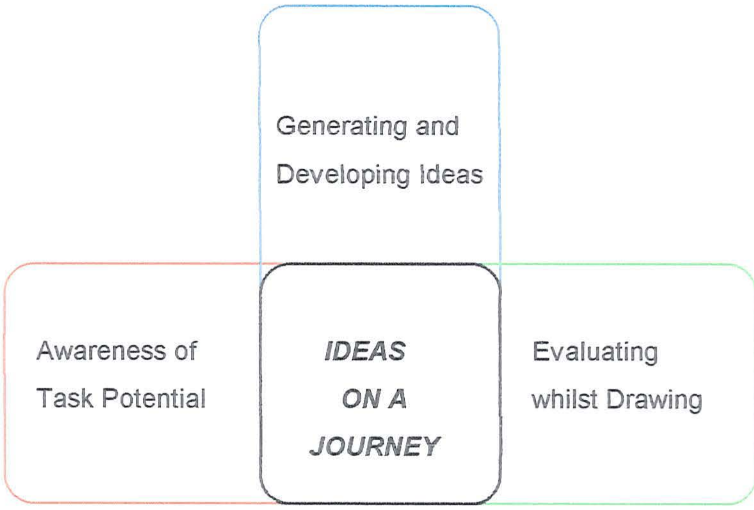



*Fig. 64 : Contributors to Ideas on a Journey*

## 6.2.7 Generating and Evaluating Creative Solutions

The results from the Structured Phase indicated a primary role for using drawing for Generating and Developing Design Ideas (Section 5.7.1-2). If the drawing is not well used here, further development of ideas through drawing did not take place. Whether or not the children recorded materials or construction techniques, the drawing supported and aided their thinking at the earliest stage of beginning to form images of what they would like to make.

By starting with using drawing to generate ideas, and understanding the process as journey, the Focus Class children took the drawing as far along the track as they felt they needed it to support their thinking. For Comparison Class children, recording how to make a product for which they had a much less clear mental image meant that there was frequently little relationship between the drawing and the final product. Although the Comparison Class could produce detailed working drawings, these did not represent part of the flow of their real design thoughts. This was in contrast to the Focus Class who either recorded several different possibilities, made improvements or indicated how they thought they might make the product. This seems to indicate a different view of the purpose of the drawing. The Focus Class were using drawing to develop a design solution, whereas the Comparison Class were defining the design problem, which made it more likely that the drawing would be subsequently ignored.

Boden (2001), in discussing "exploratory creativity", makes a brief comment in passing that mental spaces are easier to change or adapt than physical ones. It would appear that their greater facility with design drawing had provided the Focus Class with a means of scaffolding their thinking, so that their own thoughts had become visible to themselves and others and thus available for review and discussion. This enabled a greater creativity of response through playing with ideas which, whilst still in the mind's eye, could be adapted and changed through reference to the drawing. The Focus Class were beginning to use the drawing as a modelling tool, whereas the Comparison Class tended to wait until they were handling the materials before making the real decisions about the product they were going to make.

The Focus Class were much more able to accept task constraints and search for a solution of the task as set. The Comparison Class seemed almost cavalier about the task, abandoning the cardboard tube that was central to the Easter Egg Holder problem, for example. The "tightness" of the early activities of the Programme, strongly teacher-led (for example, the analogy game-making activities) forced the Focus Class to accept my definition of success. The Comparison Class did not experience parallel activities and were, perhaps, given opportunities for freer exploration of their own ideas, rather than being asked to solve specified problems.

The analysis of the Dimensions of Design Drawing led me to realise that creativity in Design and Technology does not come about just by free-play experimentation with the materials. Realisation of the task potential is vital to formulate a creative solution to the problem. This is a balancing act between Addressing the Constraints and Exploring the Possibilities of the task as set. Understanding the purpose of design drawing as supporting the resolution of the tensions between these two apparently opposite demands enables the drawing to be used to move ideas from clarification of the task towards a design solution.

The Focus Class' greater ability to reason within the parameters of the task, was, I believe to do with their greater ability to reason within the rules of the design game, through having a clearer idea of what those rules were and, hence, which ones to bend and which ones must be adhered to more strictly. The design game says that the definitions of reality and fantasy are inherent within the task as set and that the successful conclusion of the task will be a solution which satisfies these parameters and, preferably, be novel or aesthetically pleasing.

In his rejection of the notion of logic as a universal pure, context free principle, Wittgenstein (1969) referred to the construction of meanings within separate domains of human endeavour as "language games," each with their own rules and internal logic from which phenomena are "seen as" and whose interpretation depends on the rules of the language game in question. Polanyi (1958) viewed each subject discipline as having its own tacit knowledge in which the rules make sense and the internal logic cohered but did not transfer to other disciplines or cultures. He saw this as being the reason for science and religion being unable to converse, since neither accepted the rules of engagement of the other's logic system.

Induction into language games can be seen in most didactic situations. The course writer has a clear view of the aims of the course and the teacher creates a social situation in which the learning of such outcomes can best be achieved and engineers the pupils into learning, not just the facts, but the underlying "seeing as". Teaching is not just of facts but also of how to answer questions posed in certain word frames.

For example:

> Key Stage 1 Science SATs question: *"How could we help the seeds in the dark cupboard grow better?"*
> The teacher was irritated with Maria's answer: *"Draw a picture of the sun and rain and pin it up inside the cupboard for the seeds to look at."*

But I find I want to create a story in which the bad teacher had put some poor seeds in a dark cupboard and then a sweet little girl came along and drew a picture of the sun and rain for them to look at and overnight the seeds grew and grew.... which is the stuff of children's literature, of metaphor and poetry and jumping from reality to fantasy and creating a new world order in which such things are possible. But this is not the right language game for science.

I believe that Wittgenstein's "seeing as" is central to using drawing as a design tool (see Section 3.4.3a) and that this is related to metaphorical perception. Solving a problem appropriately implies understanding and applying the "seeing as" limits of the question. Maria's answer does not necessarily imply that she understands little about science, only that she played the wrong language game with the question. Liddament (1991) applied Wittgenstein's concept of language games to designing and I believe this to be a powerful concept in defining what the skill of designing is. It involves the ability to reason within a set of perceived constraints and yet find a creative solution, in a way that has a family resemblance to a game of football in which players with flair can exploit the game potential whilst remaining within the constraints of the game's rules.

In design terms, this is the ability to juggle conflicts inherent in the problem-space and find a creative solution that satisfies both user and situational constraints. It is the ability to image fantasy onto reality, what might be onto what is, and to accept and reason within the fantasy / reality interface inherent in the design task. Pandy's Suitcase illustrates this dilemma: the children were asked to design a "real" suitcase for a toy panda "going on holiday" into which his real plastic mac would fit and which was the right size for Pandy to "carry".

I think this "seeing as" skill is also parallel to the ability to create paracosms, a complete fantasy world that has its own cultural and social history. Successful problem-solving depends on this paracosm ability, the ability to set up, reason and imagine within a clearly defined mind-space. Its beginnings are in the role-playing of young children.

The Programme enabled the Focus Class children to play with ideas within the design paracosm as defined to them through the Container / Journey metaphor. By defining a design play-space with the children that was clearly linked to the purpose of the design drawing, this became the basis of discussion of design reasoning. The shared vocabulary, the discussion of process, the externalisation of the conceptual foundations, all re-inforced the development of meta-cognition and the ability to think about design thinking.

One of my colleague Sue Hammond's powerful ideas about developing children's writing skills was that children should be encouraged to see themselves *as writers* and that as they role-played *being writers*, they would *become writers*. Children will role-play *being designers* if they know what designers do. They need to be told the rules of the game.

## 6.2.8 Multiple literacies: Discussing, Drawing and Writing

A contributing factor to the difference between the two classes' performance was the point at which the children discussed their ideas with each other. The Focus Class talked as they drew. The Comparison Class did not (they drew in silence for the Maze). I believe that this had an impact on the quality of ideas recorded in the drawings. It would indicate the importance of language for idea development and clarification. Ideas flowed in talk and the drawing interacted with the both the telling and the thinking. When children said *"What I'm going to do is"* to their neighbour as they drew, then the idea became more clear to themselves. I felt that this had an improving effect on the Focus Class' capability in using drawing to model design ideas and also to encourage creativity whilst keeping each other on-task (Section 5.3.2). It also demonstrated their understanding of the role of the drawing.

These observations are in accord with current research by Mantell (2000) into the role of language in designing and her observations of the way language frees us from the here and now and makes possible the imaging of the future. Such observations of the roles of drawing and language would lend support to Schon's assertion that:

> "Drawing and talking are parallel ways of designing and together make up ... the language of designing." (Schon; 1987: 45)

Koutsides (2001), quoting the work of Hennesey & Murphy (1995) suggests positive effects on problem solving skills in an environment in which co-operation and discussion is encouraged, where "concrete models and graphical representations play and important mediating role" (Koutsides, p. 57).

The ability to Address the Constraints of the Task was also aided by this talk. In discussion, ideas not only flowed but were challenged. The individualised view of recording in the Comparison Class meant little cross-pollination of ideas, discussion of the possible and adaptations in light of peer suggestions.

The conversation between some of the Comparison Class children when they were in the Reception class (Section 1.2.2) illustrated the way they co-operated, negotiated and built on each others ideas as they conversed. I hoped that I might see similar conversations across design drawings. In the Focus Class this was so but in the Comparison Class discussion was whilst making, not drawing. They were then less able to be reflective of their ideas since they had committed themselves to cutting into the materials. If this talk had happened at planning stage, then better ideas (more creative and task appropriate) may well have ensued.

A clear link emerged between *Generation of Design Ideas* and *Evaluation whilst Drawing*, linked in turn, I believe, to the level of peer discussion. The Comparison Class frequently drew a single undeveloped idea, with no changes or improvements recorded. I felt that their inability to address the task as set was exacerbated by their lack of discussion whilst drawing and planning. It was clear that they had no expectations of discussing each others' ideas at this stage, of presenting their ideas to each other for critical review or of offering evaluative feedback to each other. It was difficult to know which was cause or effect: whether they did not evaluate because they did not see answering the task criteria as vital to success, or whether they lost sight of the task because of their low level of evaluation.

Both classes used annotation of drawings to clarify and develop their design ideas. The choice to do so was frequently based on common sense (words such as *"green"* or *"shiny"* or *"lots of little stars cut out"*) which was used as a short-hand for recording ideas that would be inappropriate or take too long to draw. Only Peter (Comparison Class) did not draw at all and his choice of writing hampered the development of design ideas. He was not imaging a solution, only writing about the problem. Most children had no difficulty combining text and graphics and I concluded that their facility with the genre was probably enhanced by the study of non-fiction texts in Literacy Hour.

## SECTION 6 : Conclusions and Reflections

The relative roles assigned to writing and drawing seemed to be that the drawing was used to capture inner images and writing for descriptives. In the Sandals project, the Focus Class chose to write what they liked about the sandals they were shown and drew their ideas for sandals they would like to make. When they first put pencil to paper to begin designing, almost all children begin by drawing, very few even put their name on the paper before beginning to draw. Writing is then added for clarification, annotation and comment. Occasionally thoughts extending their ideas will be recorded in writing but it is more likely that the child will add another drawing, even if they are only changing the colour or pattern.

Whereas in the past, reading and writing were the essentials of education, in our fast-changing world, graphics have become equally powerful means of communication. Children live in a world in which they are surrounded by multiple literacies through television, advertising, computer screens as well as in books, posters and road signs. Increased foreign travel requires a greater facility with non-language-based communication. The rapid growth in computing power has enabled animation and special effects to make communication of sophisticated concepts less dependent on traditional text-based systems. The language of our world is no longer just speech and text. In such a cultural and social context, therefore, it becomes vital for children to be able to manipulate graphic symbols for developing and explaining their thoughts and ideas, not just for Design and Technology lessons, but as part of their repertoire for recording their own thoughts and in communicating with others.

The following, attributed to Wittgenstein, challenges all educators to provide children with tools for thought:

*The limits of my language mean the limits of my world.*

I would argue that the ability to use drawing to take ideas on a journey, both within and beyond a design context, extends thought beyond the barriers and limits imposed by the language of words and into the realm of visual imagery that can be produced and manipulated, turned through three (or even four) dimensions, simulated and digitised. The children of our world know that this is possible; they see it daily on their televisions and consoles. It is our duty as educators to provide the tools by which they can enter into this world as creators and not just consumers. Teaching young children to use drawing as a tool for thought seems, to me, to be an early step along that path.

# 6.3 Recommendations based on the Research

The following recommendations come from a position of caring deeply about both the education of young children and about the professional development of their teachers. Although my recommendations fall within the framework of the research into children's design drawing skills that I have conducted, I believe there are applications beyond its remit that affect the daily lives of our most important stake-holders in education, the children. Their needs are implicit in each of my recommendations and, although I address recommendations to teachers, managers, policy makers and curriculum writers, teacher educators and professional supporters, and parents, I believe that the needs of the children are central to education.

However, from my experience as a teacher conducting research, there are issues I would like to raise first concerning teachers as researchers.

## 6.3.1 Teachers as Researchers

When I delivered the paper "Participant Research from the Perspective of a Participant Researcher" at the IDATER 2001 conference, I told of the time that I walked back to class after lunch one day just after the introduction of the National Curriculum in 1989 and thought to myself "Research is dead, then." It seemed to me that once national directives about what and how we were to teach came into force, there was no point in anyone conducting research into children's learning. That the documents were called "Orders" seemed ominously significant. Since then, the orders have been framed ever more tightly, culminating in the Literacy Hour clock, and even the current apparent freedom in foundation subjects is countered by the QCA schemes of work that were sent to all schools. In a climate of such prescription, with target setting dominating the landscape and defining achievement, the teacher who wants to try something new and different in their classroom is doomed to a long and lonely walk.

As a teacher, I should feel most comfortable addressing other teachers but when I have conducted Inservice Training (Inset) sessions, I have found that the questions they bring with them relate to how to deliver a very narrowly conceived curriculum or published scheme of work. Fear of inspection failure appears to drive teachers into wanting to be provided with the formula for inspection success, in terms of which lessons to deliver and which practical skills to teach children in order to ensure achieving prescribed objectives. A culture change is needed within Primary education from "delivery" to "reflective practice." This change must come from policy-makers and implementers. It cannot be initiated by teachers, since they do not have the political power to do so.

I found it daunting to be the only Primary teacher at research conferences and yet I worked within a school community in which informal reflective discussions on children's learning and cognitive theory took place. I found myself becoming increasingly suspicious of the deficit model of action research that was emerging under Performance Management . It seemed that teachers could conduct research on how to improve our delivery of the National Curriculum and this could feed into our Performance Management. We were not good enough yet, but we could get grants to conduct research in our classrooms to find out how to become better at delivering the National Curriculum. Action research should be about competent teachers researching how to extend the boundaries of knowledge about how to improve and enhance children's learning in all directions, not just towards the unquestioned "targets" within an unassailable national framework.

There needs to be, too, a shift in perception of the relative roles of researcher and researched. Welch & Mueller (2002) speak of the need for teachers to become the creators of knowledge, not just the consumers. I believe that unless teachers are creators of knowledge, then educational standards can only decline as teachers seek the "one right answer" to passing Ofsted inspections and surviving the pressures of achieving externally set targets.

Teachers are increasingly being encouraged to undertake study at Master's Level, as a means to promotion in management roles, and yet largely remain outside the community of contributors to policy. If research into children's learning was recognised as part of the teacher's role and the findings of such research were respected by policy makers, then a transformation of teachers' perceptions and self-esteem would result. However, time and resources would need to be allocated to research activities and there would need to be some guarantee that outcomes would lead to implementation.

As summary to each sub-section of Section 2 Research Methodology, I applied the issues to myself: *Where do I fit?; Myself as both Teacher and Researcher; Applicability to my Research Methodology.* So, in my final comments here, how did the research process affect my perception of myself as a teacher conducting research?

My pessimism in 1989, that research was dead, was coupled with a realisation that, as a Primary teacher, not only that I did not have a voice, but I could not even ask the question: on what research evidence was the Design and Technology National Curriculum for Key Stage 1 based? Nearly ten years later, with a Master's degree and registered with Goldsmiths College to begin my M.Phil./Ph.D, I was able to ask Richard Kimbell that question.

Since its introduction, that curriculum document has changed in response from pressure from industry and from teachers' professional organisations. However, the relationship between policy and research into children's learning remains weak. The tinkerings are at the pragmatic rather than the pedagogical level, teachers are encouraged to think about "what works in classrooms", rather than develop their own understanding about how children learn.

After two years away from the classroom, I could not go back to having to accept government directives about what and how to teach or to working within a straight-jacket interpretation of how children are to be taught. I could not go back to non-research based teaching. I have been saddened to see one of my moderation panel leave full-time teaching and the other two accept unreflectively the adoption of all the QCA schemes of work for all foundation subjects in both Key Stage 1 & 2. Our home-grown creative ideas are now the programme for D&T Club for Key Stage 2 children after school.

In my final term in school, we had an Ofsted inspection. I received a good report of the Design and Technology lesson that was observed. The inspector was impressed that I was teaching Design and Technology to the whole of my Year 1 class without a teaching assistant : "This is very well organised, I usually see chaos." He was less interested in my credentials as Co-ordinator, dismissing my interim research findings, conference papers, photographs of exhibitions taken to international conferences: " We get shown photographs of children's work at every school. What I am interested in is your planning and assessment policy."

Such devaluing of teachers' contributions to knowledge speaks to me of an education system in crisis. Richard Kimbell's Keynote address at the DATA International Millennium Conference, entitled "Creativity in Crisis" gave strong warnings of the culture that Ofsted inspection teams were encouraging through their emphasis on management and their ignoring of creativity and innovation. Without the freedom to experiment, the recognition of innovation or the respect for professional creative curiosity, the most reflective practitioners will seek something more interesting to do.

My first recommendation, therefore, is that *research-based practice* should become the dominant model on which curriculum development should be based and areas of the curriculum that are under-researched should be funded by government. This should replace the politically motivated, policy-driven model that has dominated the educational landscape in the last two decades and is threatening to stifle the creation of knowledge about pedagogy and children's learning. My research in the development of children's design drawing skills has inevitably led to reading and reflection on other areas of children's cognitive and creative development. I could have used this knowledge to enhance the children's learning across the curriculum, but the structure of the imposed curriculum, as well as its tightly defined content, was prohibitive.

Thus to Headteachers and School Governors, I would say that teachers conducting research need support, patronage and their results incorporated into school policy. Ofsted Inspectors visiting schools need to respect these initiatives and see these as signs of vibrant life within the school community, not something to be measured against a one-size-fits-all yardstick of what teaching and learning looks like. The Ofsted team that visited my school in October 2001 were not informed that doctoral research was being conducted into an area of the curriculum. The management team wanted to show how we were conforming, not how some of us might be delving into theories of learning.

Such a radical change in outlook would require national government to put aside the belief that education can (or even should) be centrally controlled and monitored. It requires a re-appraisal of the nature of teachers as professionals, whose own motivation and curiosity can be relied upon to move children's education forward.

## 6.3.2 Developing Children's Design Drawing Skills

The recommendations that I would make regarding the development of children's design drawing skills are addressed to the many contributors to design education:

- *View design as a holistic, creative process* involving generating and evaluating, communicating and developing, exploring ideas which creatively answer a design problem, into which drawing can be fitted wherever it is helpful to move children's design ideas forward. This needs to be imparted in documentation issued by policy-makers and curriculum writers. The way in which information is presented is important. Pascal and Bertram's (1991) model is child-centred, holistic and adaptable.

The desire of managerial policy-makers to make everything easily auditable, does not allow for the creative (at times anarchic) nature of innovation and design development. There needs to be a change from a bureaucratic model of curriculum development and assessment to one that acknowledges that a creative process such as designing cannot be cut into manageable lesson bites with predicted outcomes for prescribed grades of pupils. Headteachers and subject co-ordinators need to examine carefully the view of designing embedded within curricular guidance and published schemes of work, to ensure that it adequately represents the spirit of the current National Curriculum documentation and also reflects the creative heart of Design and Technology activity.

Those who are involved in teacher education and professional development must seek to counter the linear view of the design process, with drawing "my design ideas" at the beginning and writing "my evaluation" at the end, which still lingers from the days of numbered Attainment Targets. It is perpetuated by publications that set out schemes of work organised as design-make-evaluate series. This can only be addressed by a rejection of such schemes by schools, which, hopefully, will lead to a more creative approach to scheme writing, that does not provide an off-the-shelf lesson for every week of the year, but a range of options that affirm that designing cannot progress without evaluating, that both designing and evaluating are continuing during making, and that evaluating after the making is completed could result in re-designing.

A change of language in curricular documentation, from "Targets" or "Levels" to "Dimensions" , would also help to affirm that each aspect of design capability is interrelated and is used in varying degrees in different situations. "Targets" imply that these must all be met and are equally important. "Levels" implies linear progression and that using a strategy on a "lower" Level implies regression, rather than choice of appropriate strategy for the circumstances, prior knowledge and experience with materials or techniques. In the Structured Phase of my research, the children's different responses to problem scenarios and product designs showed that Year 2 children could choose different and appropriate strategies to achieve a design solution.

- *View drawing as one medium through which design ideas can be recorded and developed, but not the only medium.* Drawing is, I believe, a very powerful medium for design development, but children should not be expected to draw as a matter of course in every design project. My research has focused on drawing but I was at pains to ensure that the Focus Class did not receive a drawing course. In the Summer term, the children did very little drawing and yet this did not prove detrimental, rather it allowed them the freedom to apply their understanding of ideas development into other media and then re-apply insights gained there back again to drawing.

The marriage of assessment to accountability, viewed as requiring paper evidence ("something in their books") militates against using drawing creatively and also against using other media for ideas development. Research into children's use at different ages of constructions kits or plastic material (such as clay) to model ideas, for example, might find parallels to my Drawing Types, or cast more light on children's view of the interface between model and product.

Management and monitoring of children's progress needs to be subject-appropriate. Although my research has focused on analysis of children's design drawings, the design drawing is not *by itself* an appropriate assessment tool for the broader educational concept of design capability. Children's design intentions within the Structured Phase were also judged by their articulation about their drawing and making, the video recordings and also by examination of the final products. Assessing design capability needs to be multi-stranded, with recognition of the centrality of modelling as the core skill. Research into the way in which children use a range of media (including drawing, writing and discussion) to scaffold and develop design ideas needs to be conducted. Policies on curricular review should include a research agenda that seeks to discover both what children at different ages can currently do and then attempts to find ways to enable improvements.

- *Explain the purpose of drawing for designing to the children.* Children do not use drawing to support designing because they have not been shown how, not because they are incapable of understanding. And they cannot second-guess that it might be useful. The Comparison Class did not do so, despite taking part in a similar range of practical activities. The design capability of the Focus Class was higher than any children I had previously taught, including the Year 3 class that I taught weekly in 1998-9. The difference was the use of the Container / Journey metaphor to explain the nature of design and the role of drawing. The Focus Class became better users of drawing to support their design thinking because they understood its purpose, not because they were taught particular techniques.

My Programme worked because I had a personal construct of what design drawing is for, and which I could convey to the children through the use of the Container / Journey metaphor. Those who provide professional support and guidance for teachers must aim to convey understanding of what designing is about and the role of drawing within it, not just imparting information about how to deliver a new method of working. This is not a quick-fix, bolt-on, tips-for-teachers method that will instantly enable children to produce design drawings. It has to come from the teachers' own personal understanding of the nature of design and how drawing can be used to support design development. This needs to become integrated into teacher education and professional development for Design and Technology.

- *Allow children to use drawing to support their thinking to the extent to which they find it helpful.* It is counter-productive for children to be engaged in an activity to which they see no point and that might inhibit the flow of genuinely creative ideas. Drawing for designing should support designing, not be a substitute for it so that the teacher can see "evidence" in books.

There should be no requirements on children to draw in a particular way. The Programme contained no lessons on Multi-designing or how to do Progressive drawings. I suspect that I would have had superficially more impressive results if it had. However, I am a teacher, not an instructor, and I wanted the result to be real learning and for drawing to be useful to support the children's designing, and not the product of having learnt a range of techniques. I would certainly have learnt less myself about children's ability to adapt their use of drawing to their perception of task needs. The Comparison Class had learnt to draw labelled diagrams prior to the Easter Egg Holder task but it inhibited, rather than aided, their use of drawing to develop design ideas. Teachers need to teach for understanding, not specific performance.

Those who write books or create web-sites on how to enhance children's design skills need to resist the temptation to provide ready-made frameworks and "design sheets" which tell the children to use drawing to record particular stages of the design development in particular ways. I only used design sheets in the early stages of the Programme to scaffold the children's design skills and to enable them to have focused discussions about their developing ideas.

The Card Assessment Task also had a "design sheet" that appeared to aid the Focus Class more than the Comparison Class. I believe this was probably because my underlying assumptions about the nature of design, and the way drawing can be used to support it, was similar to that of the designers of the sheet. The Comparison Class could not second-guess these underlying assumptions and so were little aided by the sheet. Thus, the provision of photocopiable design sheets will not by themselves enhance children's design drawing capabilities. However, such sheets can be useful for assessment, as the cues on the sheets trigger responses based on understanding of underlying processes.

- *Encourage children to discuss their work as they draw.* This aids clarification of their ideas, peer-checks that ideas answer the task and sparks off new good ideas. Communication clarifies thought and drawing enables communication. It is not just to place-hold personal good ideas. From the start of the Programme, the Focus Class were encouraged to discuss the ideas they had drawn with one another and the group-work in the final term explicitly required the children to produce drawn plans that had been produced in discussion. The contrast between the two classes' approach to the Maze task centred on the difference in the role and time of talk.

Part of teachers' problems with group-work and discussion is related to assessment: how will we know what a child can do if half of their ideas come from their friends? I would counter this with another question: Is education about teaching and learning or testing and tracking? The emphasis on accountability in the current political climate has become detrimental to collaborative learning. All learning takes place in a social context and is improved by working with, rather than against, the social needs of children. Knowledge and understanding is deepened by observation and questioning, bouncing ideas back and forth, parading possibilities before each other's eyes and having castles in the air built up or knocked down.

Constructing a group solution to a design problem requires greater facility with communication skills than constructing one's own solution. In the marble run activity (Teaching Input, Summer term) the least successful products came from pairs who divided the board "your half / my half" and the most socially adept pair (Randal and Carl) continued building, adapting and re-inventing their construction long after the photo-shoot that was intended to end the activity. The skills of joint decision-making, negotiating, and being able to allow others to critique one's ideas are essential high-level work-force skills. Writers of future Design and Technology curricular guidance should take steps to ensure that such essential skills are fostered (but not as another list of targets to achieve).

- *Model the use of drawing for a range of purposes, including designing.* Children often only see teachers writing, which, despite being surrounded by multi-media texts on-screen as well as on paper, teaches them that this is the most highly-valued form of communication for educational success. Teachers should use charts and diagrams, concept webs, cartoons, story-boards, colour and pattern, to make the interaction of text and graphics appear natural and useful. Teachers often feel inhibited drawing in front of children as they feel they are "no good at drawing" but however poor an adult's drawing might be, it is better than a child's, and everyone improves with practice.

Children need to be shown examples of design drawings in order to know what the teacher is talking about. The introduction of the Container / Journey metaphor to the Focus Class was successful because they were shown and asked to discuss features of drawings that demonstrated the development of design ideas to a greater and lesser extent. Suitable examples can be collected from a range of sources, including books intended for the home market, television programmes and videos. All these can be a rich source of encouragement to children's imaginations and enthusiasm for making things and can be used to show children that ideas can be developed through drawing. The role of parents in encouraging their children's design skills needs to be affirmed.

Children need to see adults using drawing to support thinking in a range of circumstances, both within school and at home. Parents frequently believe that linear text, "writing", is the form of communication that they should encourage children to practice at home, since this was the preferred medium in their own school experience. They also have limited knowledge of drawing genres and, although surrounded by graphic messages, do not see the need to help children read them and create their own. Parents' Information Evenings to encourage parents to help children use a range of media for developing thinking will probably need to be given titles such as "Extending the Boundaries of Literacy" in order to attract a large audience.

- *View the whole of knowledge, understanding and learning as holistic.* Divisions into subject areas are convenient organisational devices but Design and Technology does not neatly sit within the classic division of arts vs. sciences but inconveniently and creatively straddles both. In teaching children to use drawing to support design thinking, a tool is being provided that can be used across the curriculum. Teaching young children to plan ahead of engagement with materials in a design context can enhance their thinking in all forms of writing, encourage consideration of cause and effect when planning science investigations, as well as providing understanding of the rationale behind making preliminary sketches prior to painting, collage or 3-dimensional art-work. Since I taught my Focus Class for only one afternoon a week, I was unable to make these cross-curricula connections. However, Mrs. R., their class teacher, maintained that they were better able to plan their stories than other Year 2 children she had taught, and attributed this to the design drawing input.

I believe strongly in a joined-up, rather than dis-jointed curriculum for young children, in using a wide range of teaching strategies to engage the interest and incorporate the learning styles of all pupils. An adjunct to this is that a range of recording methods and styles should also be encouraged and that children should be taught to choose appropriately from as wide a range of techniques and media as possible, of which drawing is one of such multiple possibilities.

This cannot be a matter for individual teachers to address since it requires the active support of school management to do so. A radical restructuring of any aspect of the Primary curriculum is difficult for individual schools to undertake alone, firstly, because children need to transfer to Secondary Schools with similar levels of understanding and knowledge, and, secondly, innovation has to be successful in order to maintain the school's profile. It is too big a risk to introduce radical innovative pedagogy. Local clusters of schools, therefore, need to work together, with the support of Local Education Authority advisory staff, to identify the holistic design skills that all children should acquire by transfer age. These can then be promoted across the curriculum.

For policy writers of the future (and those who write curricula based on those policies) the time has come to stop further fragmenting of the Primary curriculum in terms of subject areas. A better way forward would be to build on the identification of Key Skills, of which design capability would be one, and allow development of curricula at local level.

### 6.3.3 Developing Children's Design Capability

Design and Technology should not be something children do on Friday afternoons once the real work of the week is over. Designing and creating technology (as human activity rather than school subject) is, I believe, part of that which distinguishes humans from all other species. Human civilisation is a designed, technological system, in which its members depend on the technological solutions of other members, both past and present, in order to function as part of that system. Creative designers, clever technologists and system analysts are essential to the maintenance of human society and the more complex and more technology-dependent that society becomes, then the more of these people are needed.

To push Design and Technology education into the Friday afternoon slot, alternating half-termly with Art, and to put a rigidly defined curriculum for literacy and numeracy skills in the front line as the measure of school success, is creating a generation ill-equipped to solve the complex technological problems of the designed world of the future. The principle of every child's entitlement to Design and Technology education from first entry to school was a bold move in the design of the National Curriculum, despite the lack of consultation with Key Stage 1 teachers. The current statement of Design and Technology curriculum content is an equally bold and brave statement that needs translating into creative and exciting practice. Not slippers in Year 6 for ever.

> "Design and Technology prepares pupils to participate in tomorrow's rapidly changing technologies. They learn to think and intervene creatively to improve quality of life. The subject calls for pupils to become creative and autonomous problem-solvers, as individuals and members of a team. They must look for needs, wants and opportunities and respond to them by developing a range of ideas and making products and systems. They combine practical skills with an understanding of aesthetics, social and environmental issues, function and industrial practices. As they do so, they reflect on and evaluate present and past design and technology, its uses and effects. Through design and technology, all pupils can become discriminating and informed users of products, and become innovators."
>
> (DfEE/QCA 1999: 90)

The research I have conducted addresses the ways to "develop.. a range of ideas" that can enable children to become "creative and autonomous problem-solvers." The use of drawing as a tool for thought development, as a powerful means of modelling ideas, a discussion document, communication system and presentation device, needs to be taught as part of design education.

## 6.4 Agenda for Future Research

I do not see this as the end of my research. I will continue to research children's design drawings. I have both a theoretical framework and assessment instrument for doing so and I believe that these would stand me in good stead for future work.

I would like to :

- collect and examine older children's drawings, to see whether the Drawing Types persist into Upper Key Stage 2 and how direct teaching of drawing techniques in Secondary Schools affects children's more intuitive use of drawing to support design thinking;

- try a different, shorter Programme encapsulating the Container / Journey metaphor with different aged children in different kinds of schools serving different demographic areas to test the transferability of this way of teaching the purpose of design drawing;

- share my insights with teachers to see if they have similar success to mine through embedding the Container / Journey metaphor in a Programme of their own devising;

- look at other means of modelling design ideas (through construction kits, perhaps) to find out whether my observations about the way in which children use drawing has parallels to other modelling media and whether the Container / Journey metaphor would transfer across media;

- extend the area of discussion and exploration to include using drawing as a tool for supporting and developing thinking in other curriculum areas, including literacy, science and geography, viewing drawing as just one aspect of a multi-media approach to idea development and communication;

- work collaboratively with others, especially those whose research interests are close to my own and with whom I have had long and fruitful discussions during the past five years;

- and finally, to add an international dimension and work collaboratively with those colleagues in other countries with whom I have made acquaintance during the course of this research.

## 6.5 Drawing as a Tool for Thought

Beginning from this phrase, which seemed to say what I meant by design drawing but barely knowing what I meant by it, through a journey of exploration into the achievements of young children who attended one primary school in rural Kent and on into an attempt to improve the capabilities of just one class, via a search of literature relating to cognition and language development as well as design theory and children's drawing skills, I have learnt a great deal.

I have learnt about researching, much of which seemed parallel to the children's designing: trying things out and observing the results, forming hypotheses about a possible solution and designing a product to satisfy the need.

I have learnt even more about children. Firstly, that children's capabilities should never be underestimated. I have gained a deep respect for the adaptability of young children, their eagerness to participate with earnest enthusiasm, and their desire to learn and do well at any activity that meshes with their cognitive and manual competencies and that captures their imagination. Secondly, I have learnt that capability is not fixed. One cannot say "seven year olds can but six year olds cannot" learn a particular skill or see the world in a particular way. My Focus Class were seeing the design tasks in a very different way to the view of the Comparison Class. The input changed their perception; they learnt a new game called "Taking Ideas on a Journey."

My Focus Class also learnt to enjoy their own success. They learnt that I valued their learning and that I thought well enough of their work to take examples to conferences and to include photographs of it in journal articles. They learnt that I wanted to know more about how they learnt and that they were able to tell me about it. They learnt that their growing reflectiveness on their design processes was important and they wanted to tell me about it and for me to write down what they had to say about what they were doing. It became a two-way process, a joint enterprise in which I could genuinely talk to them of what *we* were doing. They knew we were breaking new ground and were delighted to be part of it.

I recently went to their Leavers' Assembly. It was their last morning at First School and they sang songs and recounted their memories of their first days at school. As each child walked across the stage to endure the Headteacher's humour and collect their Record of Achievement, I pulled up mental images of their design drawings and the resultant products.

As they go forward into their Middle Schools and beyond, I wish them every success in life and will remember them always with gratitude and affection.

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# APPENDICES

# APPENDIX A
## Taxonomy of Design Drawing

TAXONOMY OF APPLICATION OF DRAWING IN THE DESIGN PROCESS TAXO-1 What they could/could not produce

| USES OF DRAWING | EVIDENCE FROM TASKS YR.1 | YR.2 | YR.3 | YR.4 | LITERATURE |
|---|---|---|---|---|---|
| PURPOSE | | | | | |
| drawing as "finished product" | stan96/panda98 | stan | stan | stan | Duncun93 Lowenfeld8 Cox92 Fulton90 Paines92 |
| comm'n to others/aide mem for ch | | | | | Wolverson9 Denton91 |
| INVESTIGATING NEED | | | | | |
| perspective taking | | panda | panda | panda;insects | Stables93 |
| simple prediction | orange juice in bottles | | conation task | | Silver78 |
| forward planning | stan;panda98 | stan;panda;box | stan;panda;box;fans | stan;panda;box;art cl | |
| CONCEPT DESIGN | | | | insect kits | Scrivener98 |
| brainstorming | | | conv/div;food; boats | | |
| generation of ideas (multi draw) | stan | stan;panda | stan;panda | stan; panda;4Sclay | Ritchie95 |
| deciding what to make | | | boats | art club | |
| recording of the design stage | | 2B buggies; rnd stans | | insects;4H rndstan | |
| DETAIL DESIGN | | | | insect kits | |
| investigating production method | panda | panda | panda;fans | panda | Dunn90 Gardner,I. Garvey&Quilan |
| deciding on production method | panda - Sam Girt | | fans | | Dunn90 |
| recording production method | | box | box | box;insects | |
| sequencing production | | | fans | food prod seq | |
| dr w respect to materials | stan; wiggly worm | stan; buggies;box | stan; fans;box | stan; panda;box | |
| produce product specification | | | fans | insect kits | |
| TYPES OF DRAWING | | | | | |
| analogue/iconic/symbolic | Alex at age 4 | | | | Outterside9 Costall85 Baynes92 Eisner |
| symbolic (stereotypical) | Stan; worm;house | Stan; house | Stan;house | Stan;house | Outterside9 Wilson92 Willats85 |
| manip of inner image | | box | box | box | Fulton90 Outterside96 |
| drawing in the style of.. | Sam's Van Gogh; Rhys' Titanic. | | Glen Parody's Klee | | Winner82 |
| labelled diag | | buggies; box; panda | panda; box; fan | stan;panda;box;art cl | Constable94 |
| canonical drawing | viewpoints; old sch. | house; stan; panda | stans;old sch; house;Micc | stan;house;panda98/9 | Aitchenson9 Crook85 Karmiloff-Smith90 |
| 2D & 3D | 3D shapes; old school | stan buggies | lfa lego;panda; | art cl;4S clay;panda | Constable 9 Ingram85 |
| plan drawing/viewpoints | | panda;box | panda;box | panda;box | Constable9 Willats92 Dunn90 |
| appropriate level of detail | stan | stan | stan | stan | Van Sommers84 |
| DRAWING & MAKING | | | | | |
| make what they draw | stan; panda | stan; panda | stan; panda | stan; panda | Anning93(x McCormick Johnsey95 Prentice89 Samuel |
| pattern development | | | | insects | Dunn90p133 |
| recording of finished product | panda;Aaron's drawing of | panda | panda | panda | Samuel |

# APPENDIX A
## Taxonomy of Design Drawing

TAXONOMY OF CONTRIBUTARY FACTORS IN THE USE OF DRAWING FOR DESIGN — TAXO-2 - Why they could/could not produce it

| USES OF DRAWING | EVIDENCE FROM TASKS YR.1 | YR.2 | YR.3 | YR.4 | LITERATURE |
|---|---|---|---|---|---|
| COGNITIVE DEVELOPMENT | | | | | |
| Age/maturity | stan;panda;box | stan;panda;box | stan;panda;box | stan;panda;box | RitchieV23 Rogoff96 Piaget etc |
| Other cognitive factors | extreme examples | extreme examples | extreme examples | extreme examples | Dyslexia & autism studies |
| ADULT INPUT | | | | | |
| Nature of tasks | stan;panda98;worm | stan;panda;box | stan;panda;box;fan | stan;panda;box;art cl | Buchanan9 Bun&Kiss9 hennessey et al 93 |
| Explanation given | round stan;old sch | round stan | old sch | round stan | |
| Amount of help given | insects97;stan96/8 | 2Bflat stan | 3Wflat stan;3Whouses | | Bruner etc |
| KNOWLEDGE BASE | | | | | Black93 |
| Previous experience w materials | Yr1&insects | | | spirals | N.Smith 79 |
| Previous exp of designing | | 2P stan scores? | | 4E - panda & box res | |
| Knowledge of techniques | | 2B labelling - buggy | 3W measuring - panda | | Constable94 |
| Visual literacy | | | | | Green71 Kress&VanLeuwen96 |
| GRAPHICACITY | | | | | |
| Ability to draw | all tasks | all tasks | all tasks | all tasks | Arnheim69 Freemna et Willats79 |
| Understand drawing as proc tool | stan;panda98;worm | stan;panda;box | stan;panda;box;fan | stan;panda;box;art cl | Egan95&6 Garvey&Quinlan |
| Use dr to dev thoughts & ideas | stan | stan;panda | stan;panda | stan;panda | |
| Partial occlusion | viewpoints;old sch | | ld sch;Saxon houses-Micca | | Morra |
| MODELLING | | | | | Archer/Roberts92 Ritchie95 Baynes "Drawum" pape |
| Understand rel betw dr & make | stan;panda98;worm | stan;panda | stan;panda;box;fan | stan;panda;box;art cl | Anning |
| Fluency in symbol manip | | box;house | box;house | box;house | Williams85 Gardner/Wolf87 Clement95 Gardner84 |
| Use dr to dev sol'n in other med | | rnd stan | rnd stan; | rnd stan;4Sclay;art cl | Ritchie95 |
| Use metaphor & analogy | | | zebra crossing | | E.Winner Halford92 Gick&Holyc Gomrich60 Rumelhart& |
| Reality/fantasy | panda | panda | panda | panda | Ritchie95 Stables92 & 97 |
| Interact with the drawing | | | fans | art club (discussion) | Rogers & C Scrivener9 Dunn90p34 Oxman97 Liddament9 |
| | | | | | Simon86 Ritchie95 |
| IMAGING | | | | | |
| Make changes from drawing | stan;panda98 | stan;panda | stan;panda | stan;panda | |
| Imagine/record future state | stan;panda98;worm | box(+stan;panda) | box(+stan;panda) | box(+stan;panda) | Outterside93 Kimbell98 Stables"Out of the Mou |
| Imagine/record future intentions | stan;panda98;worm | box(+stan;panda) | box(+stan;panda) | box(+stan;panda) | Constable94 |
| Imagine & record the possible | stan;panda98;worm | box(+stan;panda) | box(+stan;panda) | box(+stan;panda) | Craft77 Weininger88 |
| REL TO OTHER WAYS OF THINKING | | | | | |
| Linguistic/narrative | | | | | Bruner62/8 Griffiths35 SueH97 Egan96 Segall91 |
| Creativity/imagination | | | | | Koestler74 Bailey71 Hudson66 Boden |
| Play | | | | | SuttonSmit Liebermann Prentice74 Singer&Sin Baynes96 |
| Conation | | | | | Atman |

# Appendix B
# Programme Lesson Plans

## Autumn Term 2000

### Assessment Task: Design a pizza

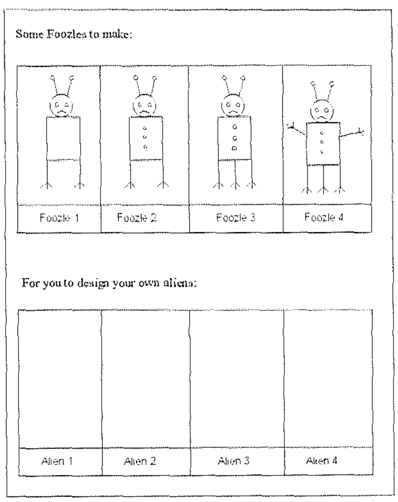
*Rationale* - A design-and-make activity suitable for children at the beginning of Year2.
*Objectives* - to use pencil drawing to generate design ideas for a collage of a pizza made from a range of sheet materials, fabrics and small items.
*Instructions* -
a) discussion of favourite toppings on pizzas and how the toppings are arranged to look appetizing.
b) explanation of using white paper to try out some ideas - up to 3 - and then choose one to make. Progression of ideas across drawings was explained and demonstrated.
c) explanation of making a collage (picture) of the chosen design
*Success criteria* -
Whether progression of ideas across the planning sheet can be seen (or if each idea stands alone unconnected to what went before) and to what extent the final collage is a reflection of that planning process. It is not expected that the collage will be a carbon copy of one of the plans - some progression of ideas into the making stage is acceptable and desirable - but some children see no connection at all between planning and making.
*Assessment procedure* - use of drawing to develop design recorded on Holistic Grid and Techniques Ticksheet for each child.

### First Teaching Block with the Focus Class; Second half of Autumn Term:

#### Wagwums & Foozles

#### Session 1: Figures

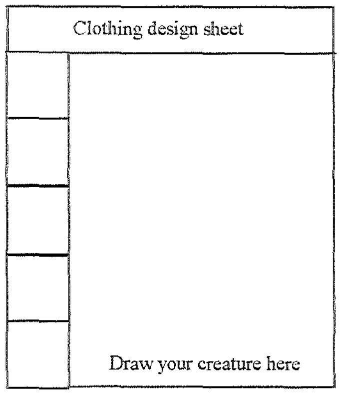
*Rationale* - To encourage the children to make what they have drawn in order to perceive the relationship between drawing and making in the process of designing.
*Objectives* - To make models of their design drawings using plasticine and matchsticks. It would be teacher-led to begin with until they grasped the idea and were able to produce their own drawings and make models of them.
*Activity* -
a) The children to be shown the Wagwum picture used for the analogy tests at the end of the first half term, invited to make it from the plastice and matchsticks. The discussion when they had finished would focus on the accuracy of their representation. and the ambiguities in the drawing.
b) Repeat task with Foozle.
c) Design sheet -



*Success Criteria* - Ability to closely link the drawing to the making
*Comments from Log* -Showed standard Wagwum figure - asked children to make it. Only about half the children made the figure as shown. Most added bits - saying out loud "I'm doing one with 2 antennae" etc.
I did a "Put your hand up if yours has got..." - going through the features.
Showed desire to be creative and not accept limitations of problem as set - Donaldson - own agenda more important than mine cf Sue's M.A.
Photographs were taken of the 4 Foozles and Alien(s) for nearly all the children.
*Evaluation of Session* - Not quite enough time for all children to make all 4 of their own Aliens. I told them to just make their best one for the photo. They were very creative and had all sorts of body shapes.

**Session 2: Clothes design**

*Rationale* - To introduce the need to plan ahead and make a pattern of the designed object before making in the real materials.
*Objectives* - To make a set of clothes for their Alien; involving planning the clothes, choosing the material and making a paper pattern rather than just cutting up the cloth and wrapping it round.
*Activity* -
a) Previous week's worksheets given out and favourite Alien chosen and made.
b) Design sheet:




Explanation of whole process, with demonstration; each stage written on blackboard:
- Draw Alien dressed in clothes - not too complicated.
- Choose cloth for each item of clothing, stick small portion on squares at left, indicate what it is to be used for with lines.
- Make pattern from newsaper and check that it fits.
- Cut out clothing from cloth.

*Success Criteria* - The instructions are followed & clothing planned and made in paper before cutting into the cloth.
*Comments from Log* - I had set them to draw the clothes & choose the cloth whilst I gave out newspaper - didn't want to clutter tables too soon. But many children making straight away in cloth -not just choosing their fabrics & then making pattern, so stopped whole class and explained again about why we need to plan - waste of cloth, disappointment when it doesn't fit...
*Evaluation of Session* - Would possibly have been better to structure the session more tightly - all draw, now all choose cloth, now all make pattern etc but would have run the risk of faster workers getting bored and losing their momentum and the slower thinkers being under pressure to complete. Stopping them and explaining again worked. Have observed previously taht repeating instructions once everyone has started is a good move - it makes more sense and they can take it in better once they are engaed on the activity.

# Appendix B
# Programme Lesson Plans

**Session 3: Transporter**

*Rationale* -To encourage evaluation at planning stage through discussion with partner.
*Objectives* - Development of single design idea to make a vehicle for plasticine Alien, to be made from recycled materials (plastic cartoons, etc) and range of small items such as matchsticks, cardboard wheels, etc.
*Activity* -
a) Planning sheet: a single fan-folded strip.

- Section 1 - record one good idea for a vehicle.
- Section 2 - how this might be made - discuss it with neighbour
- Section 3 - what a real one would be like - discuss it with neighbour
- Section 4 - final version to be made, taking discussions with neighbour into account and also the materials - each child to be given a carton or box with which to make vehicle. Option given to change the design or swop carton / box.

b) Making the vehicle - range of supporting materials available.
*Success Criteria* -
Good discussion with partner to explain and justify design choices.
Use of the issues raised in the discussion to inform designing.
Clear progresssion from designing into making.
*Comments from Log* -
Told to do quick sketch of first idea they had, in first section of paper. Quite a few did 3 on 3 sections of the paper.
Discuss with partner - OK but they tended just to say "I'm going to make a.." without describing it and the partners did not ask questions - eg How, what with?
Then told to imagine it was real, not to be made with boxes etc and to draw it & add details eg doors - then discuss with partner. - didn't really discuss. many just sat there
Finally get box and draw again in light of shape of box - many went straight into making at this stage.
*Evaluation of Session* -
Will produce a planning sheet for next week with designated sections. Amazing that their reaction was to draw lots when they were told to draw one. At least it shows that the multiple ideas for the pizzas wasn't just a fixation on me saying "Have about 3 attempts". Mrs.M commented afterwards - they don't listen - told to do one but did 3. They don't seem to appreciate they are being given instructions to follow.

**Session 4: Wagwum's house**

*Rationale* -To brainstorm ideas and then choose one to develop into a final product, using discussion with partner to aid evaluation.
*Objectives* - To make a house for the Alien model from recycled materials (boxes)
*Activity* - A3 paper - told to fold it in 4 & open out and label the 4 sections as per example on blackboard:

| | |
|---|---|
| My first ideas | The one I like best |
| How I will make it | What it looked like |

Demonstration - several different houses on 1st section - stereotypical square house with triangle roof as first and said "not this" - then demonstrated different ideas.

# Appendix B
# Programme Lesson Plans

Sections 1-3 to be completed. Discussion with partner to decide which idea to be developed from the range resulting from initial brainstorming and also how model is to be made.
b) Making of model from cardboard boxes
c) Completion of section 4 of worksheet.
*Success Criteria* - Fluency of initial ideas.Quality of discussion between partners. Development of the chosen idea into final product.
*Comments from Log* - Filling in the "How I will make it" box proved a problem - the children didn't know what to draw - Natasha asked Mrs.M if it could be written - yes - I should have told them all to do this originally.
*Evaluation of Session* - Need to be less fixated about recording in drawing if writing in sentences is more natural for the children and appropriate for the activity. They had told each other how they would make it - why not write that down?

## Spring Term 2001

### Assessment Task : Frosty the Snowman

*Rationale* - Assessment of designing skills for comparison between the two classes.
*Objectives* - Produce drawn design and make a model to demonstrate a means of getting Frosty the Snowman's shopping to him on his hilltop if the shop is on the opposite hilltop and there is a lake in between.
*Activity* - Showed Frosty (model based on card tube made by daughter), explained he was stuck on his hill in the snow & shop on other hill. How will he get his shopping? Showed Lighthouse keeper's lunch picture as "clue", plus reminder & demo how to roll newspaper to make structure.
*Success Criteria* - Use of drawing to develop ideas and then use of ideas thus developed to inform making model of problem solution.
*Assessment Procedure* -
Individual profile spreadsheet; Video of Target Group from Focus Class, photographs from Comparison Class.
*Evaluation of Sessions* -
Focus Class - amazingly good since I was alone for this session and operating video. Got on sensibly and completed activity without fussing. From personal awareness of what was being videoed - very little interaction about their ideas once making. Discussed ideas at drawing stage, but once they had decided what to make, they just worked without consulting each other.
*Reflection in Log book* -
Looking at drawings prior to analysis - Many children appear to have reverted to single-draw. Does this show that I was too specific in my explanation, that showing them the Lighthouse Keepers Lunch stopped them from having their own ideas, or is the use of drawing activity-dependent? Perhaps they had their ideas in their heads and discussed them but didn't draw them. Perhaps they simply opted for their first solution and didn't attempt to think of others. Viewing of tape indicates that Noel & Craig discussed ideas as they drew - and did not put pencil to paper to record the ideas they were discussing.

### Focus Class Activities in First Half of Spring Term:

**Session 1: Pictures from abstract shapes**

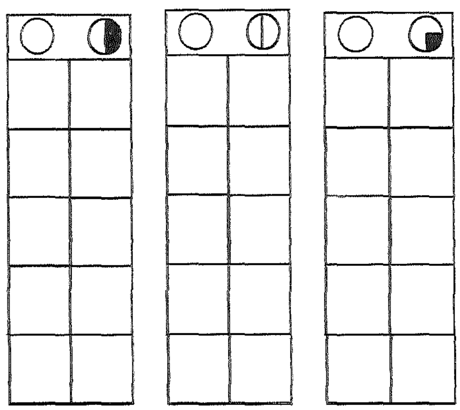
*Rationale* - Development of using what they see to stimulate ideas.
*Objectives* - Drawing activity - circles - ideation fluency
Picture activity - develop shape into whole picture.

# Appendix B
# Programme Lesson Plans

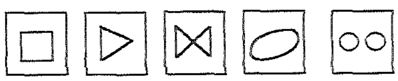
Activity -
a) the square - whole class. Square drawn on blackboard, child invited to make it into a picture of something. 2nd, 3rd, 4th square ditto.
b) the circles - individual work. The children are provided with a worksheet with rows of circles. They make as many as possible into pictures in a time limit of 5 minutes. The range of ideas will be discussed. There is frequently a run of ideas, i.e. once a child thinks "apple" a whole range of fruit often follows. These features of association of thoughts will be discussed.
c) the horseshoe shape. This idea comes from the RIOTT programme by McCracken (1985). The children were each be supplied with a card horseshoe shape to use as the basis of a picture.
*Success Criteria* - Circles - fluency of ideation; Horse shoe - development of single good idea into a picture.
*Comments from Log* -
Circles - Told them to look around the room & see what they could see that was round. Gave a couple of hints to children who were stuck.Some children did not transfer the principle to the new activity & drew a square inside the circle and put a figure inside the circle. Once Mrs.M.and I had explained again to individuals and they had the idea, they were away. Overall very impressive.
Horse shoe - Complete list of what they each did is in handwritten log book.
*Evaluation of Session* - We were impressed with their creativity with the horseshoe shape.

**Session 2: Visual analogies**

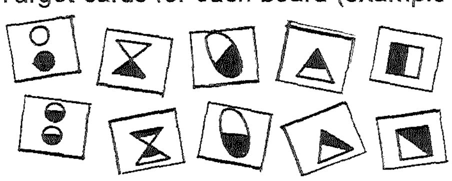
*Rationale* - To develop their understanding of and facility with visual analogies, specifically of the type *a>b:c>?*
*Objectives* -To play a card game based on Iron's visual analogy tasks and then to develop their own.
*Activity* - the children play a card game in order to understand how the analogies work. Three different sets were required so that the children could work in pairs on tables of 6.
Required - Boards based on Iron's example for the Puzzle Series 1, one per pair of children, three different puzzles per table:



Source cards



Target cards for each board (example for left hand board, above)



# Appendix B
# Programme Lesson Plans

Rules of game:
The source cards are placed face down in a pile at the top of the card and the target cards showing part filled shapes are laid out face up on the table.
The children take turns to turn over the source cards and place them on the board. They then try to match one of the target cards to it using analogical reasoning. Although taking turns, it is non-competitive.
They then shuffle the source cards and replace them at the top of the board, lay out the target cards and then move round the table to another card set.

Booklet - an A4 sheet folded to make an A5 booklet in which they designed their own analogy puzzle card game. Page 1 to be completed with the puzzle they had just solved. Inside the booklet were two similar boards with examples they had not seen before: The first had the puzzle example at the top and the source shapes. The next had the puzzle example but no shapes - their own choice. The back cover had a blank board - not even the puzzle example. Spare card was available for them to make a game using their back page game and play with their partner.
*Success Criteria -*
Understanding the analogy rule for each game and then being able to use the understanding of the rules of the game to create their own puzzle.
*Comments from Log -* Only got as far as completing booklet - no making of own game.

**Therefore - Session 3: 2nd attempt at Iron's analogies**

*Rationale - as before*
*Objectives* - To succeed in the activity designed for last week in the light of observations re children's misunderstanding of the rules of the game.
*Activity* - Almost as last week. Changes - each pair was given a wrong set as well as a right set of target cards.
Success Criteria - as before - will analyse and compare development booklets from each session and check that final game is same as development booklet p.4.
*Comments from Log -*
Most children instantly laid out and matched the correct set, ignoring the other one - only Holly & Alisa used the wrong set. To make sure, I told them to hide the cards they had put on the board among all the others laid out on the table and the all swopped seats to find a puzzle they had not done. Mostly successful in solving second puzzle. I repeated the change rule with blackboard demo.
Development booklet - fine. Making own game - mostly successful.

**Session 4: Analogy development using letter shapes.**

This is an application of the Letter Spirit Project (*internet site*). Originally planned as a 2 week activity, it was reduced to 1 because the Iron's Anologies were repeated.
*Rationale* - Application of analogical perception of letter shapes.
*Objectives* - To complete alphabet in demonstrated font and then create name-plate for bedroom door.
To transfer a pattern by scribbling across the back of the design drawing.
*Activity* - The children to be provided with sheets with letters *a - f* in 3 different fonts, based on a square, triangle & hexagon. They practice copying these onto squared paper and then choose their preferred font to write the rest of the alphabet. They write their name in their chosen style, scribble across the back and transfer the name to stout card. This can then be drawn over in coloured pens and decoration added.
*Success Criteria* - Maintaining font throughout alphabet. Using the font to write name. Transferring the design successfully onto card.
*Comments from Log* -The children were allowed to take these home to complete.
*Evaluation of Session* - No problem with fonts. They had never used scribbling across the back as a technique before and were surprised and delighted when it worked.

# Appendix B
# Programme Lesson Plans

## Second half of term:

### Session 1: Snooks Animals

*Rationale* - Understanding of what a clear design drawing looks like.
*Objectives* - Viewing of examples, leading to discussion and then trying to make clear draiwngs.
*Activity* - PowerPoint presentation of Snook's Animals, as basis for discussion of what is needed for clear deisgn draiwngs - instructions, material lists, expansion to show small details, construction details etc. Children then given piece of found materials (e.g. driftwood) which they were to imagine how to make into an animal & then draw it "so clearly that someone else could make it".
*Success Criteria* - Clear, well-labelled drawings, lists, drawn as if from materials of construction.
*Comments from Log* -The children wanted to make them! Much clearer drawings. Good annotation.
*Evaluation of Session* - Message seems to have got across - fingers crossed for Stan next week - can we do travelling ideas too?

### Session 2: Flat Stan -

*Rationale* - To introduce the children to the Container / Journey metaphor of design drawing.
*Objectives* -
a) For the children to understand and apply the metaphor to their design drawings to generate and develop ideas about Stan's clothing.
b) to produce a puppet of Flat Stan to fit in an A5 envelope
*Activity* - The children shown 2 examples of drawings for design and 2 in narrative genre and asked to identify the differences. The way the ideas have travelled across the page in the design drawings indicated.The Container / Journey metaphor drawn on the flip chart and explained.
The children to be reminded of the "Flat Stanley" story and told that they will be making a model of Flat Stanley to go into an A5 envelope. A3 paper to be distributed and children sent to tables to begin drawing. Pink card and materials to come after children begin drawing (deterrant to instant making). Envelope to be available for storage of drawing and model when finished.
*Success Criteria* -
Puppet is flat and fits in envelope. Children have modelled their ideas on paper and that a clear progression of ideas can be traced through the drawngs and on to the making.
*Assessment Procedure* -
Although originally intended as a non-assessed activity, I could not resist building a set of spreadsheets identical to the Purpose of Drawing grids to be used for assessment activity results. Flat Stan has too long a history not to be assessed! I also built a collation spreadsheet to compare the Stans, both between the three types to see if there was progress and also to look at the 1998 Stans on the new assessment instrument.
*Comments from Log* - Got Stacey & Lauren to hold up two examples each of narrative & design drawing. The children Had difficulty spotting the significant difference between the two tyoes. Needed to spell it out & explain. Seemed to be OK. All drew intently for about 15 mins - same as previous presentations.
I re-explained what to do with the card (final idea to be made with this) but I usually have to do this. This time I explained this in terms of the Container / Journey Metaphor. No one tried to throw away their drawing. I had not realised I had automatically trained them into giving me the drawing. At least some Flat Stan drawings usually need rescuing from the bin!
*Evaluation of Session* -
Overall, pleased. Results look good. Will need to compare with a previous Yr2 presentation - perhaps 2D (done before Christmas) as well as a Yr2 from 1998
Video of debriefing is definitely more worthwhile than trying to video them working. Get much more data.
Will not video them again until assessment activity or they will get good at being debriefed.

# Appendix B
# Programme Lesson Plans

**Session 2: Round Stan -**

*Rationale -* To develop understanding of the Container / Journey metaphor.
*Objectives -*
a) To begin to use drawings to develop ideas about construction - materials, different viewpoints, expanded diagrams of small details.
b) To design and make a puppet of Round Stan from toilet roll middle.
*Activity -* Reminder of Container / Journey metaphor diagram.
Show good examples from last week which illustrate ways of moving ideas further through drawing into making decisions about materials, construction etc. The aim here is to begin to move children into using progressive drawings - sketches to develop ideas.
The Round Stan story to be told - At Christmas, Stanley tried to blow up a balloon and all the air rushed back into him and he became round. They are to use a toilet roll middle to be his body. They can use any of the materials in the trays to make the rest of him.
*Success Criteria -* Drawings showing clear progression of ideas across the paper.
*Comments from Log -*
Reminded children of Container / Journey diagram and how we can take our ideas on journeys across the page. Re-iterated the process in terms of this metaphor as I showed examples by Jade, Michael, Richard, Connor Best (2D), as examples of diffferent ways to take your ideas on a journey.
Then I told children Ray's story of Round Stan and drew picture of this as I told it. This was a mistake - quite a few thought they had to do a Christmas picture (including Emma W, Megan, Natasha). Carl: "What are we making?" I should have had a toilet roll middle in my hand as I explained to them what they were to do. Shows how much they rely on seeing, as opposed to just listening (Donaldson). I repeated the explanation of the activity..
Once sorted, fine. Good work.
Not all finished and I had to leave them for Chris to finish off sometime - since I was expecting to see Gerry at 2.30 re fixed term exclusion for J in my class. Over weekend, I decided I would go & get these unfinished ones on Monday - they will have forgotten their ideas & I have got the bit boxes back in my room now.

**Session 3: Customised Stan -**

*Rationale -* To reinforce understanding of the Container / Journey metaphor and to extend this understanding to thinking about materials of construction.
*Objectives -*
a) To create own adventure figure based on Stan saga
b) to think about matreials and try drawing figures as if made from the materials available
*Activity -* There were no corks in school and none in Boots - so went to Pound Shop and got plastic cups and pegs - each child had cup and 2 pegs instead of corks & nails as per previous presentations of DIY Stan.
Recap of Stan; explanation of activity - they would decide Stan's next adventure.
I explained the metapor diagram on the blackboard. Then told them to have 2 or 3 ideas and try to draw them as if made from the materials - showed them plastic cup & 2 pegs (other materials available off-side). I did a demo of what I meant on the board.
*Success Criteria -* Could they think about the materials as they designed and draw the figure as if made of these? Could they produce more than one idea done like this? Is their designing improving and developing or do they now think they know what Stan looks like & so are not developing their ideas?
*Comments from Log -* Re-iterated Cont /Journey diag on blackboard with them in their places rather than gather on carpet.Showed them to cups & pegs. Said that they wer going to take thier ideas on journey into what it would look like made of these things. Showed them on blackboard, having ideas (2) and then trying out what they looked like made out of the cup & pegs. I didn't mind whether they had the several ideas first or had one & then tried it in the stuff & then had another new idea. But wanted them to take their ideas on the journey into thinking about how it would look made form these things & draw it like it to try it out. They found this hard. Lots of good character ideas eg. Chloe - wizard. They found drawing as if made form materials hard. And to think of several, very hard.

# Appendix B
# Programme Lesson Plans

## Assessment Task : Easter Egg Holder

*Rationale -* To assess the children's use of drawing to develop design ideas and to ascertain possible emerging differences between the two classes.
*Objectives -* To design and make a holder for an Easter Egg from a cardboard tube and other recycled materials.
*Activity -*
Explanation that they would be making a holder for an Easter Egg - wording purposely left vague since I did not want to guide their thoughts into "box" or "carton" etc
The children were shown a large cardboard tube (length approx.120 cm, width approx.100 cm) and box of hard-boiled eggs (explaining that that they would be using these for sizing, not chocolate eggs - too messy) and I demonstrated that the tube was far too big for the egg. They had to design something attractive which would hold the egg. Explanation also of using paper to work out ideas, talking about developing ideas across the page, avoiding use of words "design journey" since I did not want to specifically cue 2R into using a technique - it being their understanding of designing and not the use of a particular technique which I wanted to compare.
*Success Criteria* - Use of drawing to support and develop design ideas.
*Comments from Log -*
Focus Class: Managed to have my log book under my arm & write down their comments.
Also sketched some of their work as they did it.
Comparison Class: The children immediately began to say "I know what I'm doing" and seemed to want to make an instant choice rather than go away and come up with a range of ideas.
I spent quite a lot of time helping children to cut holes in things. They seemed to want a lot of practical help - couldn't cut through card tube etc.

## Summer Term 2001

### Session 1: Designing a marble run.

*Rationale -* To evaluate each other's ideas and create a joint product.
*Objectives -*
a) To create a marble run from plasticine, lolly sticks, strips of card and plastic bottle tops.
b) To work collaboratively and share ideas and plans.
*Activity-* Different to original planning - after seeing mess made by Yr4 with paper mache and there was no modroc in school, decided that 2R would design playgrounds in discussion with partner and choose best of each to make on shared board with plasticine, lolly sticks, plant sticks & bottle tops.
*Success Criteria -* Joint project which reflects a contribution from each partner, adapted through discussion and collaboration.
*Comments from Log* -Took photos.
Went well, except that some children needed help with co-operating with their partner - quite a few helped themselves to their own board - needed correcting. Carl dominated Jack who did not contribute much. Other pairs in trouble sharing were mostly the ex-2S. Michael found difficulty sharing with Zac - each had their won half of the board. Generally they stayed close to their drawn ideas but developed them as they combined ideas - fair enough.

### Session 2: Necklaces

*Rationale -* To do no drawing at all!
*Objectives -* To make bead necklaces from paper.
*Activity -*
Again, change of plan because of lack of resources - no clay in school. I took home some paper to try this out and found that long triangles worked best, wound around a pencil, with just

a blob of glue on the end. Played with long-ways beads as well. had difficulty finding pictures of necklaces.
Used old travel brochures - left over from 1H role play.
Showed the children how to make the beads & they got on with it. They spent a happy afternoon doing this. I circulated and had a go as well, giving my beads to the slower workers.
At the end they all had a string of beads which they wore round their necks to story!
They had fun and had a string of beads at the end. Totally low-key. They all wanted to wear their necklaces to story, so they definitely had fun.

**Sessions 3& 4: Beach Buggy (2 weeks plus finishing in class-time)**

*Rationale -*
a)To plan and make a longer project, since most activities, although related, have been single session.
b) To use drawing part-way through the design and make process rather than at the beginning.
*Objectives -*
a) Plan and make a beach buggy based on folding a sheet of card into a box shape
b) To viualise and draw the sides, front, back & top view of the buggy once the basic box is made. In this way it is akin to the Box Car assessment activity conducted on previous occasions in that they need to visualise the different viewpoints and they need to think of a logo or graphic for the sides etc.

***Week 1***
*Activity-* Began with flat card and showed the children how to make a box, which they did step-by-step along with me and then put axles through it and fitted on the whhels - Someone (unknown) said "Oh its a car" at this point - despite my previous demo of how the wheels fitted nicely on the axles!
Drawing done at this point, to design sidea, front, back & top view. they were unsure what I meant by top view & I demonstrated on the board.
*Success Criteria -* Hoping for - completed box car plus seats and drawing of sides etc ready for next week to do outsides.
*Evaluation of Session -*
Explanation of what we were going to make - did this verbally - Therese reported that Lauren did not understand what she was making at all - words "beach buggy" meant nothing. Therese talked to her about Barbie vehicles. Others also lost sight ofwhat they were making I think I should have had a picture or two.
I was hoping for good modelling of ideas here, since they had been involved in making the basic box cart immediately before, but it did not seem to be all that ckear to everyone. Making seats from egg-boxes was OK.

End of lesson - resolved to start next lesson with new explanation.

***Week 2***
*Objectives -*
a) Completing inside of buggy.
b) Planning graphics on sides etc of buggy and tranferring these to buggy using range of materials and colouring techniques.
*Activity-* Had all children on carpet and reminded them about containers & journeys - everyone seemed satisfyingly au fait with the terminology and seemed to understand what I was talking about as I did the diagram.
Did demo - I had done a side, front & back design for my beach buggy and took this along. "Since it was too small for everyoone to see" I redrew it on the flip chart and explained to them how my thoughts had gone on a journey..
New paper given out as well as their design sheet from last week. Some of them still had seats etc to do.
*Success Criteria -* Planning the graphics & getting buggy finished (no one finished).
*Comments from Log -* Time wizzed by - at 2.15 we packed up and I promised to ask Chris if they could finish them with her tomorrow and take them home. I did not take photos this time.

*Evaluation of Session* - They worked purposefully and well - where did the time go? Many of them made really good seats etc inside, but some had them in funny places - lower than the axles. Interesting that they don't really think about where parts of a car are in relation to each other. Steering wheels were far away from seats. No thought of an engine - the steering wheel went into the front of the car.

## Second half of term:

### Sandals

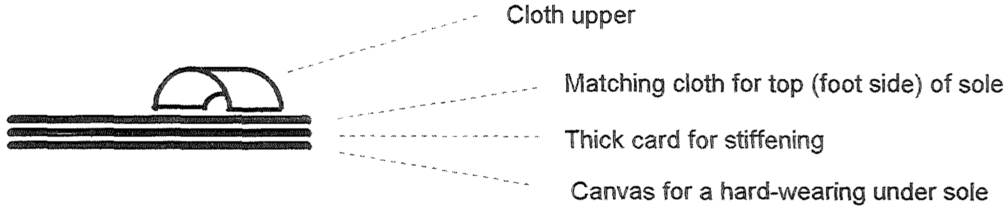
#### Session 1: Deciding what to make.

*Rationale -*
a)To begin from product analysis
b) To engage the children in the reality of sandal production rather than the fantasy aspects of design creation.
c) To work on an extended project, which would put together the aspects of designing so far encountered in single sessions.
d) To use drawing part-way through the design and make process rather than at the beginning.
*Objectives -* To look closely at a range of sanadals and to identify through discussion the features of the sandals, record responses and generate ideas for sandals to be made in future sessions.
*Activity-* The children were asked to bring in sandals and beach shoes for this session so that they could look at different styles. The vocabulary of shoe parts were provided so that they could discuss in groups the features of the shoes, how they were made and how feasible it would be to try to make each type. They cannot pretend that paper is waterproof - they needed to engage their knowledge of real materials here and also to consider the real demands made on sandals in use. It was anticipated that the children would need some guidance and some demonstrations of the way real sandals accommodate foot movements when walking. They were encouraged to produce and record different ideas for each of the soles and uppers. It was anticipated that they would probably have some ideas about what they would like the finished sandal to look like and so they could record these ideas as well.
*Success Criteria -* Good, purposeful discussions; identification of material requirements for shoe parts; recording of ideas which can inform planning to make next week.
*Comments from Log -*
The children chose to record more than I had anticipated. They wrote about the sandals that they observed and they drew their ideas for sandals they would like to make. Interesting - words used for observations; drawings for ideas generation, futuring.

#### Session 2: Making templates and choosing materials

*Rationale -*
a) To understand how to make a sandal that will fit their own foot
b) To engage in the reality of template making
c) To choose suitable materials for soles and uppers
*Objectives -*
a) To make templates of their feet from card, both soles and uppers
b) To make choices about materials and record these ready for next week.
*Activity -*
Initial discussion reminded them of the need of shoes in use. Discussion of how the upper is fixed to the sole: The simplest and most secure fixing solution is to make an upper which is a strip of cloth sandwiched between two layers of the sole and which passes across the top of the foot; need to allow for fabric to go under foot when making template. Introduction of template-making: Thin card provided to make a template of one foot only, both sole and upper, to be cut out and shown to me to check that it fits. Then sole template to be drawn round onto thick card for stiffener for sole of sandal, canvas for base and fabric (upholstery samples) for

inner lining of sole; template for upper to be drawn round onto chosen fabric (either to match or complement fabric chosen for inner sole). Diagram on blackboard to aid understanding (I told them it was like a sandwich!):




*Success Criteria* - Completion of template for sole and upper. Materials chosen and some parts of sandals cut out ready to assemble next time.
*Comments from Log* - Difficulty getting them to understand they only needed one template not two. Some made the templates into sandals & wanted to decorate them by colouring etc. Not understanding we were making real sandals? Not understanding role of template? Most children a long way from completion so arranged with Chris that they could continue to work on the sandals during the week.

**Session 3: Making sandals** Conducted by Mrs.R.

**Session 4: Completing construction of sandals**

*Rationale and Objectives* - To complete sandal-making activity
*Activity* - Some children had almost finished making their sandals apart from decoration of uppers but some still had a long way to go. Therefore those who finished quickly were encouraged to help those who were still working. I took photos as and when they finished.
*Success Criteria* - Completion of pair of sandals which fitted their feet.
*Comments from Log* - Rather a lot of feathers chosen for decoration - not brought by me - hope Mrs.R. wasn't going to use these for something tomorrow - I was pre-occupied with my photo taking & didn't notice.

## Assessment task - Pandy's Suitcase

*Rationale* - To compare the use of drawing to support design thinking by the Focus and Comparison Classes
*Objectives* -
a) To use drawing to generate ideas, model solutions
b) To relate this to the real problem of making a suitcase for the Panda
c) To make a full size mock-up of the suitcase which fits over the Panda's paw, is appropriate size for Panda to carry and which can contain the plastic mac.
*Activity* - Design a travel bag for the toy Panda to take on holiday, using identical activity and script from Pandy99.
*Success Criteria* -
a) Suitcase fulfils design criteria: big enough for Pandy's plastic mac and hat to fit in, but small enough for him to be able to carry, and the handle must go over his paw so he could carry it.
b) Drawing used to model design ideas
c) Full-size mock-up made from card to demonstrate chosen idea.
I hope that the Focus Class will be comparable to the Year 3 children in the 1999 study.
*Assessment Procedure* - Data to be collected: Log book notes made during session, drawings and mock-ups.
Log book notes will be collated via Log Book database.
Drawings will be assessed using Assessment Grid.
Mock-ups will be used to support analysis of relationship between drawing and making.

# Appendix B
# Programme Lesson Plans

*Comments from Log -*
Details in database. Clear differences in each class' way of working. Significant number of Comparison class did not use the design sheet as such - some even drew and cut out this sheet & made their mock up from it. The younger children in Comparison class (not part of study) really struggled, whereas the Focus class ones didn't - perhaps I should have left them in after all. But as individuals they have greater learning difficulties anyway, so it could just be individuals involved - 2 of them usually have LSA.
*Evaluation of Session -* Both sessions went smoothly. Wait & see what the analysis shows up!

## Autumn Term 2002

**Sessions 1-3: Food.**

**Week 1: Menu Planning**

*Rationale -*
a) To extend design thinking into menu planning and presenting a food-related diarama.
b) To encourage team-work and use drawing to communicate ideas to each other and to record group decisions.
*Objectives -*
a) To look at recipe books to design a healthy meal.
b) To produce a menu, an advertising poster and a list of materials needed to make a model of the meal, using waste materials, as a 3-dimensional advertising feature.
*Activity -*
Discussion about foodstuffs appropriate to a well-balanced healthy meal. Working in groups of 4, the children looked at recipe books, listed ideas and devised a first draft menu. These ideas would be recorded on one A2 sheet of paper per group. By the end of the session they needed to have decided what they would use to make their models and provide me with a list of materials.
*Success Criteria -* Production of clear idea of what they were going to make plus materials list.
*Comments from Log -* ange of group working methods. Some argued their way through the whole menu. Other groups divided the workload and decided who would choose and design each course. One group did this but each memebr produced a list of ideas in drawn form from which the rest of the group made the final menu choice.
*Evaluation of Session -* Good discussion throughout, clearly focussed on task. Main fault - little recording of materials, although I stressed this loudly several times.

**Week 2: Diaramas**

*Rationale -*
a) To transfer design ideas recorded in previous lesson to construction of model.
b) To work as a team to realise ideas recorded in drawing and writing during previous lesson.
c) To develop meta-cognitive awareness of design processes
*Objectives -*
a) To create an advertising diarama of a healthy meal.
b) To make oral presentation to peers to give account of working method of the group
*Activity -*
The children were reminded of the activity as set last week and shown how to make a card tray to arrange their work on. Paper plates, bowls and cups plus straws were provided; Demonstration of fixing these to tray with split pin prior to filling with "food". They were then to choose the materials as listed by themselves the previous week and make the model. Embarrassed giggles ensued when they realised they had forgotten what they were going to use and had not recorded it on the paper. Relief was expressed when I produced the materials I had brought "in case they might need them". They were encouraged to discuss and record materials before beginnning to make the models. Models based on the plans from previous

lesson were made. At end of session, each group presented their planning sheet and finished work to the rest of the class, described their work and their working method.

*Success Criteria -*

a) A completed "meal" on a tray plus a menu and advertising poster was originally intended as outcome, however, due to only spending two sessions on this topic, the menu and poster were not completed.

b) Ability to coherently explain their healthy meal and their working method to the rest of the class.

*Comments from Log -*

No time to make menus. Only one group finished in time to complete poster started previous lesson. Others had made attempt at drawing pictures of their meal on to paper provided and writing a title but generally poorly done (in contrast to diaramas whch showed imagination and good team work)

*Evaluation of Session -* Presentation by groups good - able to give account of working methods and how they had worked as a group. I felt this was more valuable than the details of their models. Ran out of time - needed to allow 15 mins for this, not all groups got enough feedback through having to rush through last three groups

**Week 3 - Sandwich-making**

*Rationale -* Not sure - see QCA

*Objectives -* To give Focus Class same fun activity as rest of Year Group (they had spent some weeks working up to the grand tasting; we did it all in one!)

*Activity -* Organised with military precision to avoid mess on floor!

Variety of ready sliced breads and rolls (excluding Tescos economy sliced), range of spreads (butter, Olivio etc. peanut butter clearly labelled) and fillings (Bovril, jam, chocolate spread, fish paste, etc), all brought by children and myself. "Tasters" to be prepared by children from ingredients supplied to their group on trays previously laid up by me. All children in group to taste these and to decide on personal favourite. Each child then provided with two slices of chosen bread to make round of sandwiches using chosen spread and filling. These were to be arranged on a large serving plate per group but the children simply arranged them on the plate on which they had made them (they wanted to eat their own, not someone else's!). Whilst they were doing this, I covered spare tables with a paper and poured orange squash. The children brought their sandwiches to me and were not impressed when I removed these from their individual plates and arranged them on the large ones and sent them back to their seat. We then enjoyed our buffet.

*Success Criteria -* Minimum mess, maximum fun!

*Evaluation of Session -* Very messy but clearly enjoyed by children. I was too neurotic about margarine on the carpet in someone else's classroom to enter into the spirit of it all. On balance, however, glad I did it.

## Second half of term:

## Session 1-4: Kit-making.

**Week 1: Introduction of activity, brainstorming in small groups and initial sketches of ideas.**

*Rationale -*

a) To generate ideas; b) To consider what would be suitable for younger children to make as a present for Mum

c) To work in teams; d) To critically review each other's ideas

*Objectives -*

a) Each group to produce a clear plan of what they would make and present idea to peers

b) To record materials (didn't for food)

# Appendix B
# Programme Lesson Plans

*Activity* - Initial introduction and discussion of task: what might be a suitable gift, what Year 1 chiildren can make, what materials are available, what techniques would be suitable. Split into groups and discuss ideas, coming to agreement about gift to be made, use paper to model and communnicate ideas. Each group to produce a plan which could then be shared with rest of class in poster form. Time allocation for plenary needs to be 15 mins (food plenary ran out of time)
*Success Criteria* - Clear and realistic plan of item to be made; Materials considered this time (food plans didn't)
*Comments from Log* - They got the point re the materials - as soon as I mentioned this in the intro they all groaned & nodded etc - so had learnt this from the food sessions - good. Although they discussed together, most groups made individual "poster" which were really neat versions of their working sheets. They tended to discuss in groups, some children recording ideas or drawing them to show others what they meant and then each member produced their own neat version. I guess they all wanted a "product" from the session.

**Weeks 2 & 3: Making the prototype.**
*Rationale* - a) Prototyping their product; b) Evaluation of own work; c) Team work
*Objectives* - To make their own version of the gift they planned last week
*Activity* - Explanation and reminder of the task and then children working at own speed (stressed helping each other). The components of the finished task (own gift, poster, instructions and kit of parts for Year 1) written on white board. Their poster drawing had to look like their gift (not what they would like it to be) or the Year 1 customer would be confused. The poster needed to include simple drawn instructions, which could be labelled but they needed to remember Year 1s can not read very well. If time, they could make a box or tray as packaging in which to send it to Year 1.
*Success Criteria* - Completion of own gift and poster.The poster drawing must look like their product; it must be achievable by a Year 1 child
*Comments from Log* - Easier to provide materials - they had all specified them. Some who finished early did not understand they were making a poster to be used as instructions, some re-drew their plans neatly on a clean sheet of paper. Interesting gap in understanding between the class and the two boys who had joined in September. They did not understand the purpose of the drawings at all. Although the Summer-born children are mostly still trailing the others, the gap is greater between these two new boys and all of the others.
*Evaluation of Session* -
Not everyone finished their own gift. They wanted a perfect gift for their own Mum (understandable) rather than prototyping something for someone else to make. Time needs to be given next time to finish.

**Week 4: Assembly of the kit.**

*Rationale* - To address needs of a client
*Objectives* -
a) To produce kit of parts for Year 1 child to make their product
b) To produce poster, instructions for final version and kit of parts in envelope
*Activity* - Despite some not having finished own gift last week, I decided that I would insist that they put together the kit for Year 1 or the younger children would not have time to make theirs. Year 3 could finish their own gift with own teacher at another time (I wanted to observe Year 1 following the instructions next week)
*Success Criteria* -
Poster & instructions which are suitable for Year 1 to make and follow instructions
It could be made by year 1 - Evaluation by Year 1 to follow!
*Comments from Log* -
Panic ensued as they realised that their work really was going to Year 1 and that the younger children would have a view on their success!

# Appendix B
# Programme Lesson Plans

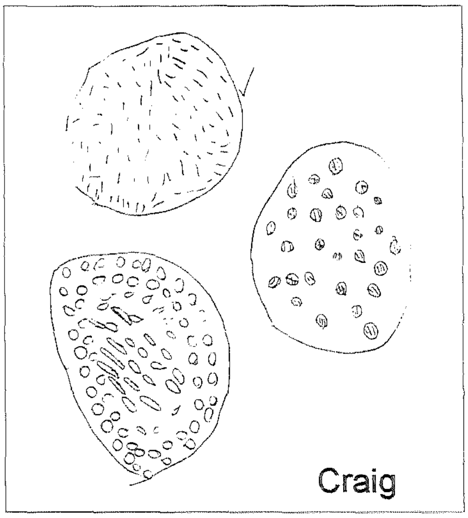
## Spring term 2002

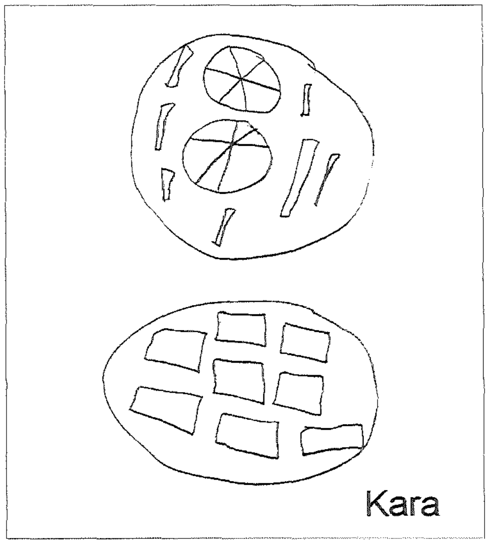
### Final Assessment Task : Theseus' Maze

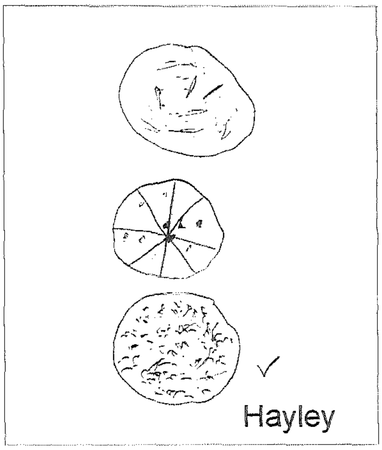
*Rationale* -To compare the use of drawing to support design thinking by Focus and Comparison Classes
*Objectives* - To design and make a model of King Minos' maze to help Theseus find the Mniotaur and escape safely.
*Activity* - Discussion of the myth, which the children had heard in Literacy Hour. The children were then shown a pop-up book with a 3-dimensional maze. I stressed that theirs did not need to be pop-up but that it did need to be 3-dimensional. They should plan the positions of the walls on paper before making the model in card and I demonstrated this on the whiteboard, showing them a ground-plan view and saying this is how someone would plan out where the walls would go before they were built. They might change their minds (demonstrating rubbing bits out) or want to show that arches and doorways would be here (indicated by arrows) and, of course, they might change their mind completely and start again (demonstrating doing another drawing next to the first). Once the ground plan decided on, then thick yellow card is for the base and thinner red and blue card is for the walls. String is available for showing Thesus the route in and out.
*Success Criteria* - Ideas worked out on paper; Drawing informs making.
*Comments from Log* - Comparison Class (done first) - not a clue half of them. They were not making real mazes! A lot of them drew a maze on the yellow card and made walls round the drawing. The few who really engaged with the task frequently did not use drawing to plan it - only a very few made what they drew into something 3-dimensional (inc. Myscular Dystrophy child who was without his helper today - has constant adult support scaffolded meaning for him in a whole range of ways?). On to Focus Class feeling the activity had failed dismally - but much better - they were using the drawing to support real thinking about a solution (with only 3 exceptions) and they made 3-D mazes, many of which bore some resemblance to what they had drawn.

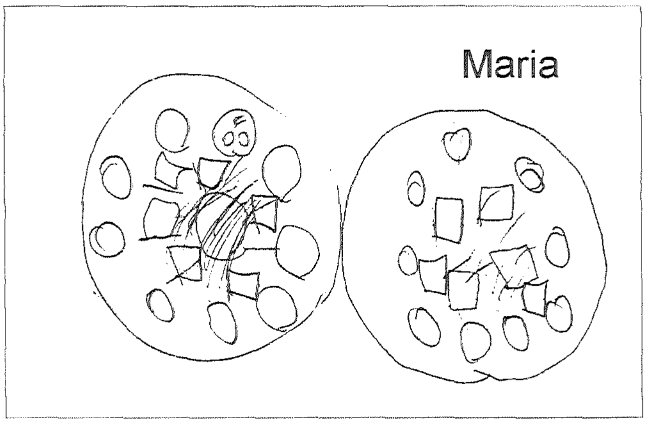
# APPENDIX C
# Target Groups : Pizza

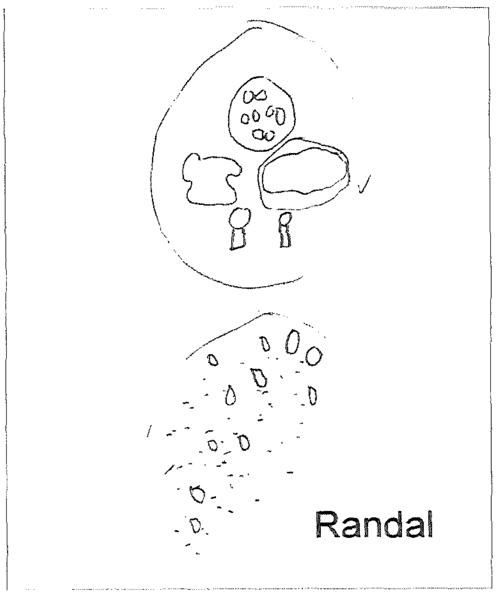
## Focus Class:

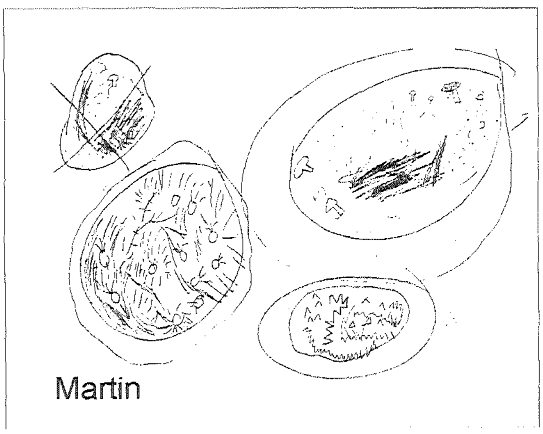


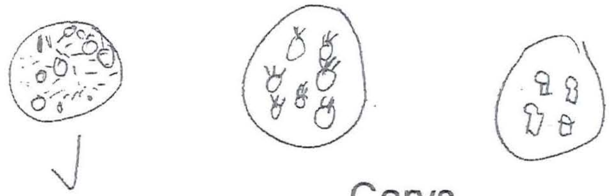



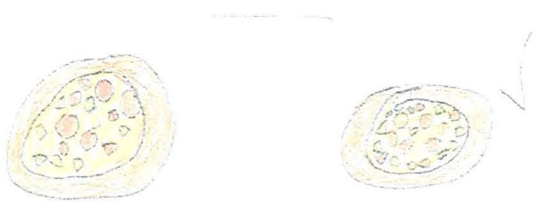



# APPENDIX C
## Target Groups : Pizza

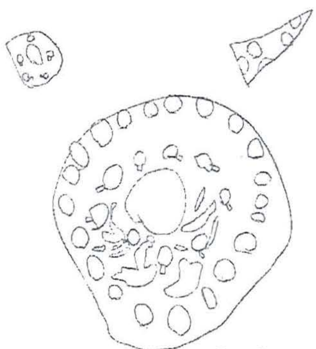
### Comparison Class:



Carys



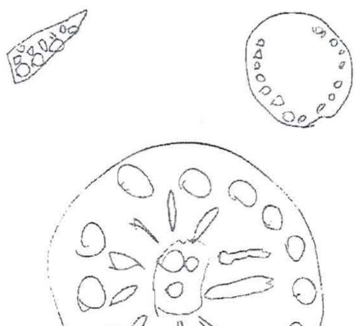
Emma



Jordan

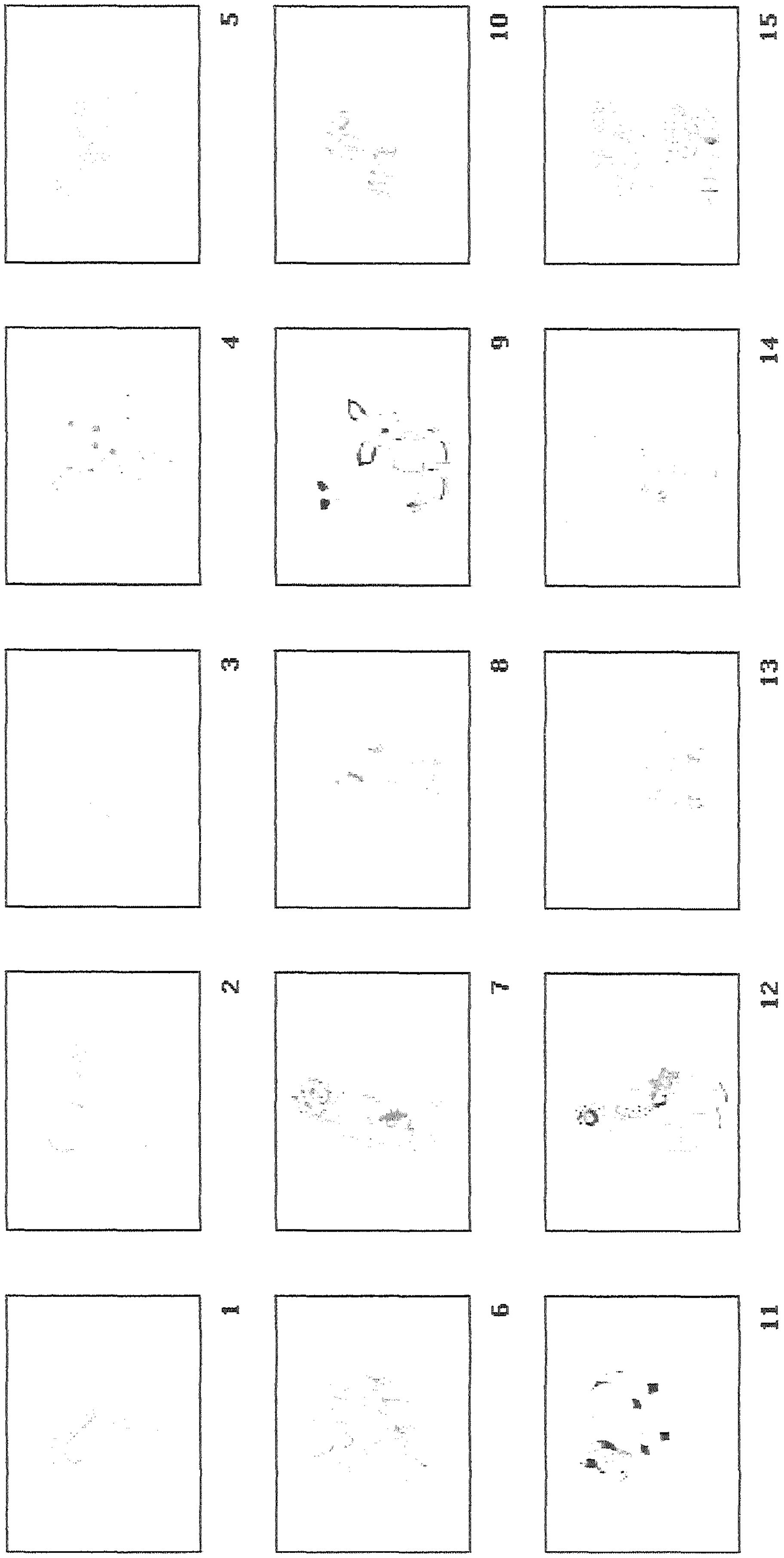
Lee

Robert



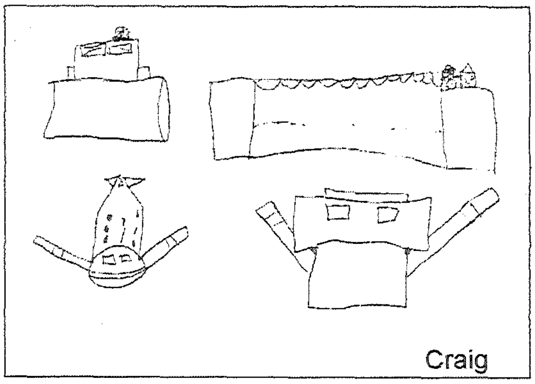
Zara

# APPENDIX D
## PowerPoint Presentation (Snook's Animals)

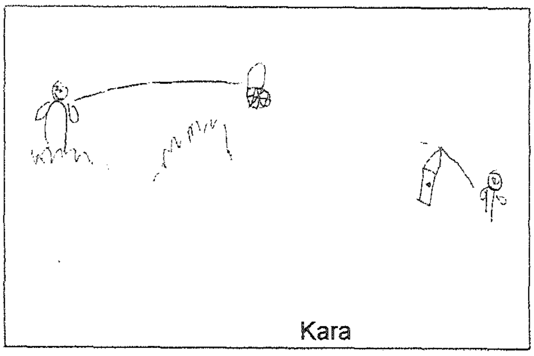


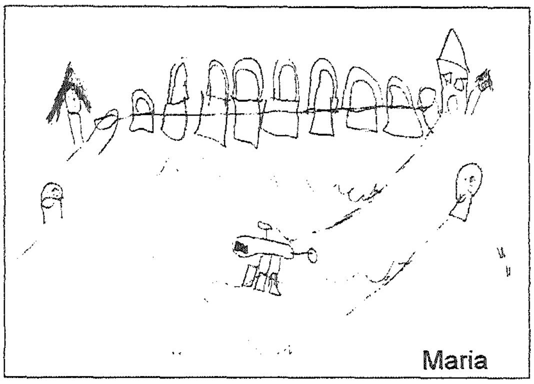
# APPENDIX E
## Target Groups : Frosty

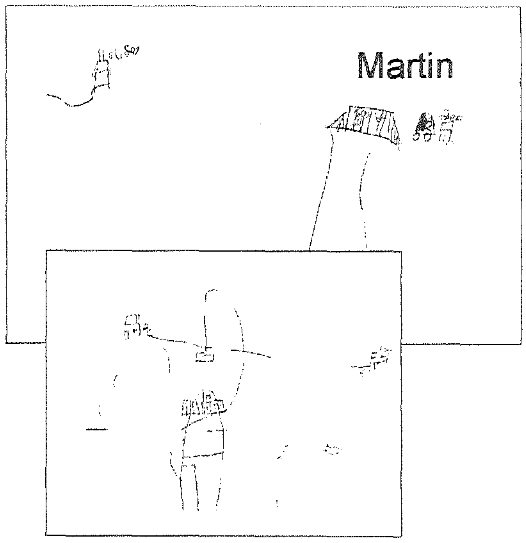
### Focus Class:

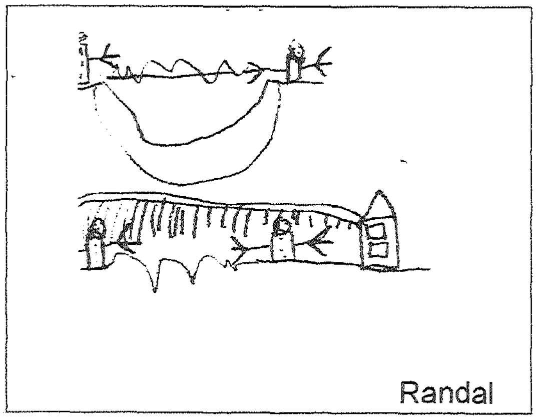



Hayley



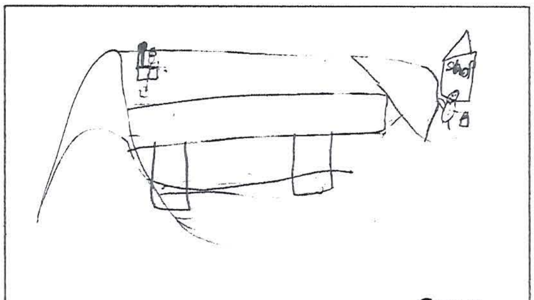



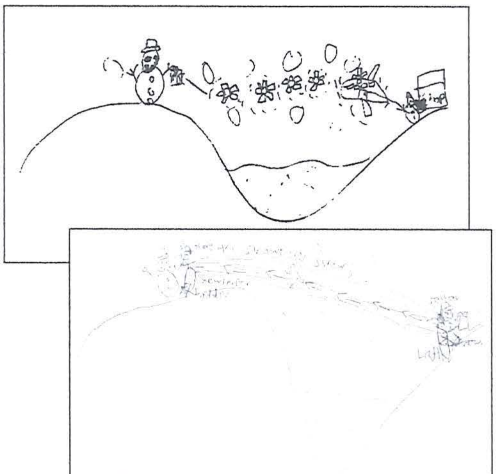



# APPENDIX E
## Target Groups : Frosty

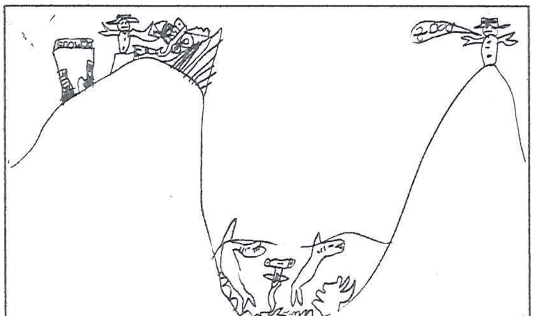
### Comparison Class:



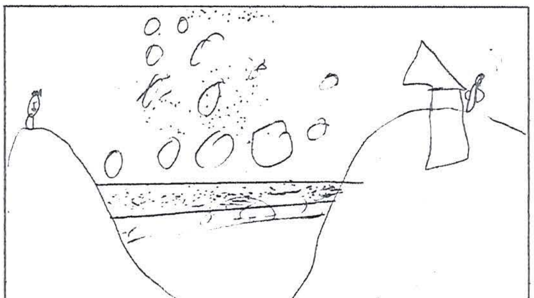
Carys



Emma

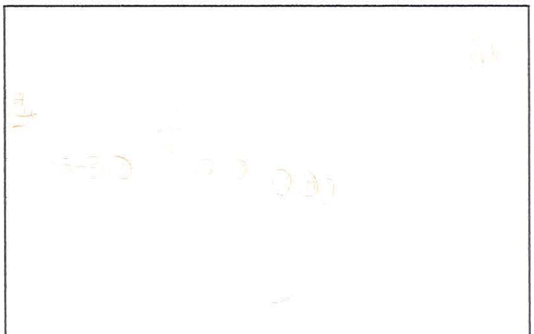


Jordan



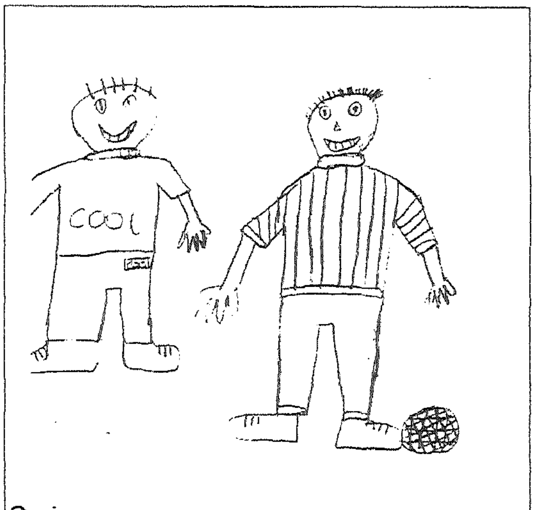
Lee

Robert

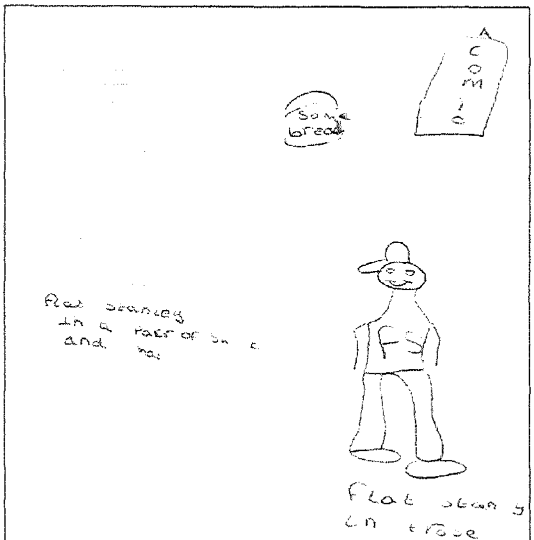


Zara

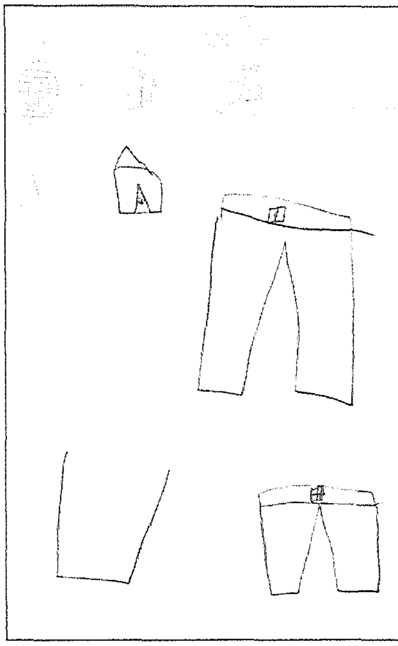
# APPENDIX F
## Focus Class Target Group : Flat Stan



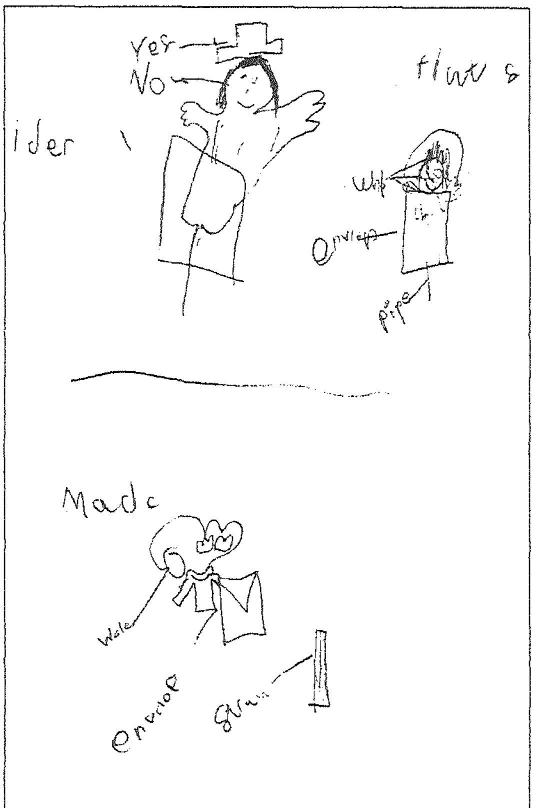
Craig



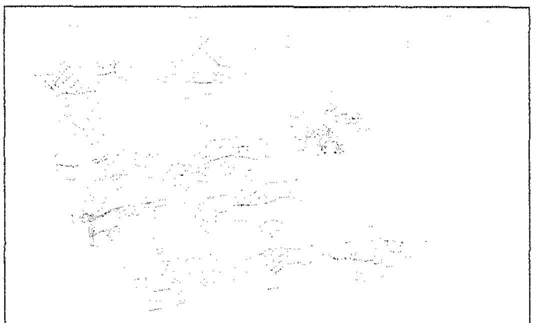
Hayley


Kara

Maria

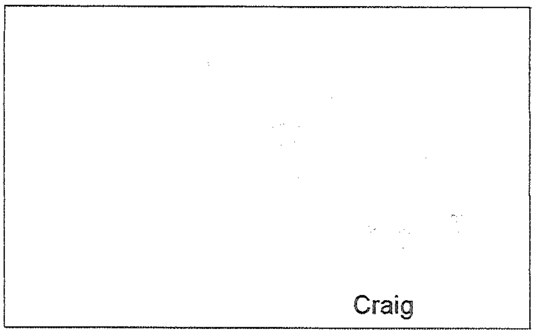


Martin

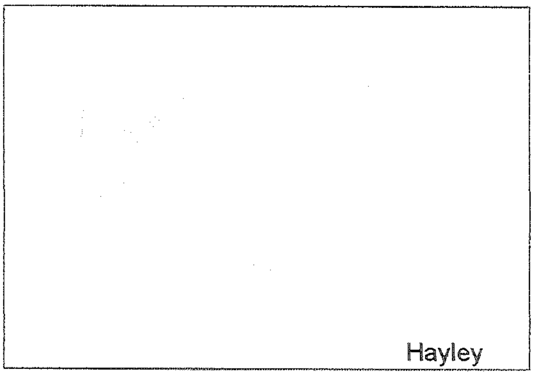

Randal

# APPENDIX G
# Target Groups : Easter Egg Holder

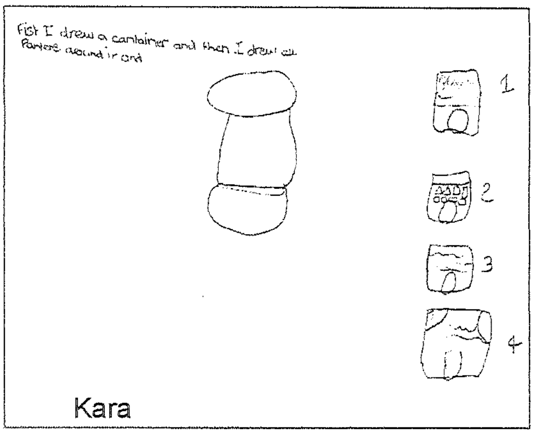
## Focus Class:



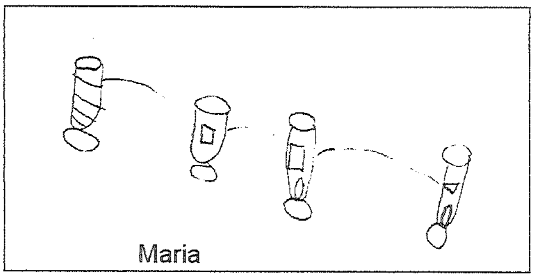
Craig



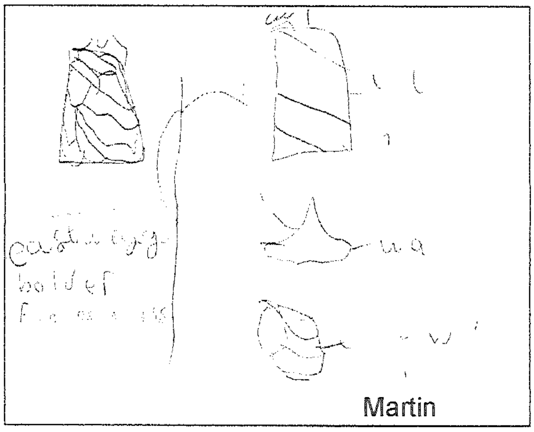
Hayley



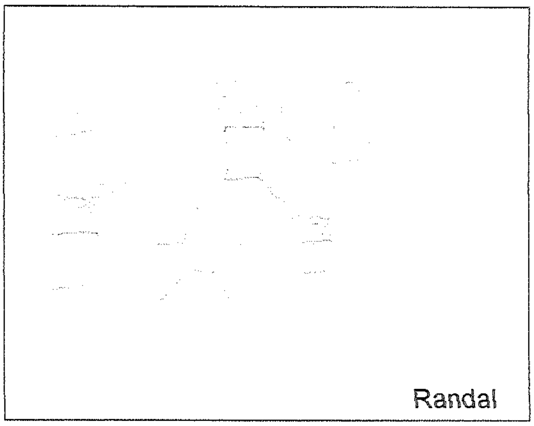

Kara



Maria



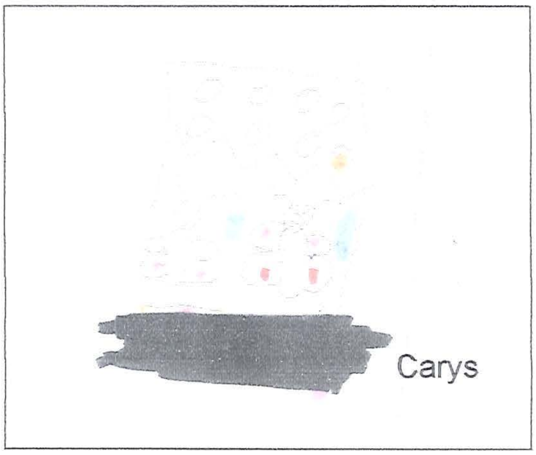
Martin



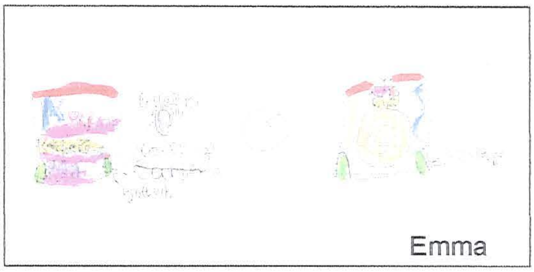
Randal

# APPENDIX G
# Target Groups : Easter

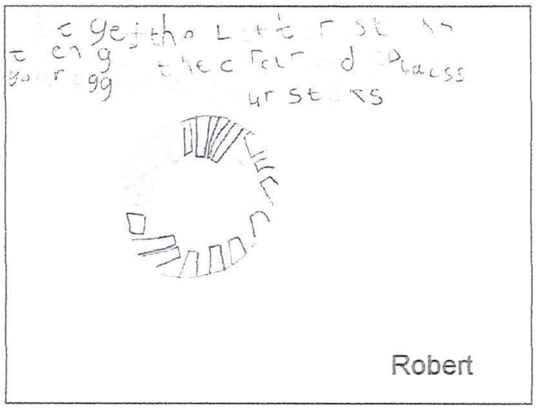
## Comparison Class:

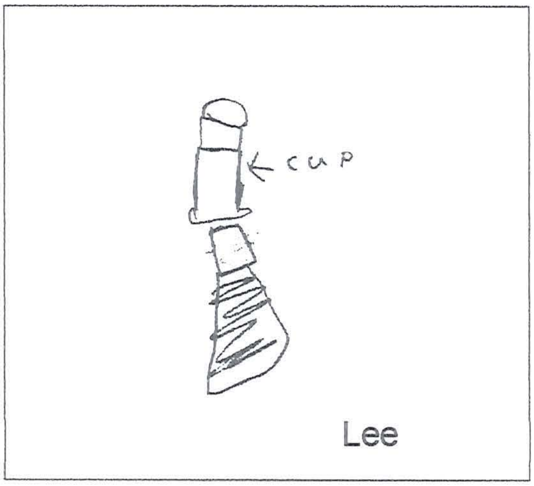


Carys

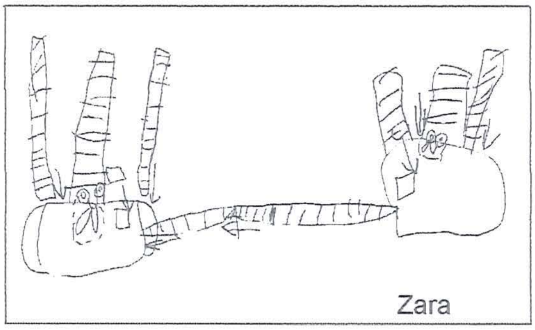

Emma


Jordan


Robert



Lee


Zara

# APPENDIX H
## Easter Egg Holders : all products

### Focus Class:

MIa

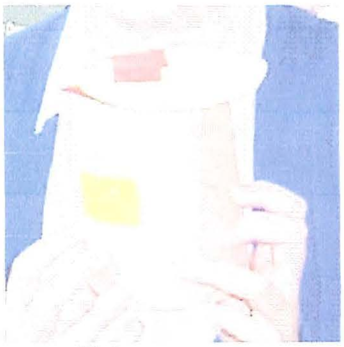
Emily

Maria

Beth

Martin

Carl



Kate

Noel

Natasha

Tasmin

Chloe

Natalie

# APPENDIX H
## Easter Egg Holders : all products


Connor


Hayley


Damian


Lisa


Craig


Lewis


Randal

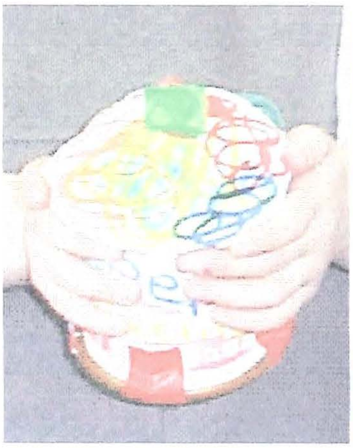

Jolene


Kara


Ellie

# APPENDIX H
# Easter Egg Holders : all products

## Comparison Class:


Emma


Kirsty


Cassy


Holly


Lee


Rhiannon


Kathy


Garth

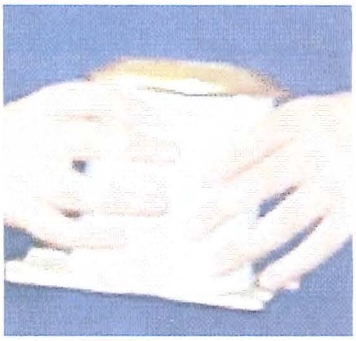

Sophie

# APPENDIX H
# Easter Egg Holders : all products


Jordan


Wendy


Alistair


Peter


Matthew


Carys


Ellie


Robert


Nicola


Zara


Alice


Chloe

# Surprise Card Design Sheet

**3** This is a list of people I would like to send a card to

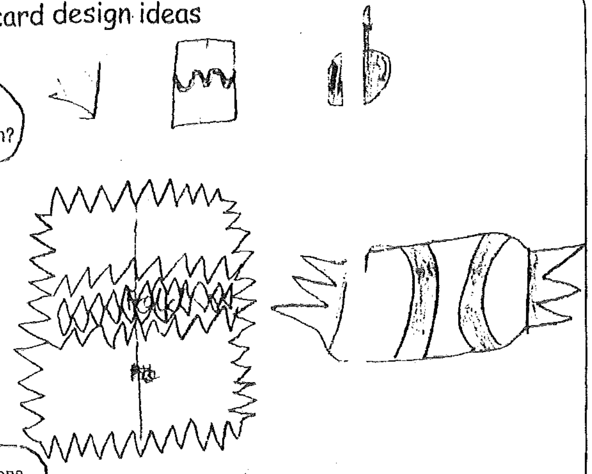
Richard and
his family
Blairs
..........................

**4** Things the person likes are foot ball
and play Stasion
and Bomers.
..........................

What is it made from?

What happens when it opens?

**5** My card design ideas



Does your card need a special envelope?

**6** How I will make my card ...

First fold Neat
cut
fold
Stick inside.

Which materials and tools will you need to use?

**7** The printed message in my card will be ...

Hello Hello Hello
good to see
you again

**8** The best things about my card are ...

becose it is a Bomerg Shape and it is a Bomer inside as well.

The things that could be better about my card are ...

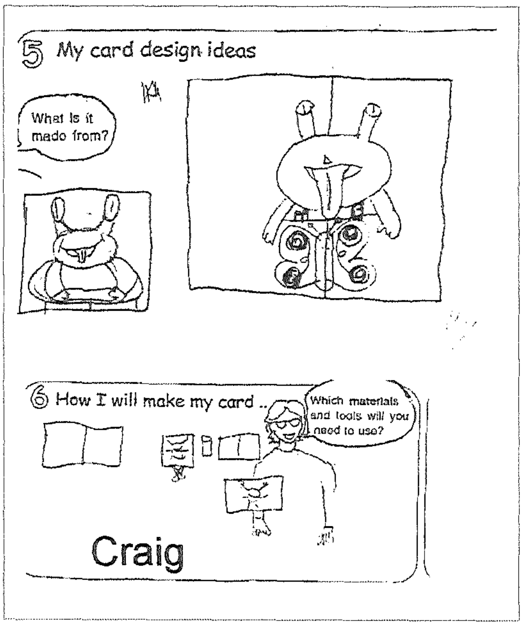
I cood dror sum isers.

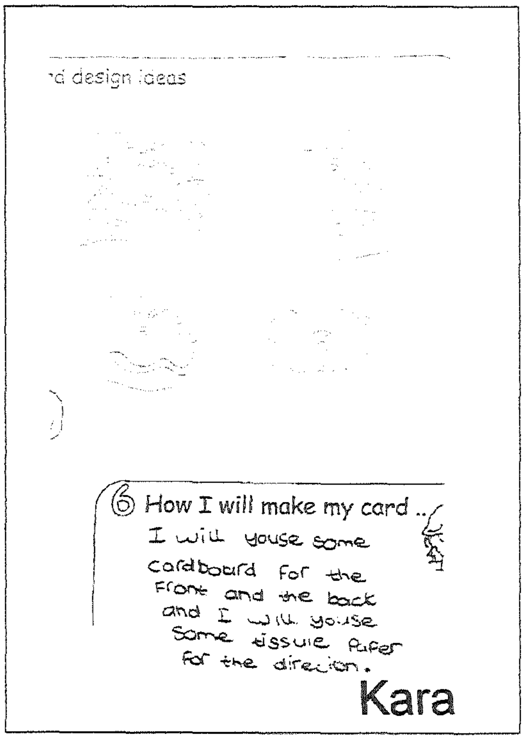
**9** My final card design

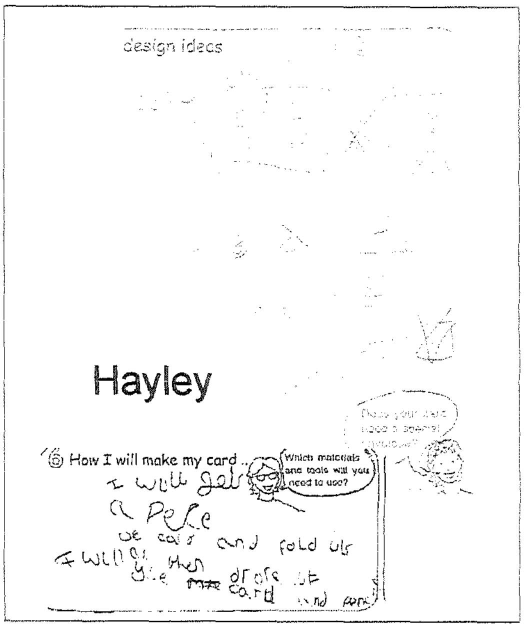
Why will the person will be surprised with your card?

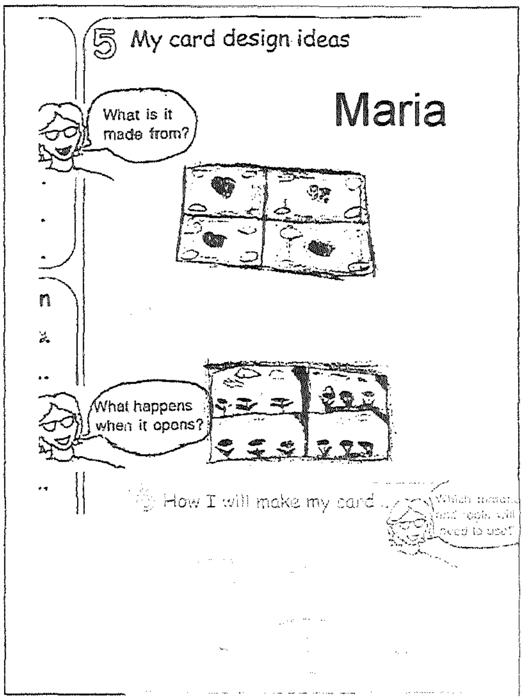
# APPENDIX I
## Target Groups : Card

### Focus Class:



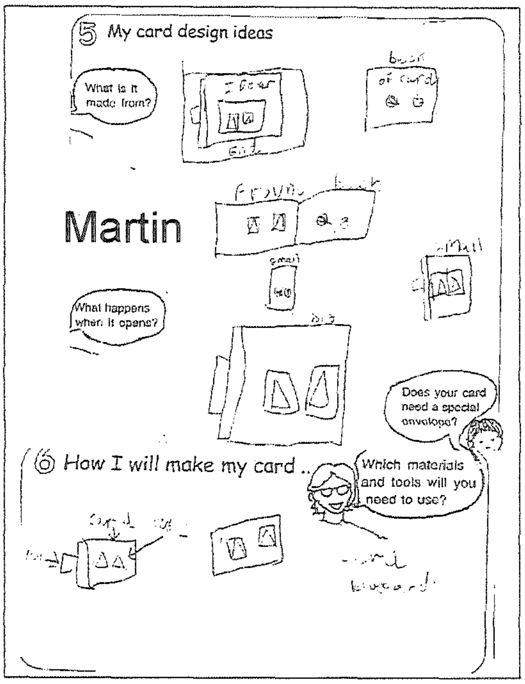



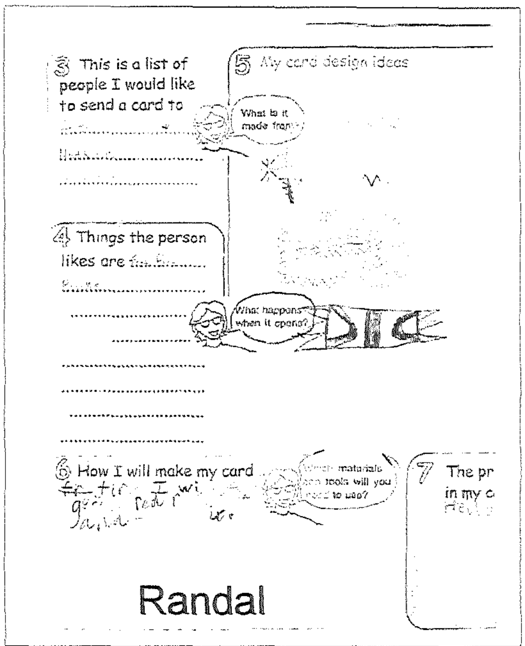



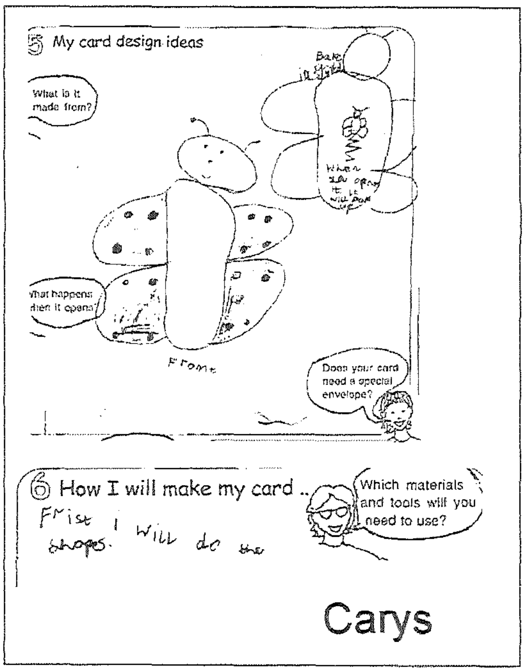
# APPENDIX I
# Target Groups : Card

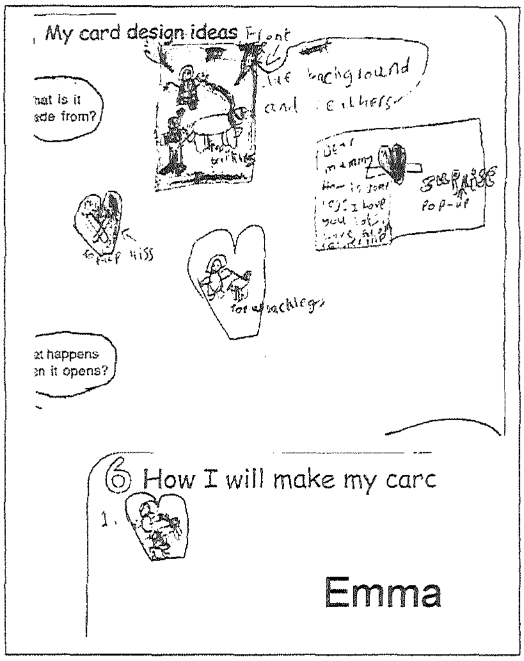
## Focus Class (cont.)



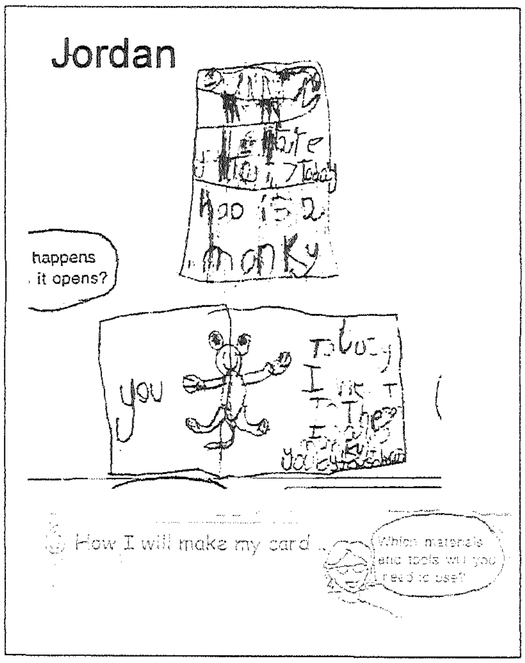

## Comparison Class :

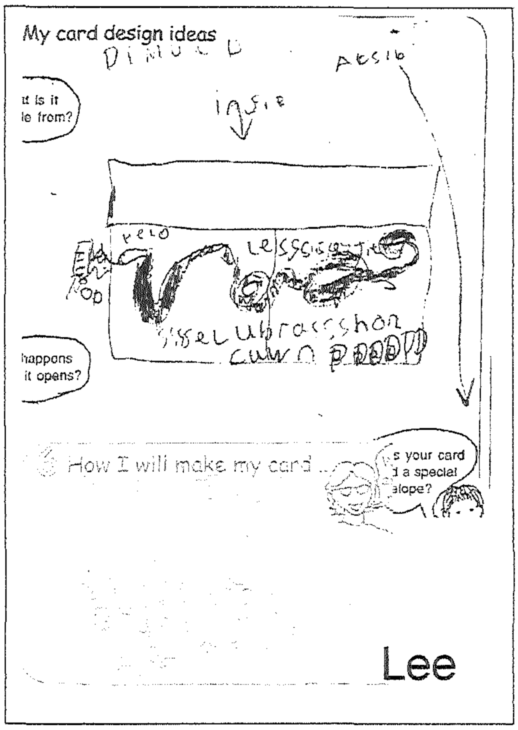


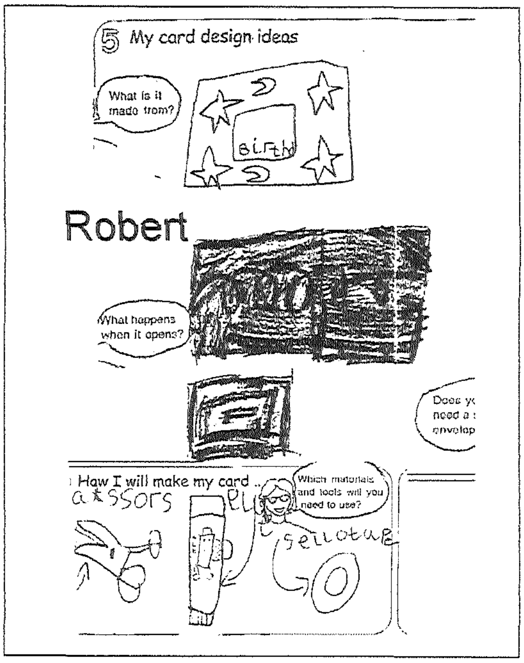



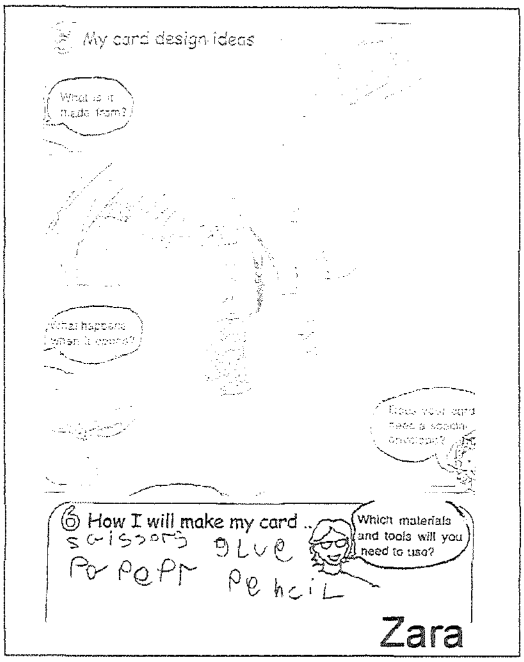
# APPENDIX I
## Target Groups : Card

### Comparison Class (cont.) :



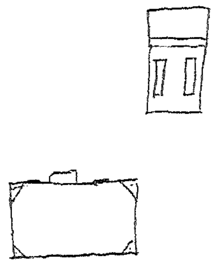
# APPENDIX J
## Focus Class : Sandals Project

# APPENDIX J
## Focus Class : Sandals Project

# APPENDIX K
## Target Groups : Suitcase

### Focus Class:

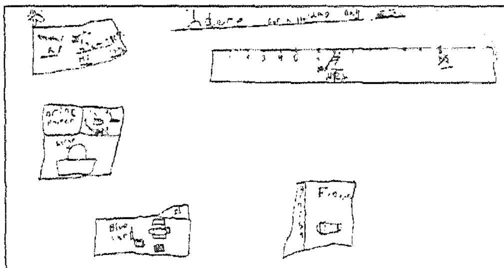
Craig



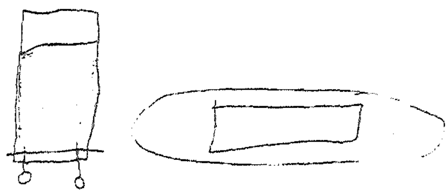
Hayley

Kara

Maria



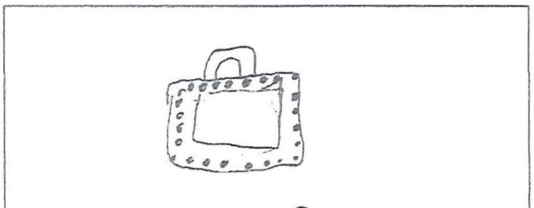
Martin



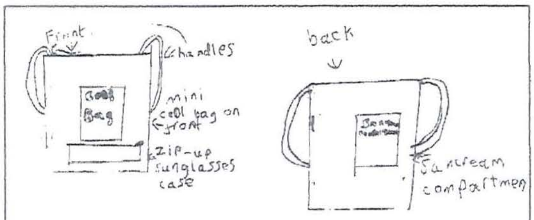
Randal

# APPENDIX K
## Target Groups : Suitcase

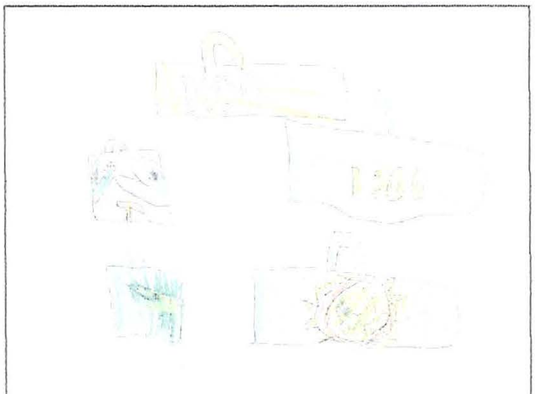
### Comparison Class:



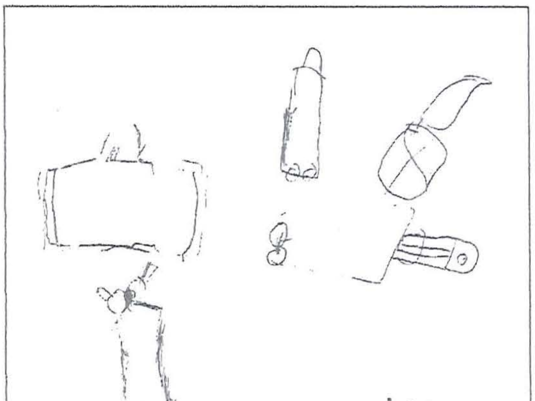
Carys



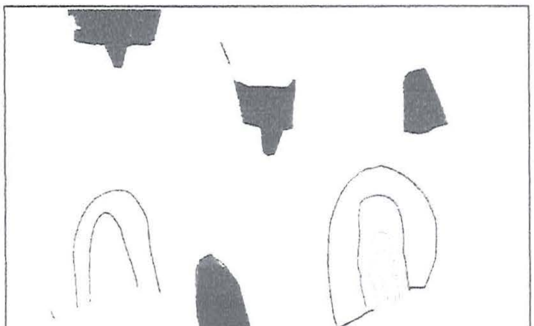

Emma



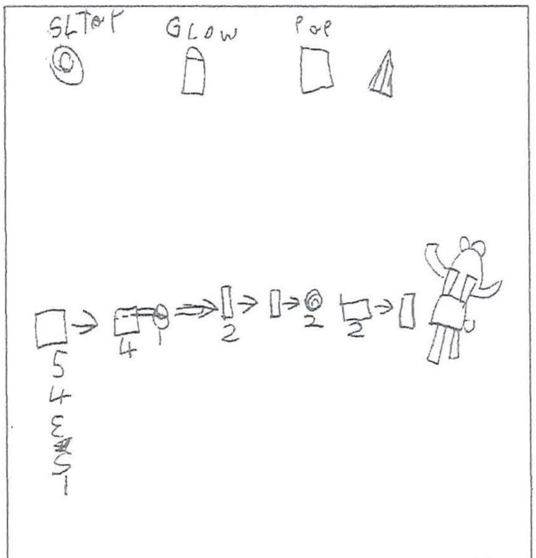
Jordan



Lee



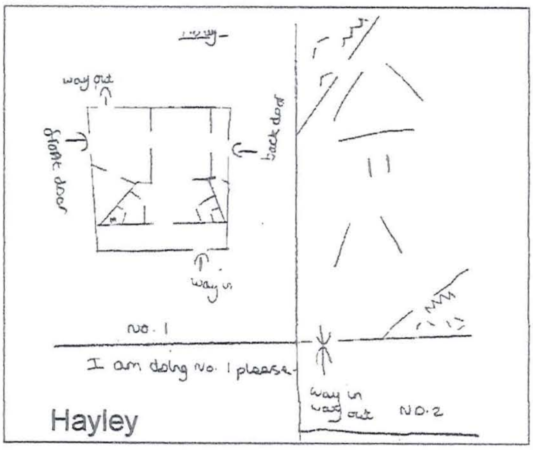
Robert



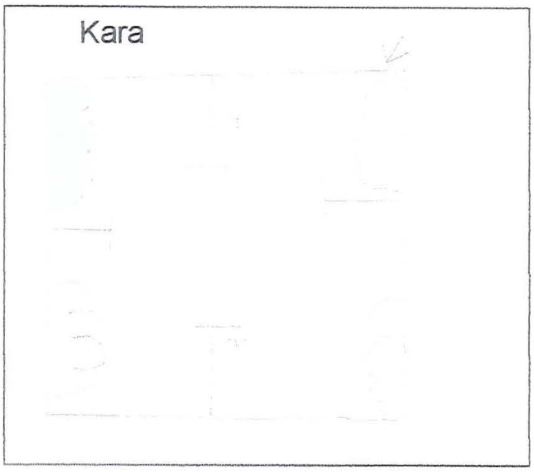

Zara

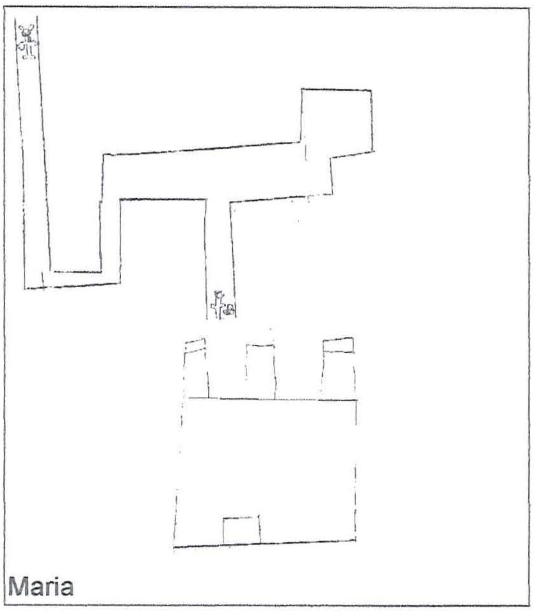
# APPENDIX L
# Target Groups : Maze

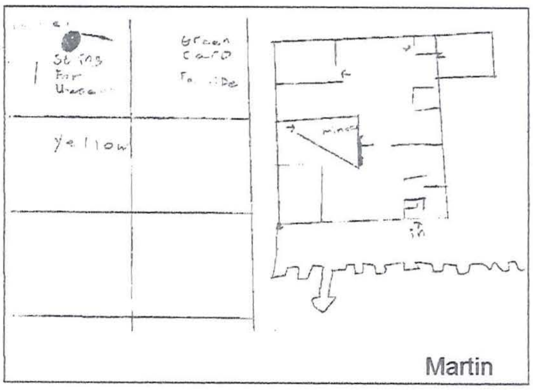
## Focus Class:



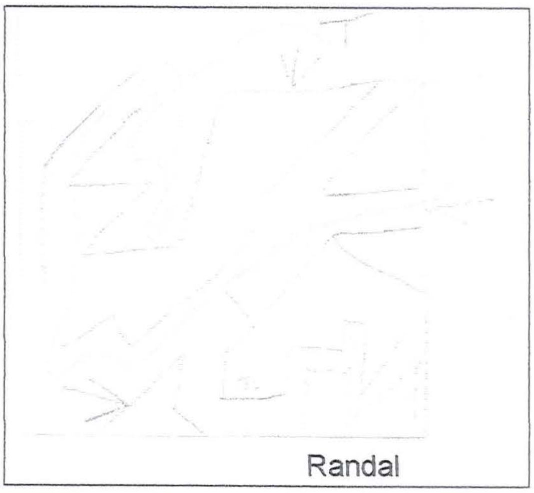
Hayley

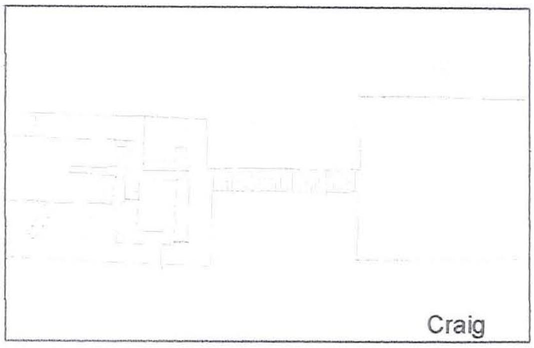

Kara


Maria



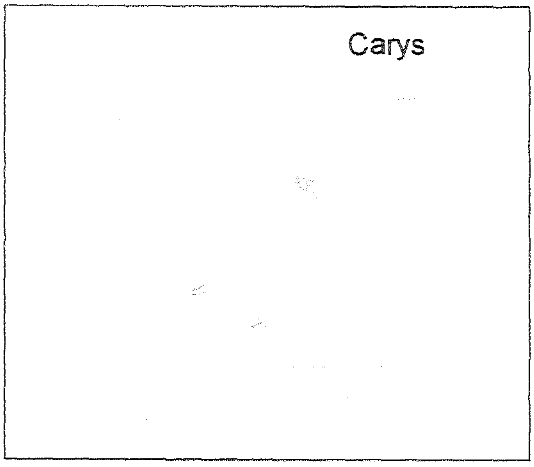
Martin


Randal

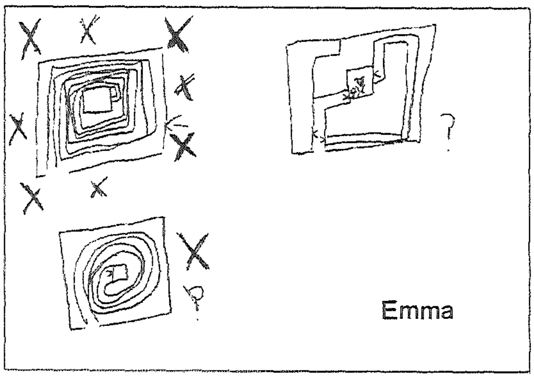

Craig

# APPENDIX L
## Target Groups : Maze

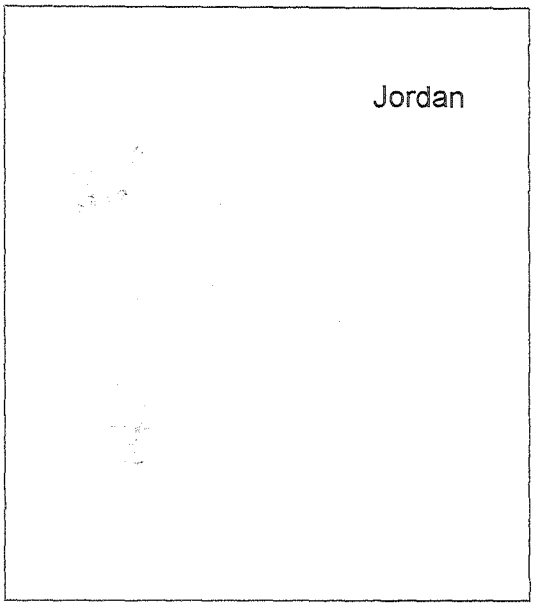
### Comparison Class:



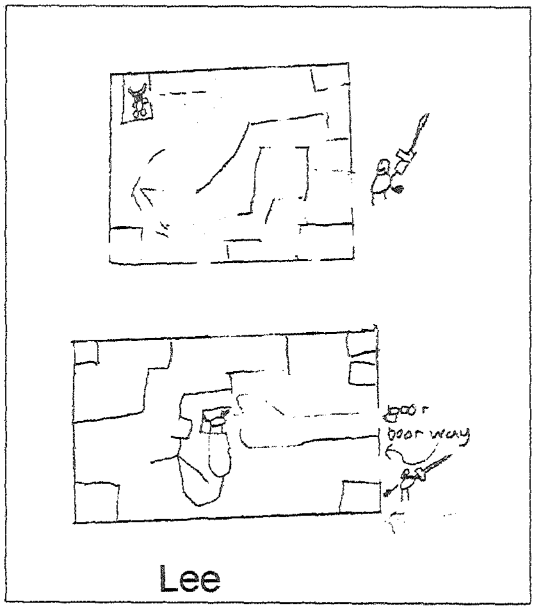
Carys



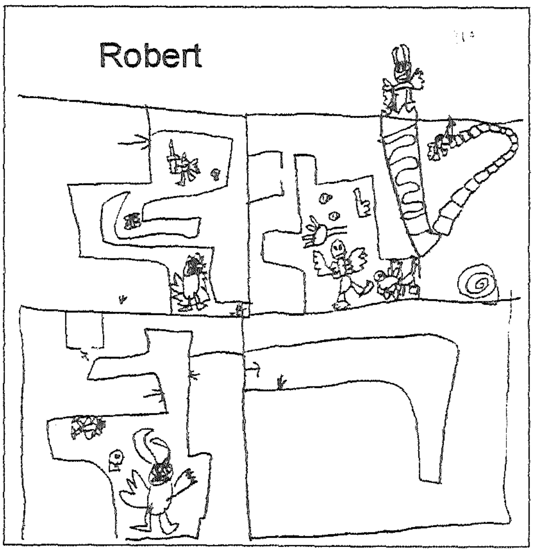
Emma



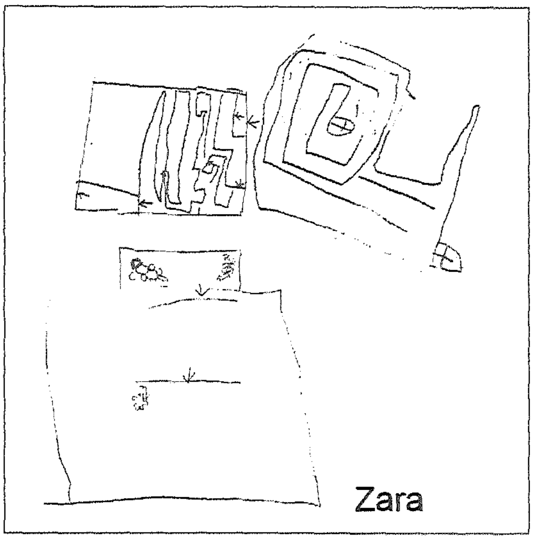
Jordan



Lee



Robert



Zara

# APPENDIX M

Appendix M contains the Log Book Index by which Log Book entries were catalogued and the transcript of the video of the Focus Class Target Group during the Frosty Assessment Task.

# APPENDIX M
## Log Book Index

**Log Book Index**

| Name | Class | Task | Observation |
|---|---|---|---|
| Ellie | F | Pizza | Cut out chosen design from design sheet |
| Louise | F | Pizza | Pipe cleaner bent round = pepperoni |
| Chloe | F | Pizza | Decorated design sheet |
| Noel | F | Pizza | Has stuck black tissue underneath pizza and nothing on top. |
| Maria | F | Wag figure | did an open frame structure |
| Noel | F | Wag figure | looks like a Mr.Man - no distiction between head & body. |
| Martin | F | Wag clothes | wanted to go straight to the cloth and cut it up immediately after making the model |
| Emily | F | Wag clothes | wanted to go straight to the cloth and cut it up immediately after making the model |
| Carl | F | Wag clothes | designed football coat, bots & hat - has no.20 on coat, but can't make it. |
| Kara | F | Wag clothes | cut out a triangle to be a skirt - I got Natalie to come & show how a skirt is made - by turning round etc - skits go all round, not just stuck on front. |
| Stacey | F | Wag clothes | made paper template and drew round it onto the cloth |
| Connor | F | Wag clothes | figure is Superman |
| Martin | F | Wag buggy | still drawing long after everyone else is making |
| Randal | F | Wag buggy | drew one rocket. Insisted that the single drawing contained everything he needed to know, but when it came to the making, said he didn't know what to mal |
| Craig | F | Wag buggy | model - technically good - slots for rocket foils to fit into. |
| Michael | F | Wag house | "Bars so they can't break in" (his motorbike was stolen last week) |
| Randal | F | Wag house | liked the shape of the house he'd drawn |
| Lewis | F | Wag house | liked the shape of the house he'd drawn |
| Martin | F | Wag house | like Millenium dome |
| Natasha | F | Wag house | Asked if she could write how to make the house |
| Craig | F | Wag house | identified a problem - he's drawn a round house - cereal packet won't do - I tell him to go & find something round in the bag. Comes back with 2 round pots |
| Maria | F | Wag house | is making a 2D collage on the inside of a piece of the box. |
| Lewis | F | Wag house | has drawn on inside of the box "So he can cut" |
| Martin | F | Wag house | using paper to make a curved roof over the top of the cereal packet - original - and no one copied this idea |
| Randal | F | Wag house | cut up the box to make shapes - might as well have had falt card. |
| Carl | F | Wag house | really good - just like the picture. |
| Craig | F | Wag house | really good - just like the picture. |
| Kate | F | Wag house | knows how she will make "scrunchy bits" |
| Maria | F | Wag house | realised Wagwum can't go in house - not 3D. Goes looking for a box - I let her use the lid of the paper box I'd brougt some of the materials in. This is then |
| Lewis | F | Wag house | still flat. & looking like a donkey |
| Randal | F | Wag house | still flat. Richard gets in a paddy with it. He has now cut out sides for it, but no time to make it - we're clearing up. |
| Martin | F | Wag house | is playing with the whole set - Wagwum, house & buggy |
| Damian | F | Wag house | excellent - has quietly worked away and hardly asked for any help. |
| Natasha | F | Wag house | inside the box is better than the outsdie - fireplace, chair, picture, mat. |
| Michael | F | Circles | drew a square inside the circle and put a figure inside the circle. |
| Noel | F | Circles | drew a square inside the circle and put a figure inside the circle. |
| Emily | F | Circles | using circle as framework only. |
| Maria | F | Irons 1 | very naughty throughout, even when sent to book corner. |
| Stacey | F | Irons 1 | With Katie, having trouble finding right shapes in game. |
| Kara | F | Irons 1 | With Katie, having trouble finding right shapes in game. |
| Louise | F | Irons 1 | explaining to Rosie and Katie. |
| Hayley | F | Irons2 | With Alisa, used the wrong set of cards to match |
| Lisa | F | Irons2 | With Alisa, used the wrong set of cards to match |

# APPENDIX M
## Log Book Index

| Name | Class | Task | Observation |
|---|---|---|---|
| Louise | F | Flat Stan | only child to Single-draw |
| Jolene | F | Flat Stan | even brainstormed in words |
| Martin | F | Flat Stan | - he had drawn and wanted to make a puppet - popping out of the envelope - hence cutting hole in envelope |
| Craig | F | Round Stan | What are we making?" |
| Kate | F | DIY Stan | I'm going to do a wizard. |
| Stacey | F | DIY Stan | has worked out what heres will look like - drawn it as pot with cotton wool feet. |
| Michael | F | DIY Stan | drawn a picture frame round his design |
| Louise | F | DIY Stan | wants the one on the left. Drew this first and then the one on the irght. Liked the first idea best. |
| Natasha | F | Easter | told me about ears after she'd done other drawings. Added them to No.2 when I said I'd forget. |
| Randal | F | Easter | Can I do that one? (No.1 - he did) |
| Kara | F | Easter | That one's wrong (1st attempt |
| Craig | F | Easter | has cut the tube and bent it round to make it smaller. His drawing shows this. |
| Maria | F | Easter | drawing appears to show a design journey, but she says she is doing No2. In fact she is doing stripes - No.1. |
| Carl | F | Easter | has drawn chicken laying eggs but has simply covered the tube. I query where the good idea has gone. He makes a pink (sic) chicken to go inside the tube |
| Craig & L | F | Easter | There is a great deal of negotiation & sharing of ideas & copying good ideas going on. |
| Ellie | F | Easter | There is a great deal of negotiation & sharing of ideas & copying good ideas going on. |
| Hayley | F | Easter | There is a great deal of negotiation & sharing of ideas & copying good ideas going on. |
| Stacey | F | Easter | There is a great deal of negotiation & sharing of ideas & copying good ideas going on. |
| Kate | F | Easter | There is a great deal of negotiation & sharing of ideas & copying good ideas going on. |
| Natasha | F | Easter | There is a great deal of negotiation & sharing of ideas & copying good ideas going on. |
| Emily | F | Easter | red on drawing means red base |
| Louise | F | Easter | has egg holder inside at bottom - not visible in photo. |
| Jolene | F | Easter | Did not finish product. |
| Randal | F | Marble run | was good - shame they changed it after I said I liked it. |
| Damian | F | Marble run | was good - shame they changed it after I said I liked it. |
| Craig | F | Marble run | dominated Jack who did not contribute much |
| Martin | F | Marble run | Michael found difficulty sharing with Zac - each had their won half of the board. |
| unknown | F | Beach buggy | Oh its a car |
| Chloe | F | Beach buggy | very good seats. |
| Craig | F | Beach buggy | wanted to put guns on - no! |
| Connor | F | Beach buggy | did bench seats all round. |
| Maria | F | card | not looking at big book - is she listening? -Chris says her dad left at weekend. Me to table to support & ensure she did thelist |
| Emily | F | card | I told her to draw rather than write "love hearts & flowers" - got rather into it "Miss, I've got a pattern" |
| Connor | F | card | Are you allowed to do your Mum & your Dad? Me - yes, i expect so. |
| Tasmin | F | card | drew Megan's rectangle - told to rub out & do her own. |
| Emily | F | card | Her drawing is the blue spiral demo + pop-up at top. Me: prompt to think about front. |
| general c | F | card | knowing how large/small to make first drawing so space left for more - good idea - not realised by many |
| Louise | F | card | Who is my best friend? > inside: Natasha is my best friend |
| Carl | F | card | two pieces of paper on top of each other & folded "And I'm going to keep on gong down in size" |
| Michael | F | card | drawing the demo cards & mechanisms- hasn't really designed something of his own. |
| Damian | F | card | drawing a how to make - most writing - ditto CRiag |
| Natasha | F | card | hers opens like the booklet - 2 flaps revealing a central page |
| Emily | F | card | has carried on designing into box6 |
| Mia | F | card | the drawing is of card & pencils |
| Michael | F | card | Me: what is your message? Max: A frog & a mouse |

# APPENDIX M
## Log Book Index

| Name | Class | Task | Observation |
|---|---|---|---|
| Tasmin | F | card | put "best" in "make better" space |
| Martin | F | suitcase | Immediately meauring mac with a ruler |
| Ellie | F | suitcase | also get ruler to measure mac |
| Louise | F | suitcase | also get ruler to measure mac |
| Natasha | F | suitcase | also get ruler to measure mac |
| Lisa | F | suitcase | also get ruler to measure mac |
| Tasmin | F | suitcase | measuring Panda's arm |
| Maria | F | suitcase | done 3 small drawings & shown me -Natalie: You haven't done much have you? |
| Natasha | F | suitcase | measuring again |
| Martin | F | suitcase | measuring again |
| Ellie | F | suitcase | looking on |
| Natasha | F | suitcase | says "7" |
| Emily | F | suitcase | drawn Panda |
| Maria | F | suitcase | Now has mac at table & is measuring it |
| Ellie | F | suitcase | I am going to make a box because Mrs Reed taught us how to make a box. |
| Jolene | F | suitcase | I know what we could do, we could make him a little model car. |
| Connor | F | suitcase | I'm going to pretend he's just bought it from Tescos. |
| Hayley | F | suitcase | Could make some sweets to go in his bag. |
| Randal | F | suitcase | wheels - you can get these bars & the bar goes up into the suitcase |
| Randal | F | suitcase | Skateboard with bag attached. Or thing that goes around the skateboard. - waving arms about to show me & Amy |
| Jolene | F | suitcase | Has folded over the edges of the piece of card she has cut out - wil the mac still fit? |
| Natasha | F | suitcase | drawing round mac onto card |
| Stacey | F | suitcase | shown me rectangle & mac - it's too small. What to do? Me - cut out another. |
| Maria | F | suitcase | Miss, it works. Me: good. You just need to cut out the other side now, don't you. Megan grins - seems to understand. |
| Stacey | F | suitcase | 2 pieces of card, right size - mac sandwiched - how to join together? thinks she will use sellotape. |
| Jolene | F | suitcase | still too small - does she realise? |
| Jolene | F | suitcase | now playing with hers - making into letterbox, trolley etc |
| Maria | F | suitcase | I don't know how to make the handle. Me: draw round the inside of the sellotape & cut in half. |
| Noel | F | suitcase | Made one card one & realised it was too small - tried the mac in it |
| Kate | F | suitcase | made box by glueing strips to rectangle base |
| Jolene | F | suitcase | Me: does the mac fit? Have you tried it? - no to both |
| Kara | F | suitcase | has 2 rectangles -what next? me:stick them together. Katie not sure. Told her to look at Jade's |
| Carl | F | suitcase | has stuck 2 halves together - will mac fit? yes |
| Craig | F | suitcase | has made really good bag - but will the mac fit? bit small - came apart - making another |
| Jolene | F | suitcase | now finished larger bag - it works |
| Maria | F | suitcase | about to abandon hers - disappointed |
| Lisa | F | suitcase | mine fits! mac slides right through tube-like structure |
| Stacey | F | suitcase | put bits of string at sides so it opens further to get mac in. |
| Ellie | F | suitcase | really large box |
| Natasha | F | suitcase | same as Beth only smaller |
| Emily | F | suitcase | cut out 2 very large squarish shapes - now making handle out of string |
| Chloe | F | suitcase | long cuboid object - flap at end to put things in & out.Handle on top. |
| Lewis | F | suitcase | single piece of card folded up rather than 2 separate sides. |
| Michael | F | maze | did outside view - told to do top/down |
| Maria | F | maze | did outside view - told to do top/down |

# APPENDIX M
## Log Book Index

| Name | Class | Task | Observation |
|---|---|---|---|
| Connor | F | maze | You can go out of the first maze and into the second maze |
| Craig | F | maze | I need two parts joined by a bridge |
| Hayley | F | maze | doing the one on top left of paper. |
| Lisa | F | maze | Can I make slots - I can make slots. |
| Randal | F | maze | Can we change it cos it's quite hard to make that. |
| Craig | F | maze | has two pieces joined by bridge |
| Connor | F | maze | making castellations on outside walls |
| Noel | F | maze | measuring his wall against the plan. Craig: You don't stick it on there, mate. {was he?] Nathan now cutting out more green to make it same length as yellow |
| Stacey | F | maze | has lost her way. I say "Look back at drawings - remind yourself of what you were ding" Katie - sorted her out - folded edge of card. |
| Ellie | F | maze | large box structures |
| Natasha | F | maze | large box structures |
| Carl | F | maze | large box structures |
| Emily | F | maze | checkerboard floor pattern - copied from Lauren? |
| Tasmin | F | maze | checkerboard floor pattern - copied from Lauren? |
| Lisa | F | maze | holes in card are for minotaur to got hrough - bits left are the bridges |
| Michael | F | maze | drawing on yellow. |
| Chloe | C | Pizza | Copied design onto pizza by drawing it on pizza.But did so independently - not sitting with others. |
| Alistair | C | Pizza | wants a deep crust pizza |
| Wendy | C | Pizza | Copied design onto pizza by drawing it on pizza.Sitting together. |
| Ellis | C | Pizza | Copied design onto pizza by drawing it on pizza.Sitting together. |
| Alice | C | Pizza | Copied design onto pizza by drawing it on pizza.Sitting together. |
| Robert | C | Pizza | Stuck things directly onto design sheet |
| Zara | C | Pizza | Stuck things directly onto design sheet. Wendy gave orange paper. Sh:"Is this really what I have to do it on?" |
| Zara | C | Pizza | Arranged matchsticks on pizza, marked their position "So if anyone knocks it I'll know where they're meant to be" |
| Kirsty | C | Pizza | Me "Which one are you going to make?" S "The cheese one" Me "Which one is that?" S pointed to first. Me " What are the others?" S "Forgotten now" |
| Emma | C | Pizza | To Wendy "Is this pepperoni colour?" Wanted me to cut circles - how many? Counted the circles on her design drawing. |
| Garth | C | Pizza | Did not draw pizza on orange sheet, just cut out a freehand cicle."It's not a circle." Me "Make it into one then." He cut a bit off so it was. |
| Garth | C | Pizza | I can't make it that size" pointing to drawing. |
| Zara | C | Pizza | Tried to put red tissue between match sticks (already stuck on) to be the sauce. To Wendy: "I want to do more detail." |
| Alice | C | Pizza | Looking for something to be ham. |
| Wendy | C | Easter | I helped cut through tube. |
| Matthew | C | Easter | going to label materials for me |
| Ellis | C | Easter | I don't know how I'm going to decorate this. I didn't think about that. |
| Robert | C | Easter | wanted some lolly sticks - got some from clair's stock. |
| Alistair | C | Easter | wants to do drawing of top as well |
| Rhiannor | C | Easter | mine is a bit like Sophie's. You can put the egg int here, or there. |
| Zara | C | card | has drawn round the blue mechanism provided |
| Alistair | C | card | has drawn one huge picture |
| Garth | C | card | Michelle is telling him exactly what to do & showing him on a scrap of paper |
| Cassy | C | card | her flower vase is to be like the demo card with the wobbly head |
| Sophie | C | card | her first drawing is of the green mechanism example. |
| Peter | C | card | Can I write it? - he has done all writing |
| Kathy | C | card | Me - what's inside? K - I forgotto do the back of it. |
| Chloe | C | card | A little grl on the front - words on inside left, picture on right |
| Alistair | C | card | For Gran & Grandad - they like birds - when you open it there will be a bird which springs out really quickly and come alive & fly away. It's going to come ou |

# APPENDIX M
## Log Book Index

| Name | Class | Task | Observation |
|---|---|---|---|
| Jordan | C | card | front - Who's a monkey; inside - you! |
| Nicola | C | card | top bit is a flip-up football |
| Carys | C | card | has changed her design after working out how to make it |
| Robert | C | card | Me - what do you like about your card? R: the birthday cake; so he has done a range of ideas but not developed a final solution |
| Zara | C | suitcase | wanted to go & get her teddy & make a suitcase for her teddy |
| Lee | C | suitcase | sent outside for rudeness |
| Alistair | C | suitcase | Are we allowed to cut out the paper? - he has drawn a single decorated item. Got card - It can't be this big can it? waving card about |
| Robert | C | suitcase | is cutting up the paper |
| Alistair | C | suitcase | is using his drawng as a transfer |
| Lee | C | suitcase | shown me white paper - Shall I cut it out? |
| Peter | C | suitcase | doing all writing - no drawng |
| Wendy | C | suitcase | drawing & making a carry stick - you put things in & hang it over your shoulder |
| Holly | C | suitcase | has made a box shape |
| Lee | C | suitcase | came to me with cut out - it doesn't fit over Pandy's arm: "I've done a little hole" Me - Does the mac fit in it? - Don't know haven't tried it. |
| Lee | C | suitcase | brought the mac & white single sided cut out: "It fits" Me: What are you going to tdo now? - Make it properly |
| Lee | C | suitcase | Then went on to make a 2 sided bag - so was the cut out a prototype? But final product is much larger. |
| Chloe | C | suitcase | Pink paper stuck to cut out. Me: Did it fit? - I don't know I didn't try it. |
| Sophie | C | suitcase | single sided - Me: Does it fit? - yes - Me: What are you goingto do now? : Put little footballs, like on the drawing. |
| Chloe | C | suitcase | middle bit fits side bits don't. Me: Do you want to try again & make it bigger? - yes |
| Wendy | C | suitcase | single sided - fits over paw, went over shoulder - not happy - trying again. |
| Rhiannor | C | suitcase | super little bag but too small. I suggest making another one bigger |
| Peter | C | suitcase | folding the mac to try to fit onto white paper - it just about fits onto there. |
| Alice | C | suitcase | The mac fits" |
| Peter | C | maze | has drawn rope as well - really good drawing |
| Alistair | C | maze | wanted to do trap doors etc at the drawng stage - I nearly stopped him |
| Robert | C | maze | has drawn a maze on the card and a single door |
| Garth | C | maze | has shown me on the drawing which bit the card he has cut out is |
| Ellis | C | maze | I've just worked out how mine's going to work |
| Wendy | C | maze | Has cut out one piece of red - put glue on - doesn't like it - now drawn the plan on red card |
| Alistair | C | maze | brilliant "This is really, really hard. Look I've got all that to do. I'll have to do all that." |
| Kathy | C | maze | Will you draw the walls or make it? me: whatever you like K: I'm drawing it and then put walls |
| Zara | C | maze | I'm going to bend the walls so they stick to the walls so I don't have to stick them to the base |
| Lee | C | maze | Doing the walls, following his plan. |
| Zara | C | maze | This is for the crocodile to come in (blue) - Liam"It's a minotaur" Sh: No a crocodile in the garden; I'm doing a boat, walls & a door. |
| Kathy | C | maze | I'm going to make figures and maybe a little boat so he can get back [she has no internal walls] so I can put my bits inside. |
| Chloe | C | maze | Also only has walls - I'm going to make people.. |
| Jordan | C | maze | waterfall (blue) for minotaur to have a drink |
| Robert | C | maze | blue fan-folds - bones on top - where the minotaur has left bones |
| Ellis | C | maze | blue = gate |
| Chloe | C | maze | finished - drawn maze not made walls |
| Holly | C | maze | is 3D but doesn't look much like her drawing |
| Peter | C | maze | blue triangle in flat base "skulls" |
| Zara | C | maze | playing with it - walking the minotaur about |

# APPENDIX M
## Frosty Video Transcript

**video Jan2001 - video**

| Time | Child | Talking tc | Saying | Action1 |
|---|---|---|---|---|
| 1 | Noel | Craig | Discussing his drawing; explaining the features to Craig | Pointing to parts of the drawing as he talks; runs pencil around valley |
| 1 | Craig | Noel | you could do... | Pointing with pencil on Noel's drawing |
| 1 | Martin | | | not engaged with the other 2 boys. |
| 2 | Noel | Craig | cont dicsission re drawing | |
| 2 | Craig | Noel | about his drawing | |
| 2 | Martin | | | still doing own drawing; no communication with others |
| 3 | Randal | | | reaching for sellotape to wrap around rolled up newspaper |
| 3 | Damian | Noel | discussing Damian's newspaper roll | |
| 3 | Noel | Damian | | cutting length of wool to same length as drawing laying it on the drawing and carefully cutting it to same length |
| 3 | Jolene | don't kno | about drawing | pointing at parts of drawing with pencil as she talks |
| 3 | Natasha | | | got up to fetch other materials |
| 4 | Randal | Damian | negotiating use of sellotape | using sellotape to fix newspaper rolls |
| 4 | Natasha | Randal & | negotiating use of sellotape | getting the sellotape from Randal & Damian |
| 4 | Damian | Randal | negotiating use of sellotape | using sellotape to fix roll of newspaper |
| 4 | Jolene | | | rolling up newspaper & fixing with sellotape |
| 5 | Noel | | | looking at wool stuck to paper and considering what other chldren are doing - not sure he has done the rgiht thin |
| 5 | Damian | | | fxing sellotape around rolls |
| 5 | Jolene | within grc | negotiations over use of sellotape | making newspaper rolls & fixing with sellotape |
| 5 | Natasha | within grc | negotiations over use of sellotape | making newspaper rolls & fixing with sellotape |
| 6 | Randal | | | leaves table to fetch materials - returns with straws. |
| 6 | Damian | within grc | negotiations over use of sellotape | making newspaper rolls & fixing with sellotape |
| 6 | Noel | | | looking at others working & at his own paper. realising others have not stuck things to design sheet |
| 6 | Natasha | within grc | negotiations over use of sellotape | making newspaper rolls & fixing with sellotape |
| 6 | Jolene | within grc | negotiations over use of sellotape | making newspaper rolls & fixing with sellotape |
| 7 | Craig | Jolene & | concerning sellotape to fix newspaper rolls | wants sellotpe round model - Jolene does this for him whilst he holds it |
| 7 | Jolene | Craig & I | concerning sharing of sellotape | puts sellotape around Craig's model for him |
| 7 | Noel | me to No | You're not just making a picture of it, you're making a m | |
| 7 | Natasha | | | rolling and sellotaping second roll |
| 7 | Martin | me to Ma | why dont you just use the whole cork? | off-side, cutting cork in half with scissors (so is Chris) |
| 8 | Damian | | | making newspaper roll |
| 8 | Noel | | | has fetched sheet of newspaper to begin making model |
| 8 | Jolene | | | now has 2 rolls completed |
| 8 | Martin | Chris | about cutting cork | both Chris & Martin are trying to cut cork in half with a pair of scissors - I have already suggested to Martin that |
| 9 | Randal | Noel | Asks for the sellotape | From this point Randal and Damian develop thir ideas together |
| 9 | Damian | Randal | use of sellotape | from this point Randal & Damian develop their ideas together |
| 10 | Martin | me | explaining what the cork is for and what else is going to | cutting up the cork |
| 10 | Natasha | | | cutting up straws, measuring them against each other & cutting them to the same length |
| 10 | Megan | | | laid out a sheet of newspaper on the table, has some straws in her hand and is laying the straws out on the new |
| 11 | Randal | Damian | about what Randal is going to use the straws for | |
| 11 | Damian | Randal | about what Randal is oing to use straws for and whethe | |
| 11 | Jolene | | | tying string around newspaper roll |
| 11 | Natasha | me | about the length of the straws | comparing the proportions of her straws to the drawing, considering them and going off to find some more. |
| 11 | Martin | | | still trying to cut up the cork (so is Chris) |

| Time | Child | Talking t | Saying | Action1 |
|---|---|---|---|---|
| 12 | Randal | | | playing with the flattened and bent roll and rushing off to get more materials |
| 12 | Noel | | | flattening newspaper roll |
| 12 | Damian | | | watching and considering what Noel is doing with his newspaper roll |
| 13 | Martin | | | still cutting the cork with Chris |
| 13 | Megan | group | Whose is this?" as she picks up a newspaper roll - is s | picks up Noel's roll. |
| 13 | Randal | Damian | discussing straws and the cotton reel which they are fit | looking through bit box with Noel |
| 13 | Noel | | | looking through bit box with Randal |
| 13 | Damian | Randal | discussing straws and the cotton reel which they are fit | waiting for Randal & Noel to return from fetching materials |
| 13 | Jolene | | | unreeling sellotape |
| 14 | Megan | | | picks up Noel's roll but it is taken from her |
| 14 | Randal | Damian | about the cotton reel going down the roll | experimenting with fitting a cotton reel down the centre of the roll |
| 14 | Damian | Randal | about the cotton reel going down the roll | experimenting with fitting a cotton reel down the roll |
| 14 | Megan | | | self-absorbed, finding end of sellotape to wind round newspaper roll |
| 14 | Jolene | me | Look at my little basket" | making basket |
| 14 | Martin | | | still cutting the cork |
| 14 | Natasha | me | about measuring basket to the drawing | |
| 15 | Martin | | | and still cutting the cork; I ask if he is going to make anything; another child jins in & comments; Martin still obliv |
| 15 | Randal | Martin | about his cork cutting | looking at his newspaper roll and considering the straws and cotton reels insde |
| 15 | Craig | | | using sellotape |
| 15 | Noel | Damian | about Noel's construction | looking at what Randal and Damian are doing |
| 15 | Damian | | | fitting two straws end to end |
| 15 | Jolene | | | making pizza to go in the basket |
| 16 | Randal | Damian & | Discussion re what to do with straws | Putting straw down centre of Noel's roll |
| 16 | Noel | Randal & | Discussion re what he is doing with the newspaper roll | |
| 16 | Damian | Randal & | Discussion re what to do with straws | |
| 16 | Martin | | | putting a collection of materials on the table where he sat to do the drawing, despite the fact that Randal, Damiar |
| 16 | Jolene | | | putting string on the basket |
| 17 | Jolene | | | tying string - basket? |
| 17 | Natasha | | | looking at the drawing & working out what to do |
| 17 | Damian | | | waiting for Randal to return |
| 18 | Noel | | | waiting for Randal to return |
| 18 | Jolene | | | fixing basket to ropeway |
| 18 | Randal | | | sent by Damian to fetch materials |
| 18 | Noel | | | sent by Damian to fetch materials |
| 18 | Damian | Randal & | There's some over there!" directing them to find materia | |
| 18 | Martin | | | laying out the newspaper on the table where Noel was working & staritng to cut it up. |
| 19 | Damian | | | Waiting for Randal & Noel to return & then runs off to join them on other side of the room |
| 19 | Martin | | | cutting newspaper |
| 19 | Noel | | | returning to table with Damian |
| 19 | Craig | me | I ask where he's been; indicates other table;has corks e | |
| 20 | Craig | | | gone to fetch something |
| 21 | Martin | | | beginning to roll up newspaper |
| 21 | Craig | | | trying out the position of two lolly sticks on a toilet roll middle; has abandoned the cork structure |
| 21 | Jolene | | | attaching basket to ropeway |
| 21 | Martin | | | measuring his two newspaper rolls against each other |

# APPENDIX M
## Frosty Video Transcript

| Time | Child | Talking t | Saying | Action1 |
|---|---|---|---|---|
| 21 | Megan | | | walking across room with sellotape |
| 21 | Randal | | | holding the flattened roll which he had at the start and manipulating it whilst looking at Jolene's finished product |
| 22 | Craig | | | cutting through sellotape holding lollysticks & waiting for turn of sellotape to stick them on again |
| 22 | Damian | | | measures his roll against Randal's |
| 22 | Martin | | | cutting more newspaper to size (ready for rolling) |
| 23 | Randal | Damian | about Damian's model "Yeah, Do that" | |
| 23 | Damian | Randal | asking Randal's opinion | |
| 23 | Noel | | | putting two straws end to end & beginning to fix them togeter with sellotape |
| 23 | Martin | | | laying three rolls on the table in bridge shape & starting to cut more newspaper |
| 24 | Randal | Damian | discussing how they will use the lollysticks | Randal & Damian now have lolly sticks |
| 24 | Damian | Randal | discussing how they will use the lollysticks | Randal & Damian now have lolly sticks |
| 25 | Megan | | | wrapping sellotape around end of roll |
| 25 | Randal | | | takes sellotape from Megan to use to join lollysticks |
| 25 | Damian | | | holding straws end on & looking at them |
| 25 | Martin | | | cutting newspaper |
| 26 | Martin | | | has cut hill-shaped piece of newspaper |
| 26 | Jolene | | | making a pizza to go in the basket |
| 26 | Noel | | | sellotaping two straws together end to end |
| 26 | Randal | Megan & | about use of sellotape | negotiating & sharing sellotape |
| 26 | Damian | | | brushing debris off his drawing so he can still see it. |
| 27 | Martin | | | cutting more newspaper |
| 27 | Noel | | | joining two straws together; noe that Martin is bewteen Noel & Randal/Damian, Noel works alone |
| 27 | Megan | | | trybg to get the sellotape started |
| 27 | Martin | | | still cutting up lots of newspaper |
| 27 | Randal | Damian | about the rolls & straws etc | |
| 27 | Damian | | | looking at Noel fitting straws up the rolled newspaper |
| 27 | Noel | | | has gone around the table & has joined Randal & Damian; investigating fitting his two end-joined straws up the c |
| 27 | Craig | | | tying string on to model |
| 27 | Martin | | | aligned already cut shape of newspaper to another sheet, picked up pencil, checked & adjusted alignment and tl |
| 27 | Jolene | | | fitting pizza in basket |
| 28 | Craig | | | holds out rope bridge to check he is happy with it |
| 28 | Randal | | | joining lollysticks end to end |
| 28 | Damian | | | picks up roll and inspects it; he has bundle of lollystcks in one hand; observes what Randal is doing with his |
| 28 | Noel | | | removes two rolls out of his way; assuming them to be Martin's he moves them in Martin's direction |
| 28 | Jolene | | | close-up of pizza in basket |
| 29 | Martin | | | aligning two halves of a "hill" cut from two flat sheets of newspaper |
| 29 | Damian | | | plying straws in his hands whilst watching; waiting for sellotape? |
| 29 | Craig | | | has returned with two wheels, his cork structure and string; he is tying string onto th cork structure |
| 30 | Martin | | | wants the sellotape to secure top piece to roll |
| 30 | Craig | me | claims he's finished; I query where's the basket -how w | holding up ropebridge; looks much happier with his cork construction -prefers this to the two rolls he had earlier |
| 30 | Megan | | | cutting sellotape & winding round roll |
| 30 | Randal | | | attempting to stick sellotape to end of straw |
| 30 | Damian | | | aligning straw with roll; then waiting for sellotape |
| 31 | Martin | | | tying string round end of one roll |
| 31 | Megan | | | twists roll; wanders around; returns with piece of string |

# APPENDIX M
## Frosty Video Transcript

| Time | Child | Talking to | Saying | Action1 |
|---|---|---|---|---|
| 31 | Damian | | | unpeeling sellotape; has straws in other hand |
| 31 | Randal | | | sticking straws to come out of end of roll |
| 31 | Noel | | | now has three straws all sellotaped end to end |
| 32 | Noel | | | trying a straw up the inside of the roll; pushing it in and out - to see if it moves freely? |
| 32 | Damian | | | trying straw up inside of roll (same as Noel, but more tentative) |
| 32 | Randal | | | fitting straws in the end of the roll so that they are poking out. Was this idea his & the others copied & improved |
| 32 | Craig | Noel | "It can go zoom" complete with action - this confirms th | |
| 33 | Martin | | | trying to stcik the two halves of his hill together unsuccessfully - sticks to drawing instead |
| 33 | Damian | | | fitting straws into roll; considers them & fiddles with pulling the straws in & out |
| 33 | Randal | | | bending the straws down & prodding it on the table to see if this will work: the straws are the "legs" and the roll is |

# APPENDIX N
# Development of Quantitative Assessment Instrument

## CONTENTS :

# APPENDIX N
# Development of Quantitative Assessment Instrument

## AN1 Exploratory Phase Databases

### Introductory Explanation

AN1 contains the databases created to quantify the observations and evauations made of the Exploratory Phase whole school surveys of children's design drawing skills, as detailed in Section 3.3.2.

**AN1.1 Form view of Stan database:**
Table 2 in Section 3.3.2a shows the form view of the Flat Stan part of this database, together with an explanation of how it was used to attempt to analyse the child's capability with design drawing. AN1.1 shows both pages of the form view of one child's record for both Flat and Round Stan tasks. There were 371 records on the database.

**AN1.2 Spreadsheet of Stan data:**
The numerical data were collated from the Stan database into this spreadsheet, from which charts such as Charts 1-3 in Section 3.3.2a were created.

**AN1.3 Form view of Panda & Box database:**
This shows the form view of the same child's record from the Panda and Box database as that shown in AN1.1. The Panda database shows the addition of fields that were to aid my understanding of children's ability to engage in the juxtaposition of fantasy and reality , which became an emergent theme from the Structured Phase. The Box task is refered to briefly in Section 3.3.2 and Ex.6 in Section 3.2.4b is taken from this activity. Its function was as an introductory activity prior to Pandy's Suitcase. No product was made and results of analsys are not reported in the main text.

**AN1.4 Spreadsheet of Panda data:**
The numerical data from the Panda database were collated onto this spreadsheet, from which the prevalence of the Drawing Types identified through Stan98 could be seen. It was also realised through this analysis, that categories beyond Multi-design were needed.

# APPENDIX N

## Development of Quantitative Assessment Instrument

### AN 1.1 Form view of Stan database 1998

FIRST NAME: Ellis  M/F: M  COHORT CODE: 96X

SECOND NAME: Munday  CLASS 97/8: 2B

FLAT STAN: 6  F.EXP.: with supply teacher

F.CRITERIA: 2  F FITS: 1  FLAT: 1

F.DRAW SCORE: 2

F DR DET: 1  F PRE-DR: 1  F MULT DR: 0  F MULT DES: 0

F VIEWPOINTS:  F EXPANDED:  F LABEL:

F.RECORD MATS: 0  F DRAW MATS: 0  F WRITE MATS: 0

F COLOURS: 0  F INSTRUCTS:  F EQUIP:

F.MAKE SCORE: 2  F MATS: 1  F RESEMB: 0  F EXACTLY: 0

F MK DETAIL: 1

ROUND STAN: 9  R.EXP: shown examples of design drawing

R.CRITERIA: 2  R FITS: 1  3D MODEL: 1

R.DRAW SCORE: 2  R PRE-DR: 1  R MULT DR: 0  R MULT DES: 0

R DR DET: 1  R VIEWPOINTS:  R EXPANDED:  R LABEL:

R.RECORD MATS: 2  R DRAW MATS: 1  R WRITE MATS: 1

R COLOURS: 0  R INSTRUCT:  R EQUIP:

R.MAKE SCORE: 3  R MATS: 1  R RESEMB: 1  R EXACTLY: 1

if 2D - RMK.DETAIL:

# AN1.2 Spreadsheet of Stan data

| FLAT STANS | 4L | | 4M | | 3R | | 3S | | 3W | | 2D | | 2P | | 2B | | Y1 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **scores** | | *0%* | | *0%* | | *0%* | | *0%* | | *0%* | | *0%* | | *0%* | | *0%* | | *0%* |
| **0** | | *0* | | *0* | | *0* | | *0* | | *0* | 0 | *0* | 0 | *0* | 0 | *0* | 0 | *0* |
| **1** | | *0* | | *0* | | *0* | | *0* | | *0* | 0 | *0* | 0 | *0* | 0 | *0* | 4 | *10* |
| **2** | | *0* | 1 | *3* | | *0* | | *0* | | *0* | 0 | *0* | 5 | *18* | 0 | *0* | 3 | *8* |
| **3** | | *0* | 0 | *0* | | *0* | 2 | *6* | | *0* | 1 | *3* | 2 | *7* | 0 | *0* | 4 | *10* |
| **4** | 2 | *14* | 1 | *3* | 1 | *3* | 4 | *13* | 4 | *13* | 4 | *14* | 4 | *14* | 0 | *0* | 4 | *10* |
| **5** | 1 | *7* | 2 | *7* | 5 | *16* | 3 | *9* | 3 | *10* | 11 | *38* | 4 | *14* | 4 | *14* | 2 | *5* |
| **6** | 4 | *29* | 8 | *28* | 8 | *25* | 8 | *25* | 7 | *23* | 6 | *21* | 3 | *11* | 8 | *28* | 6 | *15* |
| **7** | 2 | *14* | 6 | *21* | 7 | *22* | 10 | *31* | 3 | *10* | 5 | *17* | 3 | *11* | 7 | *24* | 9 | *23* |
| **8** | 1 | *7* | 2 | *7* | 7 | *22* | 3 | *9* | 9 | *30* | 3 | *10* | 3 | *11* | 4 | *14* | 6 | *15* |
| **9** | 1 | *7* | 4 | *14* | 4 | *13* | 1 | *3* | 0 | *0* | 0 | *0* | 3 | *11* | 0 | *0* | 0 | *0* |
| **10** | 2 | *14* | 2 | *7* | | *0* | 1 | *3* | 2 | *7* | 0 | *0* | 0 | *0* | 2 | *7* | 0 | *0* |
| **11** | 0 | *0* | 3 | *10* | | *0* | | *0* | 1 | *3* | 0 | *0* | 0 | *0* | 0 | *0* | 0 | *0* |
| **12** | 1 | *7* | | *0* | | *0* | | *0* | 1 | *3* | 0 | *0* | 1 | *4* | 0 | *0* | 0 | *0* |
| NO OF CH. | 14 | | 29 | | 32 | | 32 | | 30 | | 29 | | 28 | | 29 | | 39 | |

| | YR4 | | YR3 | | yr2 | | all Flats | |
|---|---|---|---|---|---|---|---|---|
| **scores** | | *0%* | | *0%* | | *0%* | | |
| **0** | 0 | *0* | 0 | *0* | 0 | *0* | 0 | 0 |
| **1** | 0 | *0* | 0 | *0* | 0 | *0* | 4 | 2 |
| **2** | 1 | *2* | 0 | *0* | 5 | *6* | 9 | 3 |
| **3** | 0 | *0* | 2 | *2* | 3 | *4* | 9 | 3 |
| **4** | 3 | *7* | 9 | *10* | 8 | *10* | 24 | 9 |
| **5** | 3 | *7* | 11 | *12* | 19 | *23* | 35 | 14 |
| **6** | 12 | *28* | 23 | *24* | 17 | *20* | 58 | 22 |
| **7** | 8 | *19* | 20 | *21* | 15 | *18* | 52 | 20 |
| **8** | 3 | *7* | 19 | *20* | 10 | *12* | 38 | 15 |
| **9** | 5 | *12* | 5 | *5* | 3 | *4* | 13 | 5 |
| **10** | 4 | *9* | 3 | *3* | 2 | *2* | 9 | 3 |
| **11** | 3 | *7* | 1 | *1* | 0 | *0* | 4 | 2 |
| **12** | 1 | *2* | 1 | *1* | 1 | *1* | 3 | 1 |
| | 43 | | 94 | | 83 | | 258 | |

| ROUND STANS | 4H | | 4M | | 3R | | 3RCAD | | 3W | | 3S | | 2B | | YR 1 | | all RNDs | | all Stans | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **scores** | | *0%* | | *0%* | | *0%* | | *0%* | | *0%* | | *0%* | | *0%* | | *0%* | | | | |
| | | *0* | | *0* | | *0* | | *0* | | *0* | | *0* | 0 | *0* | 0 | *0* | 0 | 0 | 0 | 0 |
| **0** | | *0* | | *0* | | *0* | | *0* | 1 | *4* | | *0* | 0 | *0* | 0 | *0* | 1 | 1 | 5 | 1 |
| **1** | 1 | *3* | 2 | *7* | | *0* | | *0* | 2 | *8* | 2 | *7* | 1 | *4* | 3 | *11* | 11 | 6 | 20 | 4 |
| **2** | 2 | *7* | 4 | *14* | 1 | *5* | 1 | *9* | 1 | *4* | 3 | *11* | 2 | *7* | 7 | *25* | 21 | 11 | 30 | 7 |
| **3** | 2 | *7* | 4 | *14* | 4 | *20* | 0 | *0* | 2 | *8* | 7 | *26* | 3 | *11* | 9 | *32* | 31 | 16 | 55 | 12 |
| **4** | 1 | *3* | 2 | *7* | 3 | *15* | 3 | *27* | 5 | *21* | 9 | *33* | 4 | *14* | 3 | *11* | 30 | 15 | 65 | 14 |
| **5** | 7 | *23* | 3 | *11* | 5 | *25* | 2 | *18* | 2 | *8* | 4 | *15* | 6 | *21* | 2 | *7* | 31 | 16 | 89 | 19 |
| **6** | 2 | *7* | 2 | *7* | 4 | *20* | 7 | *64* | 2 | *8* | 1 | *4* | 4 | *14* | 3 | *11* | 25 | 13 | 77 | 17 |
| **7** | 6 | *20* | 2 | *7* | 3 | *15* | 2 | *18* | 7 | *29* | 1 | *4* | 4 | *14* | 1 | *4* | 26 | 13 | 64 | 14 |
| **8** | 2 | *7* | 4 | *14* | | *0* | | *0* | 1 | *4* | | *0* | 5 | *18* | 0 | *0* | 12 | 6 | 25 | 5 |
| **9** | 5 | *17* | 2 | *7* | | *0* | | *0* | 1 | *4* | | *0* | 0 | *0* | 0 | *0* | 8 | 4 | 17 | 4 |
| **10** | 2 | *7* | 3 | *11* | | *0* | | *0* | | *0* | | *0* | 0 | *0* | 0 | *0* | 5 | 3 | 9 | 2 |
| **11** | | *0* | | *0* | | *0* | | *0* | | *0* | | *0* | 0 | *0* | 0 | *0* | 0 | 0 | 3 | 1 |
| **12** | | | | | | | | | | | | | | | | | | | | |
| NO OF CH. | 30 | | 28 | | 20 | | 11 | | 24 | | 27 | | 28 | | 28 | | 196 | | 459 | |

## AN1.2 Spreadsheet of Stan data (cont.)

| FLAT STANS | | 4L | | 4M | | 3R | | 3S | | 3W | | 2D | | 2P | | 2B | | Y1 | | Yr.4 | | Yr.3 | | Yr.2 | | all | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 0% | | 0% | | 0% | | 0% | | 0% | | 0% | | 0% | | 0% | | 0% | | 0% | | 0% | | 0% | | 0% |
| CRITERIA | 0 | 2 | 14 | 4 | 14 | 0 | 0 | 2 | 6 | 1 | 3 | 1 | 3 | 3 | 11 | 0 | 0 | 7 | 18 | 6 | 14 | 3 | 3 | 4 | 5 | 20 | 8 |
| | 1 | 4 | 29 | 12 | 41 | 2 | 6 | 19 | 59 | 10 | 33 | 24 | 83 | 18 | 64 | 0 | 0 | 14 | 36 | 16 | 37 | 31 | 33 | 42 | 51 | 103 | 40 |
| | 2 | 8 | 57 | 13 | 45 | 30 | 94 | 11 | 34 | 19 | 63 | 4 | 14 | 7 | 25 | 29 | ## | 17 | 44 | 21 | 49 | 60 | 64 | 40 | 48 | 138 | 54 |
| DRAW SCORE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8 | 29 | 0 | 0 | 8 | 21 | 0 | 0 | 0 | 0 | 8 | 10 | 16 | 6 |
| | 1 | 1 | 7 | 4 | 14 | 3 | 9 | 2 | 6 | 1 | 3 | 1 | 3 | 2 | 7 | 3 | 10 | 4 | 10 | 5 | 12 | 6 | 6 | 6 | 7 | 21 | 8 |
| | 2 | 5 | 36 | 6 | 21 | 11 | 34 | 9 | 28 | 8 | 27 | 5 | 17 | 6 | 21 | 18 | 62 | 12 | 31 | 11 | 26 | 28 | 30 | 29 | 35 | 80 | 31 |
| | 3 | 4 | 29 | 12 | 41 | 12 | 38 | 12 | 38 | 15 | 50 | 15 | 52 | 6 | 21 | 7 | 24 | 11 | 28 | 16 | 37 | 39 | 41 | 28 | 34 | 94 | 37 |
| | 4 | 4 | 29 | 7 | 24 | 6 | 19 | 9 | 28 | 6 | 20 | 8 | 28 | 6 | 21 | 1 | 3 | 3 | 8 | 11 | 26 | 21 | 22 | 15 | 18 | 50 | 20 |
| REC MATS | 0 | 7 | 50 | 14 | 48 | 28 | 88 | 30 | 94 | 25 | 83 | 22 | 76 | 14 | 50 | 27 | 93 | 37 | 95 | 21 | 49 | 83 | 88 | 63 | 76 | 204 | 80 |
| | 1 | 4 | 29 | 6 | 21 | 4 | 13 | 2 | 6 | 2 | 7 | 6 | 21 | 8 | 29 | 2 | 7 | 2 | 5 | 10 | 23 | 8 | 9 | 16 | 19 | 36 | 14 |
| | 2 | 1 | 7 | 3 | 10 | 0 | 0 | 0 | 0 | 3 | 10 | 1 | 3 | 5 | 18 | 0 | 0 | 0 | 0 | 4 | 9 | 3 | 3 | 6 | 7 | 13 | 5 |
| | 3 | 2 | 14 | 6 | 21 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 4 | 0 | 0 | 0 | 0 | 8 | 19 | 0 | 0 | 1 | 1 | 9 | 4 |
| MAKE SCORE | 0 | 2 | 14 | 4 | 14 | 0 | 0 | 4 | 13 | 2 | 7 | 4 | 14 | 3 | 11 | 0 | 0 | 6 | 15 | 6 | 14 | 6 | 6 | 7 | 8 | 25 | 10 |
| | 1 | 3 | 21 | 3 | 10 | 5 | 16 | 5 | 16 | 2 | 7 | 15 | 52 | 9 | 32 | 1 | 3 | 12 | 31 | 6 | 14 | 12 | 13 | 25 | 30 | 55 | 21 |
| | 2 | 3 | 21 | 9 | 31 | 18 | 56 | 11 | 34 | 17 | 57 | 8 | 28 | 13 | 46 | 14 | 48 | 4 | 10 | 12 | 28 | 46 | 49 | 35 | 42 | 97 | 38 |
| | 3 | 4 | 29 | 10 | 34 | 2 | 6 | 12 | 38 | 5 | 17 | 3 | 10 | 2 | 7 | 8 | 28 | 12 | 31 | 14 | 33 | 19 | 20 | 13 | 16 | 58 | 23 |
| | 4 | 1 | 7 | 3 | 10 | 5 | 16 | 0 | 0 | 4 | 13 | 0 | 0 | 1 | 4 | 6 | 21 | 4 | 10 | 4 | 9 | 9 | 10 | 7 | 8 | 24 | 9 |

| ROUND STANS | | 4H | | 4M | | 3R | | 3RCAD | | 3W | | 3S | | 2B | | Y1_TP | | 1H | | Yr.4 | | Yr.3 | | Yr.1 | | all | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 0% | | 0% | | 0% | | 0% | | 0% | | 0% | | 0% | | 0% | | 0% | | 0% | | 0% | | 0% | | 0% |
| CRITERIA | 0 | 0 | 0 | 7 | 25 | 3 | 15 | 0 | 0 | 3 | 13 | 18 | 67 | 0 | 0 | 1 | 4 | 2 | 7 | 7 | 25 | 6 | 28 | 3 | 11 | 16 | 12 |
| | 1 | 13 | 43 | 12 | 43 | 17 | 85 | 4 | 36 | 20 | 83 | 8 | 30 | 7 | 25 | 12 | 43 | 4 | 14 | 25 | 86 | 41 | 205 | 16 | 57 | 82 | 59 |
| | 2 | 17 | 57 | 9 | 32 | 1 | 5 | 5 | 45 | 1 | 4 | 2 | 7 | 21 | 75 | 2 | 7 | 8 | 29 | 26 | 89 | 7 | 55 | 10 | 36 | 43 | 31 |
| DRAW SCORE | 0 | 4 | 13 | 1 | 4 | 0 | 0 | 0 | 0 | 2 | 8 | 0 | 0 | 1 | 4 | 3 | 11 | 2 | 7 | 5 | 17 | 2 | 8 | 5 | 18 | 12 | 9 |
| | 1 | 1 | 3 | 1 | 4 | 5 | 25 | 1 | 9 | 0 | 0 | 4 | 15 | 3 | 11 | 6 | 21 | 6 | 21 | 2 | 7 | 6 | 34 | 12 | 43 | 20 | 14 |
| | 2 | 16 | 53 | 18 | 64 | 2 | 10 | 3 | 27 | 9 | 38 | 11 | 41 | 21 | 75 | 5 | 18 | 2 | 7 | 34 | 118 | 14 | 75 | 7 | 25 | 55 | 40 |
| | 3 | 4 | 13 | 4 | 14 | 12 | 60 | 4 | 36 | 8 | 33 | 10 | 37 | 2 | 7 | 0 | 0 | 3 | 11 | 8 | 28 | 24 | 130 | 3 | 11 | 35 | 25 |
| | 4 | 5 | 17 | 4 | 14 | 1 | 5 | 3 | 27 | 5 | 21 | 2 | 7 | 1 | 4 | 0 | 0 | 1 | 4 | 9 | 31 | 9 | 53 | 1 | 4 | 19 | 14 |
| REC MATS | 0 | 4 | 13 | 3 | 11 | 11 | 55 | 0 | 0 | 12 | 50 | 25 | 93 | 10 | 36 | 8 | 29 | 14 | 50 | 7 | 24 | 23 | 105 | 22 | 79 | 52 | 37 |
| | 1 | 8 | 27 | 11 | 39 | 5 | 25 | 10 | 91 | 7 | 29 | 2 | 7 | 7 | 25 | 4 | 14 | 0 | 0 | 19 | 66 | 22 | 145 | 4 | 14 | 45 | 32 |
| | 2 | 17 | 57 | 4 | 14 | 4 | 20 | 1 | 9 | 5 | 21 | 0 | 0 | 11 | 39 | 2 | 7 | 0 | 0 | 21 | 71 | 10 | 50 | 2 | 7 | 33 | 24 |
| | 3 | 1 | 3 | 3 | 11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 14 | 0 | 0 | 0 | 0 | 4 | 3 |
| MAKE SCORE | 0 | 0 | 0 | 10 | 36 | 0 | 0 | 2 | 18 | 3 | 13 | 2 | 7 | 1 | 4 | 0 | 0 | 2 | 7 | 10 | 36 | 5 | 31 | 2 | 7 | 17 | 12 |
| | 1 | 11 | 37 | 4 | 14 | 8 | 40 | 4 | 36 | 7 | 29 | 7 | 26 | 16 | 57 | 8 | 29 | 9 | 32 | 15 | 51 | 19 | 106 | 17 | 61 | 51 | 37 |
| | 2 | 10 | 33 | 4 | 14 | 8 | 40 | 3 | 27 | 8 | 33 | 14 | 52 | 4 | 14 | 3 | 11 | 3 | 11 | 14 | 48 | 19 | 101 | 6 | 21 | 39 | 28 |
| | 3 | 9 | 30 | 10 | 36 | 4 | 20 | 0 | 0 | 6 | 25 | 4 | 15 | 7 | 25 | 3 | 11 | 0 | 0 | 19 | 66 | 10 | 45 | 3 | 11 | 32 | 23 |
| | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

# APPENDIX N
## Development of Quantitative Assessment Instrument
### Form view of Panda and Box database 1999

CLASS 98/9: 3W

PANDA: 9 P_PRE_DR: 1

P_DRAW_SCORE: 3 P_MULT_DRAW: 1 P_MULT_DES:

P_VIEWPOINTS:

SINGLE FACE: 1 3d_DRAWING: P_MAKE_DIAG:

P_MEASURE: 1 P_LABEL: P_EXPAND:

P_MAKE_SCORE: 3 P_RESEMBLE: 1 P_EXACTLY: 1
P_MULTIMAKE: P_MADE_MEAS:

SINGLE_SIDED: FLAT_BAG: 1 BOX_BAG:
BOX_SHAPE: SUITCASE:

P_INSTRUCTS: 3 P_STATE: 1 P_HOW_TO: 1 DESC_PRODUCT: 1

P_WORDSEQ: 1 P_PICSEQ: P_DIAG: 1 P_INTSR_MEAS:

BOX: 5 BX_PRE DR: 1

BX_VIEW: 3 BX_CHOICE_VIEW: side

BX_TOP: 1 BX_FRONT: 1 BX_REAR: 1

BX_DRAW_MATS: 1 BX_1ST VIEW: 1
BX_TOP_MATS: BX_FRONT_MATS: BX_REAR_MATS:

BX_REC_MATS: 1 (extra to box)
BX_DR MATS: BX_WRITE MATS: 1 BX_EXPAND:
BX_INSTRU: BX_LABEL: BX_INSTR_WDS:

## AN 1.4 Panda's Suitcase 1999

| | 4E | | 4S | | 3P | | 3R | | 3W | | 2B | | 2D | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0% | | 0% | | 0% | | 0% | | 0% | | 0% | | 0% | |
| P-MULTI-DR | 14 | 50 | 18 | 53 | 13 | 48 | 31 | 100 | 20 | 67 | 19 | 61 | 19 | 66 | |
| P-MULT-DES | 4 | 14 | 2 | 6 | 7 | 26 | 10 | 32 | 3 | 10 | 2 | 6 | 3 | 10 | |
| P-EXPAND | 3 | 11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| P-LABEL | 19 | 68 | 2 | 6 | 2 | 7 | 1 | 3 | 4 | 13 | 1 | 3 | 1 | 3 | |
| P-MEASURE | 6 | 21 | 17 | 50 | 5 | 19 | 0 | 0 | 17 | 57 | 0 | 0 | 2 | 7 | |
| SINGLE-FACE | 15 | 54 | 30 | 88 | 26 | 96 | 23 | 74 | 28 | 93 | 26 | 84 | 25 | 86 | |
| 3D-DRAWING | 6 | 21 | 1 | 3 | 0 | 0 | 5 | 16 | 1 | 3 | 2 | 6 | 0 | 0 | |
| MAKE-DIAG | 9 | 32 | 3 | 9 | 0 | 0 | 4 | 13 | 1 | 3 | 1 | 3 | 1 | 3 | |
| MULTI-VIEWS | 8 | 29 | 4 | 12 | 1 | 4 | 3 | 10 | 0 | 0 | 0 | 0 | 1 | 3 | |
| | | | | | | | | | | | | | | | |
| P-RESEMBLE | 19 | 68 | 29 | 85 | 24 | 89 | 26 | 84 | 27 | 90 | 24 | 77 | 22 | 76 | |
| P-EXACTLY | 10 | 36 | 12 | 35 | 12 | 44 | 19 | 61 | 15 | 50 | 14 | 45 | 14 | 48 | |
| P-MULT-MK | 3 | 11 | 5 | 15 | 2 | 7 | 2 | 6 | 0 | 0 | 4 | 13 | 1 | 3 | |
| P-MD-MEAS | 2 | 7 | 11 | 32 | 1 | 4 | 0 | 0 | 5 | 17 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | |
| SING-SIDED | 0 | 0 | 1 | 3 | 5 | 19 | 4 | 13 | 1 | 3 | 7 | 23 | 13 | 45 | |
| FLAT-BAG | 15 | 54 | 16 | 47 | 14 | 52 | 18 | 58 | 18 | 60 | 19 | 61 | 13 | 45 | |
| BOX-BAG | 9 | 32 | 15 | 44 | 6 | 22 | 1 | 3 | 7 | 23 | 1 | 3 | 2 | 7 | |
| TRUE BOX | 2 | 7 | 1 | 3 | 0 | 0 | 2 | 6 | 5 | 17 | 1 | 3 | 1 | 3 | |
| SUITCASE | 2 | 7 | 0 | 0 | 0 | 0 | 2 | 6 | 0 | 0 | 1 | 3 | 0 | 0 | |
| | | | | | | | x | x | | | | | | | |
| P-STATE | 15 | 54 | 33 | 97 | 21 | 78 | 16 | 52 | 28 | 93 | 27 | 87 | 17 | 59 | *Instructions* |
| P-HOW-TO | 11 | 39 | 23 | 68 | 12 | 44 | 5 | 16 | 13 | 43 | 15 | 48 | 11 | 38 | *How-to* |
| DESC-PROD | 10 | 36 | 17 | 50 | 9 | 33 | 3 | 10 | 10 | 33 | 8 | 26 | 8 | 28 | *Accurate* |
| WORD-SEQ | 6 | 21 | 19 | 56 | 11 | 41 | 10 | 32 | 20 | 67 | 8 | 26 | 7 | 24 | *Words* |
| PIC-SEQ | 1 | 4 | 2 | 6 | 4 | 15 | 1 | 3 | 6 | 20 | 4 | 13 | 1 | 3 | *Picture* |
| P-DIAG | 6 | 21 | 3 | 9 | 1 | 4 | 0 | 0 | 8 | 27 | 5 | 16 | 4 | 14 | *Diagram* |
| P-INST-MEAS | 3 | 11 | 6 | 18 | 0 | 0 | 0 | 0 | 3 | 10 | 1 | 3 | 0 | 0 | *Measurements* |
| | | | | | | | | | | | | | | | |
| TOTAL CH | 28 | | 34 | | 27 | | 31 | | 30 | | 31 | | 29 | | |

# APPENDIX N
# Development of Quantitative Assessment Instrument

## AN2 Structured Phase Spreadsheets & Databases

### Introductory Explanation

AN2 illustrates the development of the quantitative analysis instrument used in the Structured Phase of the research. Throughout the evolution of the analysis instrument, the individual child's record comprised a three paged spreadsheet: page 1 was the Grid ( AN2.1, 2.3 or 2.5), a Collation sheet onto which the data on the grid was collated, and the Ticksheet on page 3.

The records shown are of one child, Craig, from the Focus Class Target Group, whose work can be found in Appendices C - L. All recording was done through entry of 1= yes.

AN2.1 Individual Marking Grid:
This is the first page of the first version of the analysis instrument, as shown in Table 9, Section 5.4.1b, but with the recording cells that were used to collate the numerical data. The columns on the Grid represent the features of the Drawing Types and the rows represent the Aspects of design drawing, to create a grid of descriptor cells. Within each descriptor cell, six *entry cells* were used to record the occurence of the descriptor in relation to the drawing produced in response to each Assessment Task. As in all versions of this Grid, the letters P,F,E,C,S & M refer to entries for each of the Assessment Tasks (Pizza, Frosty, Easter, Card, Suitcase and Maze). Placing all tasks on one sheet in this way reduced the spreadsheet to three pages, whilst still being able to see the criteria against which each drawing was to be evaluated. Since the Grid was revised in Spring 2001, only the Pizza and Frosty tasks are recorded on this example of it.

AN2.2 Technique Ticksheet 1:
This first version of the Ticksheet is as shown as Table 10 in Section 5.4.1b.

AN2.3 Purpose Grid:
This second version of the Grid is as shown in Table 12, Section 5.4.2a, with the addition of the sub-cells by which the child's achievements were recorded for each task. Since the analysis instrument underwent major rethinking, again, not all tasks are recorded on this example.

AN2.4 Technique Ticksheet 2:
This second version of the Ticksheet is shown as Table 15 in Section 5.4.3b(iii). The analysis in Section 5.8 was based on the collation of these Ticksheet records. To 1=yes and 0 = no, were added x= not possible based on previous 0 and N= not applicable to task.

AN2.5 Purpose & Dimensions Continua:
This shows the final version of the analysis instrument, as shown in Tables 13a & 14, Section 5.4.3b(i), with the addition of the recording cells.

AN2.6 Collation Grid:
This was page 2 of the individual child record and onto which all data for each child were collated. Each *entry cell* of the Marking Grid or Continua related to a *collate cell* on this page of the spreadsheet. Thus an entry under "drawing a picture of an object, not designing" for the Pizza Assessment Task, for example, would result in the appearance of a 1 in the first row of the first column on the Pizza Collate Grid. This created a Grid for each task, although it lost the advantage of being able to see the criteria. The Total column on each Collation Grid weighted the collation cell entries according to the numerical scale show in Tables 13a & 14. This created a profile for each child for each task that was then collated into class records on which the spreadsheets shown in Appendix O were based.

# APPENDIX N
## Development of Quantitative Assessment Instrument

### AN 2.1 Individual Marking Grid : Craig

| | PICTURE | | | | | | SINGLE-DRAW | | | | | | MULTI-DRAW | | | | | | MULTI-DESIGN | | | | | | PROGRESSIVE | | | | | | INTERACTIVE | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GENERATING & DEVELOPING IDEAS | drawing a picture of an object, not designing a product | | | | | | single, simple drawing | | | | | | several attempts to improve drawing of single idea | | | | | | several unrelated draiwngs showing range of ideas | | | | | | progression of ideas across drawings | | | | | | uses drawings reflectively to generate new ideas | | | | | |
| | P | F | E | C | S | M | P | F | E | C | S | M | P | F | E | C | S | M | P | F | E | C | S | M | P | F | E | C | S | M | P | F | E | C | S | M |
| | | | | | | | | | | | | | | | | | | | 1 | 1 | | | | | | | 1 | | | | | | | | | |
| EXPLORING THE PROBLEM | not exploring design problems | | | | | | minimal use of drawing to explore ideas | | | | | | aiming to improve the drawing not explore solutions | | | | | | brainstorming onto paper without developing a solution | | | | | | uses drawing to develop a design solution | | | | | | combines previous ideas with new ones to produce the best solution | | | | | |
| | P | F | E | C | S | M | P | F | E | C | S | M | P | F | E | C | S | M | P | F | E | C | S | M | P | F | E | C | S | M | P | F | E | C | S | M |
| | | | | | | | | | | | | | | | | | | | 1 | 1 | | | | | | | 1 | | | | | | | | | |
| ADDRESSING CLIENT NEEDS | minimal understanding of client needs and wants | | | | | | drawing conveys partial understanding of addressing client need | | | | | | drawing shows understanding of the needs of the client | | | | | | several ideas for satisfying client needs are recorded but not developed | | | | | | the client's needs and wants are considered as the design proceeds | | | | | | the client's needs and wants are treated as part of the iterative process | | | | | |
| | P | F | E | C | S | M | P | F | E | C | S | M | P | F | E | C | S | M | P | F | E | C | S | M | P | F | E | C | S | M | P | F | E | C | S | M |
| | | | | | | | | 1 | | | | | | | | | | | 1 | 1 | | | | | | | 1 | | | | | | | | | |
| APPEARANCE OF PRODUCT | views the drawing as the product | | | | | | minimal consideration of final appearance of product being designed | | | | | | only one overall finishing scheme considered | | | | | | experiements with several finishing schemes | | | | | | ideas about finishes are added to design during the drawing stage | | | | | | ideas about finishes develop interactively within overall design development | | | | | |
| | P | F | E | C | S | M | P | F | E | C | S | M | P | F | E | C | S | M | P | F | E | C | S | M | P | F | E | C | S | M | P | F | E | C | S | M |
| | | | | | | | | | 1 | | | | | | | | | | 1 | | | | | | | | 1 | | | | | | | | | |
| COMMUNICATING IDEAS | use of narrative or other drawing genre | | | | | | minimal recording of design ideas | | | | | | several drawings of same idea | | | | | | quick sketches of a range of ideas | | | | | | conveys sense of object to be made, e.g. by labelling, instructions etc | | | | | | clearly conveys ideas about object to be made e.g. multiple viewpints | | | | | |
| | P | F | E | C | S | M | P | F | E | C | S | M | P | F | E | C | S | M | P | F | E | C | S | M | P | F | E | C | S | M | P | F | E | C | S | M |
| | | | | | | | | | | | | | 1 | | | | | | | 1 | | | | | | | 1 | | | | | | | | | |
| PLANNING CONSTRUCTION | not planning to make the object drawn | | | | | | no evidence of materials or construction issues | | | | | | minimal consideration of construction | | | | | | indicates which idea will be made, but not how | | | | | | materials or *construction features* shown on drawing | | | | | | constructional issues considered en route to final design | | | | | |
| | P | F | E | C | S | M | P | F | E | C | S | M | P | F | E | C | S | M | P | F | E | C | S | M | P | F | E | C | S | M | P | F | E | C | S | M |
| | | | | | | | 1 | 1 | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | |
| EVALUATING WHILST DRAWING | no evaluation | | | | | | minimal evaluation | | | | | | rejected early atempt(s) at drawing single idea | | | | | | considered and rejected range of ideas | | | | | | decisions made about the object whilst drawing | | | | | | changes made as a result of reflecting upon previous design drawings | | | | | |
| | P | F | E | C | S | M | P | F | E | C | S | M | P | F | E | C | S | M | P | F | E | C | S | M | P | F | E | C | S | M | P | F | E | C | S | M |
| | | | | | | | | | | | | | | | | | | | 1 | 1 | | | | | | | 1 | | | | | | | | | |
| RELATIONSHIP TO MAKING | making an object is viewed as a separate, new activity | | | | | | minimal relationship between drawing and making | | | | | | object made is the same as the object drawn | | | | | | object made is one of the ideas drawn | | | | | | progression from drawing into making | | | | | | uses drawings as resource during making | | | | | |
| | P | F | E | C | S | M | P | F | E | C | S | M | P | F | E | C | S | M | P | F | E | C | S | M | P | F | E | C | S | M | P | F | E | C | S | M |
| | 1 | 1 | | | | | | | | | | | | 1 | | | | | | | | | | | | | 1 | | | | | | | | | |

# APPENDIX N
# Development of Quantitative Assessment Instrument

## AN 2.2 Technique Ticksheet 1: Craig

| | *PIZZA* | *FROSTY* | *EASTER* | *CARD* | *SUITCASE* | *MAZE* |
|---|---|---|---|---|---|---|
| SATISFIES CRITERIA OF DESIGN BRIEF | | | | | | |
| *as set by teacher* | | | | | | |
| begins from task requirements | 1 | 1 | 1 | | | |
| maintains task requirements into msking | 1 | 1 | 1 | | | |
| *as required by client* | | | | | | |
| begins from client needs | | 1 | 1 | | | |
| maintains client needs into making | | 1 | 1 | | | |
| RELATIONSHIP BETWEEN WORDS & PICTURES | | | | | | |
| pictures only | 1 | 1 | | | | |
| thinking recorded mostly in pictures | | | 1 | | | |
| thinking recorded mostly in words | | | | | | |
| single words or phrases relatiing to picture | | | 1 | | | |
| list (e.g. of materials) | | | | | | |
| full sentences to describe planned product | | | | | | |
| labelled diagram (with) arrows or lines | | | 1 | | | |
| words/pictures interact to record process | | | | | | |
| lengthy verbal explanation | | | | | | |
| instructions - words only | | | | | | |
| instructions - pictures with few/no words | | | | | | |
| instructions - labelled diagrams | | | | | | |
| FEATURES OF THE DRAWING | | | | | | |
| appropriate level of detail | 1 | 1 | 1 | | | |
| shows dynamics/movement | | | 1 | | | |
| various viewpoints | | | | | | |
| expansions to show small details | | | | | | |
| cut away diagram to show inside of product | | | | | | |
| idicates how parts will fit together | | | 1 | | | |
| APPEARANCE OF PRODUCT (FINISH) | | | | | | |
| indicates pattern or motif | 1 | X | 1 | | | |
| indicates colour | | X | | | | |
| considers more than one finish | 1 | X | | | | |
| justifies choice of finish | | X | | | | |
| PLANNING CONSTRUCTION | | | | | | |
| indicates materials by list | | | | | | |
| indicates materials by labelling drawing | | | | | | |
| materials indicated are suitable | | | 1 | | | |
| materials indicated are available | | | 1 | | | |
| indicates cuts, folds &/or fixings | | | | | | |
| indicates measurements | | | | | | |
| indicates equipment needed | | | 1 | | | |
| indicates parts to be assembled | | | 1 | | | |
| can be made in time available (roughly) | | | 1 | | | |
| technically realistic (child can make it) | | | 1 | | | |
| EVALUATING WHILST DESIGNING | | | | | | |
| choices related to appearance of product | 1 | | | | | |
| choices related to design specification | 1 | 1 | 1 | | | |
| choices related to client needs | 1 | 1 | 1 | | | |
| choices related to material constraints | | | 1 | | | |
| choices related to construction | | | 1 | | | |
| justifies choices made | | | | | | |
| RELATIONSHIP TO MAKING | | | | | | |
| same/adapted object | 1 | | 1 | | | |
| same/adapted shape | 1 | | 1 | | | |
| same/adapted size/proportions | 1 | | 1 | | | |
| same/adapted colour | | | | | | |
| same/adapted pattern, decoration, picture etc | 1 | | | | | |
| same/adapted materials | | | 1 | | | |
| same/adapted fixing technique | | | 1 | | | |
| able to justify changes | | | 1 | | | |

## AN 2.3 Purpose of Drawing Grid: Craig

| | PICTURE | SINGLE-DRAW | MULTI-DRAW | MULTI-DESIGN | PROGRESSIVE | INTERACTIVE |
|---|---|---|---|---|---|---|
| CHILD'S VIEW OF PURPOSE OF THE DRAWING | Draw the object. | Record an idea of what migl be made, to show the teacher. | Make the drawing as good a as possible before showing the teacher. | Brainstorming | Develop chosen idea and idicate how it might be made. | To work out what will be made and how to make it. |
| GENERATING & DEVELOPING IDEAS | drawing a picture of an object, not designing a product | single, non-stereotypical, drawing | several attempts to improve drawing of single idea | several unrelated draiwngs of a range of ideas | progression of ideas across drawings | uses drawings reflectively to generate new ideas |
| | | | 1 | 1 | 1 1 | |
| EXPLORING THE PROBLEM | design problems are not adressed in the drawing | minimal use of drawing to explore ideas | aiming to improve the drawi rather than explore solutions | brainstorming onto paper without developing a solutior | uses drawing to develop a design solution | combines previous ideas withnew ones to produce best solution |
| | | | 1 | 1 1 | 1 | |
| ADDRESSING CLIENT NEEDS | minimal understanding of client needs and wants | drawing conveys partial understanding of addressin client need | drawing shows understandi of the needs of the client | several ideas for satisfying client needs are recorded but not developed | the client's needs and wants are considered as the desig proceeds | the client's needs and wants are treated as part of the iterative process |
| | | | 1 | 1 1 | 1 | |
| APPEARANCE OF PRODUCT | views the drawing as the product | minimal consideration of final appearance of product being designed | only one overall finishing scheme considered | experiements with several finishing schemes | ideas about finishes are added to design during the drawing stage | ideas about finishes develop interactively within overall design development |
| | | | | 1 | 1 1 | |
| COMMUNICATING IDEAS | use of narrative or other drawing genre | minimal recording of design ideas | several drawings to express same undeveloped idea | demonstrates range of ideas often through series of quic sketches | conveys sense of object to be made, e.g. by labelling instructions etc | clearly conveys ideas about object to be made e.g. multiple viewpints |
| | | | 1 | 1 | 1 1 | |
| PLANNING CONSTRUCTION | not planning to make the object drawn | no evidence of materials or construction issues conside | minimal consideration of construction | indicates which idea will be made, but not how | drawing indicates consideration of materials o construction features | constructional issues considered en route to final design |
| | | | 1 1 | | 1 1 | |
| EVALUATING WHILST DRAWING | no evaluation relating to designing the product | minimal evaluation | rejected early atempt(s) at drawing single idea | considered and rejected range of ideas | decisions made about the object whilst drawing | changes made as a result of considering and discussing design drawings |
| | | | 1 | 1 | 1 1 | |
| RELATIONSHIP TO MAKING | making an object is viewed as a separate, new activity | minimal relationship betwee drawing and making | object made is the same as the object drawn | object made is one of the ideas drawn | clear progression from drawing into making | uses drawings as resource during making |
| | 1 1 | | | | 1 | |

# APPENDIX N
## Development of Quantitative Assessment Instrument

AN 2.4TECHNIQUE TICKSHEET 2 Craig

| | P | F | E | C | S | M |
|---|---|---|---|---|---|---|
| SATISFIES CRITERIA OF DESIGN BRIEF | | | | | | |
| *as set by teacher* | | | | | | |
| begins from task requirements | 1 | 1 | 1 | 1 | | |
| maintains task requirements into msking | 1 | 1 | 1 | x | | |
| *as required by client* | | | | | | |
| begins from client needs | 1 | 1 | 1 | 1 | | |
| maintains client needs into making | 1 | 1 | 1 | x | | |
| RELATIONSHIP BETWEEN WORDS & PICTURES | | | | | | |
| pictures only | 1 | 1 | 1 | 1 | | |
| thinking recorded mostly in pictures | | | | | | |
| thinking recorded mostly in words | | | | | | |
| single words or phrases relatiing to picture | | | | | | |
| list (e.g. of materials) | | | | | | |
| full sentences to describe planned product | | | | | | |
| labelled diagram (with) arrows or lines | | | | | | |
| words/pictures interact to record process | | | | | | |
| lengthy verbal explanation | | | | | | |
| instructions - words only | | | | | | |
| instructions - pictures with few/no words | | | 1 | | | |
| instructions - labelled diagrams | | | | | | |
| FEATURES OF THE DRAWING | | | | | | |
| appropriate level of detail | 1 | | 1 | 1 | | |
| shows dynamics/movement | | | | 1 | | |
| various viewpoints | | | | 1 | | |
| expansions to show small details | | | | 1 | | |
| cut away diagram to show inside of product | | | | | | |
| idicates how parts will fit together | | | 1 | 1 | | |
| APPEARANCE OF PRODUCT (FINISH) | | | | | | |
| indicates pattern or motif | 1 | x | 1 | 1 | | |
| indicates colour | | x | | | | |
| considers more than one finish | 1 | x | | | | |
| justifies choice of finish | | x | | | | |
| PLANNING CONSTRUCTION | | | | | | |
| indicates materials by list | | | | | | |
| indicates materials by labelling drawing | | | 1 | | | |
| materials indicated are suitable | | | 1 | 1 | | |
| materials indicated are available | | | 1 | 1 | | |
| indicates cuts, folds &/or fixings | | | 1 | 1 | | |
| indicates measurements | | | | | | |
| indicates equipment needed | | | | | | |
| indicates parts to be assembled | | | 1 | 1 | | |
| can be made in time available (roughly) | | | 1 | 1 | | |
| technically realistic (child can make it) | | | 1 | 1 | | |
| EVALUATING WHILST DESIGNING | | | | | | |
| choices related to appearance of product | 1 | | | 1 | | |
| choices related to design specification | 1 | 1 | 1 | 1 | | |
| choices related to client needs | 1 | 1 | 1 | 1 | | |
| choices related to material constraints | | | 1 | 1 | | |
| choices related to construction | | | 1 | 1 | | |
| justifies choices made | | | | | | |
| RELATIONSHIP TO MAKING | | | | | | |
| same/adapted object | | | 1 | x | | |
| same/adapted shape | | | 1 | x | | |
| same/adapted size/proportions | | | 1 | x | | |
| same/adapted colour | | | | x | | |
| same/adapted pattern, decoration, picture etc | | | 1 | x | | |
| same/adapted materials | | | 1 | x | | |
| same/adapted fixing technique | | | 1 | x | | |
| able to justify changes | | | | x | | |

# APPENDIX N

# Development of Quantitative Assessment Instrument

## *AN2.5 Purpose & Dimensions Continua*

*NAME: Carl* *CLASS: F*

**CHILD'S VIEW OF THE PURPOSE OF THE DRAWING**

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Views the drawing as the product* | | | | | | *Record an idea of what might be made* | | | | | | *Using drawing to record design possibilities.* | | | | | | *Develop chosen idea and indicate how it might be made* | | | | | | *To work out what will be made and how to make it* | | | | | |
| P | F | E | C | S | M | P | F | E | C | S | M | P | F | E | C | S | M | P | F | E | C | S | M | P | F | E | C | S | M |
| | | | | | | | | | | | | 1 | 1 | | | 1 | 1 | | | 1 | 1 | | | | | | | | |

**GENERATING & DEVELOPING IDEAS**

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| drawing a picture, not designing a product | | | | | | simple sketch, showing object to be made | | | | | | design ideas generated but not developed | | | | | | progression of ideas across or within drawings | | | | | | uses drawings reflectively to generate new ideas | | | | | |
| P | F | E | C | S | M | P | F | E | C | S | M | P | F | E | C | S | M | P | F | E | C | S | M | P | F | E | C | S | M |
| | | | | | | | | | | | 1 | 1 | 1 | | | 1 | | | | 1 | 1 | | | | | | | | |

**EXPLORING THE POSSIBILITIES OF THE TASK**

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| design possibilities are not adressed in the drawing | | | | | | stereotypical response showing little creative thought | | | | | | recording possible creative solution(s) to the task | | | | | | using drawing to develop novel design solution(s) | | | | | | combines novel solutions to produce innovative design | | | | | |
| P | F | E | C | S | M | P | F | E | C | S | M | P | F | E | C | S | M | P | F | E | C | S | M | P | F | E | C | S | M |
| | | | | | | 1 | | 1 | | 1 | | | 1 | | 1 | | 1 | | | | | | | | | | | | |

**ADDRESSING THE CONSTRAINTS OF THE TASK**

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| minimal understanding of task / user needs | | | | | | drawing shows some understanding of the task constraints | | | | | | records way to address task &/or client needs/wants | | | | | | task constraints are considered as the design proceeds | | | | | | task constraints are treated as part of iterative process | | | | | |
| P | F | E | C | S | M | P | F | E | C | S | M | P | F | E | C | S | M | P | F | E | C | S | M | P | F | E | C | S | M |
| | | | | | | | | | | 1 | | 1 | 1 | | | | 1 | | | 1 | 1 | | | | | | | | |

**PLANNING THE LOOK OF THE PRODUCT**

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| appearance of a product is not considered | | | | | | little consideration of final appearance of product | | | | | | overall decorative scheme considered | | | | | | ideas about finishes are added to design whilst drawing | | | | | | ideas about finishes develop within overall designing | | | | | |
| P | F | E | C | S | M | P | F | E | C | S | M | P | F | E | C | S | M | P | F | E | C | S | M | P | F | E | C | S | M |
| | | | | 1 | | | | | | | | 1 | | | | | | | | 1 | | | | | | | 1 | | |

**COMMUNICATING DESIGN IDEAS**

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| use of narrative or other drawing genre | | | | | | simple unlabelled sketch(es); relying on shared meanings | | | | | | conveys some sense of object to be made; e.g. indicating materials | | | | | | conveys sense of object to be made, e.g. working diagram | | | | | | clear enough for someone else to make the product. | | | | | |
| P | F | E | C | S | M | P | F | E | C | S | M | P | F | E | C | S | M | P | F | E | C | S | M | P | F | E | C | S | M |
| | | | | | | 1 | 1 | | | 1 | 1 | | | | | | | | | 1 | 1 | | | | | | | | |

**PLANNING CONSTRUCTION**

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| not planning to make the object as drawn | | | | | | minimal consideration of construction whilst drawing | | | | | | drawing indicates some consideration of construction | | | | | | drawing demonstrates consideration of construction | | | | | | constructional issues considered en route to final design | | | | | |
| P | F | E | C | S | M | P | F | E | C | S | M | P | F | E | C | S | M | P | F | E | C | S | M | P | F | E | C | S | M |
| | | | | | | 1 | 1 | | | 1 | | | | | | | 1 | | | 1 | 1 | | | | | | | | |

**EVALUATING WHILST DRAWING**

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yet to define the design task | | | | | | minimal evaluation at drawing phase | | | | | | considered and rejected range of ideas | | | | | | decisions made about product whilst drawing | | | | | | changes made as result of considering design drawings | | | | | |
| P | F | E | C | S | M | P | F | E | C | S | M | P | F | E | C | S | M | P | F | E | C | S | M | P | F | E | C | S | M |
| | | | | | | | | | | | 1 | 1 | 1 | | 1 | 1 | | | | 1 | | | | | | | | | |

A BASIS FOR MAKING

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| making an object is seen as a separate new activity | | | | | | product relates to ideas recorded in drawing | | | | | | object made is one of the ideas drawn | | | | | | clear development path through drawing into making | | | | | | uses drawings as resource during making | | | | | |
| P | F | E | C | S | M | P | F | E | C | S | M | P | F | E | C | S | M | P | F | E | C | S | M | P | F | E | C | S | M |
| 1 | 1 | | | | | | | | | | | | | | | 1 | 1 | | | 1 | | | | | | | | | |

## AN 2.6 Collation Grid : Craig

| TASK | Pizza | | | | | TOTAL |
|---|---|---|---|---|---|---|
| PURPOSE | | | 1 | | | 3 |
| GEN& DEV IDE | | | 1 | | | 3 |
| EXPL THE PRC | | 1 | | | | 2 |
| ADDRTASK CC | | | 1 | | | 3 |
| LOOK OF PRO| | | | 1 | | | 3 |
| COMM IDEAS | | 1 | | | | 2 |
| PLAN CONSTR | | 1 | | | | 2 |
| EVAL W DRAW | | | 1 | | | 3 |
| REL TO MAKIN | 1 | | | | | 1 |

| TASK | Frosty | | | | | TOTAL |
|---|---|---|---|---|---|---|
| PURPOSE | | | 1 | | | 3 |
| GEN& DEV IDE | | | 1 | | | 3 |
| EXPL THE PRC | | | 1 | | | 3 |
| ADDRTASK CC | | | 1 | | | 3 |
| LOOK OF PRO| | X | X | X | X | X | X |
| COMM IDEAS | | 1 | | | | 2 |
| PLAN CONSTR | | 1 | | | | 2 |
| EVAL W DRAW | | | 1 | | | 3 |
| REL TO MAKIN | 1 | | | | | 1 |

| TASK | Easter EggHolder | | | | | TOTAL |
|---|---|---|---|---|---|---|
| PURPOSE | | | | 1 | | 4 |
| GEN& DEV IDE | | | | 1 | | 4 |
| EXPL THE PRC | | 1 | | | | 2 |
| ADDRTASK CC | | | | 1 | | 4 |
| LOOK OF PRO| | | | | 1 | | 4 |
| COMM IDEAS | | | | 1 | | 4 |
| PLAN CONSTR | | | | 1 | | 4 |
| EVAL W DRAW | | | | 1 | | 4 |
| REL TO MAKIN | | | | 1 | | 4 |

| TASK | Card | | | | | TOTAL |
|---|---|---|---|---|---|---|
| PURPOSE | | | | 1 | | 4 |
| GEN& DEV IDE | | | | 1 | | 4 |
| EXPL THE PRC | | | 1 | | | 3 |
| ADDRTASK CC | | | | 1 | | 4 |
| LOOK OF PRO| | | | | | 1 | 5 |
| COMM IDEAS | | | | 1 | | 4 |
| PLAN CONSTR | | | | 1 | | 4 |
| EVAL W DRAW | | | 1 | | | 3 |
| REL TO MAKIN | X | X | X | X | X | X |

| TASK | Pandy's Suitcase | | | | | TOTAL |
|---|---|---|---|---|---|---|
| PURPOSE | | | 1 | | | 3 |
| GEN& DEV IDE | | | 1 | | | 3 |
| EXPL THE PRC | | 1 | | | | 2 |
| ADDRTASK CC | | 1 | | | | 2 |
| LOOK OF PRO| | 1 | | | | | 1 |
| COMM IDEAS | | 1 | | | | 2 |
| PLAN CONSTR | | 1 | | | | 2 |
| EVAL W DRAW | | | 1 | | | 3 |
| REL TO MAKIN | | | 1 | | | 3 |

| TASK | Maze | | | | | TOTAL |
|---|---|---|---|---|---|---|
| PURPOSE | | | 1 | | | 3 |
| GEN& DEV IDE | | 1 | | | | 2 |
| EXPL THE PRC | | | 1 | | | 3 |
| ADDRTASK CC | | | 1 | | | 3 |
| LOOK OF PRO| | X | X | X | X | X | X |
| COMM IDEAS | | 1 | | | | 2 |
| PLAN CONSTR | | | 1 | | | 3 |
| EVAL W DRAW | | 1 | | | | 2 |
| REL TO MAKIN | | | 1 | | | 3 |

# APPENDIX O
# Quantitative Data

## CONTENTS

# APPENDIX O
# Quantitative Data

## Introductory Explanation

Appendix O contains the spreadsheets from which the charts in Sections 5.5 - 5.-9 were produced.

AO1 is organised according to the 4 layers of the analysis instrument and contains the sheets onto which the data from each child's records were collated.

AO2 contains the Collation Sheets for all of the children, from which the sheets in AO1 were collated.

# APPENDIX O
# Quantitative Data

## Collation of Numerical Data from Individual Child Records:
## AO1.1: Purpose of Design Drawing

### Sheet 1: Mean scores on Purpose Continuum

| | Focus | Comparison |
|---|---|---|
| Pizza | 2.35 | 2.20 |
| Frosty | 2.30 | 2.28 |
| Easter | 3.45 | 2.67 |
| Card | 3.39 | 2.47 |
| Suitcase | 3.30 | 2.71 |
| Maze | 3.00 | 2.45 |

### Sheet 2: Purpose of Drawing Profiles

| | | Focus | | Comparison | |
|---|---|---|---|---|---|
| Pizza | Scores | Nos. | 0% | Nos. | 0% |
| n=20 | 0 | 0 | *0* | 0 | *0* |
| | 1 | 0 | *0* | 0 | *0* |
| | 2 | 13 | *65* | 16 | *80* |
| | 3 | 7 | *35* | 4 | *20* |
| | 4 | 0 | *0* | 0 | *0* |
| | 5 | 0 | *0* | 0 | *0* |

| | | | | | |
|---|---|---|---|---|---|
| Frosty | 0 | 0 | *0* | 0 | *0* |
| F n=23 | 1 | 1 | *4* | 3 | *17* |
| C n=18 | 2 | 14 | *61* | 8 | *44* |
| | 3 | 8 | *35* | 6 | *33* |
| | 4 | 0 | *0* | 1 | *6* |
| | 5 | 0 | *0* | 0 | *0* |

| | | | | | |
|---|---|---|---|---|---|
| Easter | 0 | 0 | *0* | 1 | *5* |
| F n=22 | 1 | 0 | *0* | 0 | *0* |
| C n=21 | 2 | 3 | *13* | 10 | *48* |
| | 3 | 8 | *35* | 4 | *19* |
| | 4 | 9 | *39* | 6 | *29* |
| | 5 | 2 | *9* | 0 | *0* |

| | | | | | |
|---|---|---|---|---|---|
| Card | 0 | 0 | *0* | 1 | *5* |
| F n=23 | 1 | 0 | *0* | 0 | *0* |
| C n=20 | 2 | 4 | *17* | 11 | *55* |
| | 3 | 9 | *39* | 4 | *20* |
| | 4 | 7 | *30* | 2 | *10* |
| | 5 | 3 | *13* | 1 | *5* |

| | | | | | |
|---|---|---|---|---|---|
| Suitcase | 0 | 0 | *0* | 0 | *0* |
| F n=23 | 1 | 0 | *0* | 1 | *5* |
| C n=21 | 2 | 2 | *9* | 9 | *43* |
| | 3 | 15 | *65* | 6 | *29* |
| | 4 | 3 | *13* | 4 | *19* |
| | 5 | 3 | *13* | 0 | *0* |

| | | | | | |
|---|---|---|---|---|---|
| Maze | 0 | 0 | *0* | 0 | *0* |
| F n=19 | 1 | 0 | *0* | 1 | *5* |
| C n=20 | 2 | 6 | *32* | 9 | *45* |
| | 3 | 9 | *47* | 10 | *50* |
| | 4 | 2 | *11* | 0 | *0* |
| | 5 | 2 | *11* | 0 | *0* |

### Sheet 3 :Growth in Understanding of Purpose across time

| **As differneces in mean scores** | | | |
|---|---|---|---|
| | Focus | Comparison | Difference |
| Problem | 0.70 | 0.17 | 0.52 |
| Product | 0.95 | 0.51 | 0.44 |
| | | | |
| **As %** | | | |
| | Focus | Comparison | Difference |
| Problem | 13.91 | 3.44 | 10.47 |
| Product | 19.09 | 10.29 | 8.80 |

# APPENDIX O
# Quantitative Data
### AO1.2 Purpose Continuum Scores

| Name | Class | Pizza | Frosty | Easter | Card | Suitcase | Maze |
|---|---|---|---|---|---|---|---|
| Lisa | F | 2 | 3 | 5 | 5 | 5 | 3 |
| Mia | F | 3 | 2 | 2 | 2 | 3 | A |
| Louise | F | A | 2 | 4 | 2 | 3 | A |
| Ellie | F | 2 | 2 | 4 | 4 | 4 | 4 |
| Craig | F | 3 | 3 | 4 | 4 | 3 | 3 |
| Kate | F | 2 | 2 | 3 | 3 | 2 | A |
| Carl | F | 2 | 1 | 3 | 3 | 3 | 2 |
| Connor | F | 2 | 2 | 3 | 3 | 3 | 3 |
| Damian | F | 2 | 3 | 3 | 5 | 3 | 3 |
| Tasmin | F | 2 | 2 | 2 | 3 | 3 | 3 |
| Hayleigh | F | 3 | 2 | 4 | 4 | 4 | 4 |
| Jolene | F | 2 | 3 | 5 | 4 | 5 | 4 |
| Kara | F | 3 | 2 | 3 | 3 | 3 | 2 |
| Michael | F | A | 2 | 2 | 3 | 2 | 2 |
| Maria | F | 2 | 3 | 4 | 3 | 4 | 2 |
| Martin | F | 3 | 3 | 4 | 5 | 5 | 4 |
| Natasha | F | 3 | 3 | 4 | 4 | 3 | 3 |
| Noel | F | 2 | 2 | 3 | 2 | 3 | A |
| Lewis | F | 3 | 2 | 4 | 3 | 3 | 3 |
| Randal | F | 2 | 3 | 3 | 3 | 3 | 2 |
| Stacey | F | 2 | 2 | 4 | 4 | 3 | 2 |
| Emily | F | A | 2 | A | 2 | 3 | 3 |
| Chloe | F | 2 | 2 | 3 | 4 | 3 | 3 |
| Alistair | C | 2 | 1 | 3 | 2 | 2 | 2 |
| Rhiannon | C | 2 | 3 | 2 | 3 | 4 | 3 |
| Sophie | C | A | 3 | 2 | 2 | 2 | 3 |
| Cassy | C | 3 | 3 | 3 | 2 | 2 | 3 |
| Chloe | C | 2 | A | 2 | 2 | 2 | 2 |
| Emma | C | 3 | 4 | 3 | 5 | 2 | 3 |
| Wendy | C | 2 | 2 | 2 | A | 3 | 3 |
| Carys | C | 2 | 2 | 2 | 4 | 2 | 2 |
| Ellis | C | 2 | 3 | 4 | A | 2 | 2 |
| Garth | C | 2 | 2 | 4 | 2 | 3 | 2 |
| Holly | C | 3 | 2 | 2 | 2 | 4 | 2 |
| Jordan | C | 2 | 1 | 3 | 2 | 3 | 2 |
| Alice | C | 3 | A | 4 | 3 | 3 | 3 |
| Kathy | C | 2 | A | 2 | 2 | 2 | 3 |
| Lee | C | 2 | 2 | 2 | 2 | 3 | 3 |
| Matthew | C | 2 | 2 | 4 | 2 | 4 | A |
| Nicola | C | 2 | 3 | 4 | 4 | 4 | 3 |
| Peter | C | 2 | 2 | 0 | 0 | 2 | 2 |
| Robert | C | 2 | 1 | 2 | 3 | 1 | 1 |
| Zara | C | 2 | 2 | 4 | 3 | 4 | 3 |
| Kirsty | C | 2 | 3 | 2 | 2 | 3 | 2 |

# APPENDIX O
# Quantitative Data
## AO1.3 Drawing Types

| Name | Class | Pizza | Frosty | Easter | Card | Suitcase | Maze |
|---|---|---|---|---|---|---|---|
| Lisa | F | 3 | 4 | 5 | 5 | 5 | 4 |
| Mia | F | 4 | 2 | 3 | 2 | 4 | A |
| Louise | F | A | 2 | 5 | 3 | 5 | A |
| Ellie | F | 3 | 2 | 5 | 5 | 5 | 5 |
| Craig | F | 4 | 4 | 5 | 3 | 4 | 2 |
| Kate | F | 3 | 2 | 3 | 3 | 2 | A |
| Carl | F | 1 | 1 | 4 | 3 | 4 | 2 |
| Connor | F | 2 | 2 | 4 | 3 | 4 | 4 |
| Damian | F | 2 | 4 | 4 | 6 | 5 | 4 |
| Tasmin | F | 2 | 2 | 3 | 4 | 4 | 2 |
| Hayleigh | F | 4 | 2 | 5 | 5 | 6 | 5 |
| Jolene | F | 2 | 4 | 5 | 5 | 5 | 5 |
| Kara | F | 4 | 2 | 4 | 3 | 4 | 2 |
| Michael | F | A | 2 | 3 | 4 | 2 | 3 |
| Maria | F | 3 | 4 | 5 | 4 | 5 | 3 |
| Martin | F | 4 | 4 | 5 | 6 | 5 | 5 |
| Natasha | F | 4 | 4 | 5 | 5 | 2 | 2 |
| Noel | F | 2 | 2 | 3 | 2 | 3 | A |
| Lewis | F | 4 | 2 | 5 | 4 | 4 | 2 |
| Randal | F | 2 | 5 | 4 | 4 | 4 | 2 |
| Stacey | F | 2 | 2 | 5 | 5 | 4 | 4 |
| Emily | F | A | 2 | A | 4 | 4 | 5 |
| Chloe | F | 2 | 2 | 5 | 5 | 4 | 4 |
| Alistair | C | 2 | 2 | 5 | 5 | 4 | 3 |
| Rhiannon | C | 3 | 4 | 4 | 4 | 5 | 4 |
| Sophie | C | A | 4 | 3 | 3 | 2 | 3 |
| Cassy | C | 4 | 4 | 2 | 2 | 2 | 4 |
| Chloe | C | 2 | A | 3 | 3 | 3 | 4 |
| Emma | C | 4 | 5 | 4 | 6 | 4 | 4 |
| Wendy | C | 2 | 2 | 3 | A | 3 | 4 |
| Carys | C | 2 | 4 | 2 | 3 | 2 | 2 |
| Ellis | C | 2 | 4 | 5 | A | 3 | 2 |
| Garth | C | 3 | 3 | 5 | 3 | 4 | 2 |
| Holly | C | 4 | 2 | 2 | 2 | 5 | 2 |
| Jordan | C | 1 | 1 | 4 | 3 | 4 | 2 |
| Alice | C | 4 | A | 5 | 5 | 4 | 4 |
| Kathy | C | 3 | A | 2 | 3 | 3 | 4 |
| Lee | C | 2 | 4 | 3 | 3 | 4 | 4 |
| Matthew | C | 2 | 2 | 5 | 4 | 5 | A |
| Nicola | C | 2 | 4 | 5 | 5 | 5 | 4 |
| Peter | C | 2 | 2 | 0 | 0 | 2 | 2 |
| Robert | C | 3 | 1 | 2 | 4 | 3 | 1 |
| Zara | C | 1 | 2 | 5 | 4 | 5 | 4 |
| Kirsty | C | 2 | 4 | 2 | 2 | 4 | 2 |

# APPENDIX O
# Quantitative Data

## Collation of Numerical Data from Individual Child Records:

## AO1.4 Dimensions of Design Drawing

### Sheet 3: Percentages of children achieving each band on the Dimensions Continua

### Pizza

| Focus | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| G | 0 | 5 | 81 | 14 | 0 | 0 |
| Ex | 0 | 0 | 67 | 33 | 0 | 0 |
| A | 0 | 10 | 57 | 33 | 0 | 0 |
| L | 0 | 10 | 52 | 38 | 0 | 0 |
| C | 0 | 0 | 100 | 0 | 0 | 0 |
| P | 0 | 10 | 90 | 0 | 0 | 0 |
| Ev | 0 | 5 | 67 | 29 | 0 | 0 |
| M | 0 | 29 | 43 | 29 | 0 | 0 |

| Comparison | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| G | 0 | 10 | 70 | 20 | 0 | 0 |
| Ex | 0 | 0 | 80 | 20 | 0 | 0 |
| A | 0 | 5 | 80 | 15 | 0 | 0 |
| L | 0 | 10 | 45 | 45 | 0 | 0 |
| C | 0 | 10 | 90 | 0 | 0 | 0 |
| P | 0 | 10 | 90 | 0 | 0 | 0 |
| Ev | 0 | 10 | 85 | 5 | 0 | 0 |
| M | 0 | 35 | 45 | 20 | 0 | 0 |

### Frosty

| Focus | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| G | 0 | 4 | 61 | 35 | 0 | 0 |
| Ex | 0 | 4 | 61 | 30 | 4 | 0 |
| A | 0 | 4 | 57 | 35 | 4 | 0 |
| C | 0 | 4 | 96 | 0 | 0 | 0 |
| P | 0 | 4 | 87 | 9 | 0 | 0 |
| Ev | 0 | 4 | 61 | 30 | 4 | 0 |
| M | 0 | 17 | 30 | 52 | 0 | 0 |

| Comparison | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| G | 0 | 17 | 44 | 33 | 6 | 0 |
| Ex | 0 | 17 | 50 | 22 | 11 | 0 |
| A | 0 | 17 | 33 | 44 | 6 | 0 |
| C | 0 | 11 | 78 | 6 | 6 | 0 |
| P | 0 | 17 | 67 | 11 | 6 | 0 |
| Ev | 0 | 17 | 44 | 33 | 6 | 0 |
| M | 0 | 39 | 17 | 39 | 6 | 0 |

### Easter

| Focus | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| G | 0 | 0 | 14 | 27 | 55 | 5 |
| Ex | 0 | 0 | 41 | 32 | 27 | 0 |
| A | 0 | 0 | 45 | 27 | 27 | 0 |
| L | 0 | 18 | 9 | 14 | 45 | 14 |
| C | 0 | 0 | 41 | 18 | 27 | 14 |
| P | 0 | 0 | 45 | 14 | 27 | 14 |
| Ev | 0 | 0 | 27 | 23 | 45 | 5 |
| M | 0 | 14 | 23 | 27 | 36 | 0 |

| Comparison | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| G | 5 | 0 | 48 | 14 | 33 | 0 |
| Ex | 0 | 5 | 81 | 0 | 10 | 0 |
| A | 0 | 33 | 43 | 10 | 14 | 0 |
| L | 0 | 62 | 10 | 19 | 10 | 0 |
| C | 0 | 10 | 38 | 29 | 24 | 0 |
| P | 0 | 5 | 24 | 33 | 38 | 0 |
| Ev | 0 | 14 | 57 | 10 | 19 | 0 |
| M | 0 | 25 | 40 | 30 | 5 | 0 |

### Card

| Focus | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| G | 0 | 22 | 30 | 39 | 9 | 0 |
| Ex | 0 | 0 | 35 | 39 | 22 | 4 |
| A | 0 | 4 | 26 | 30 | 39 | 0 |
| L | 0 | 0 | 4 | 61 | 26 | 9 |
| C | 0 | 0 | 35 | 35 | 26 | 4 |
| P | 0 | 0 | 35 | 30 | 26 | 9 |
| Ev | 0 | 0 | 39 | 26 | 26 | 9 |

| Comparison | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| G | 5 | 0 | 58 | 21 | 11 | 5 |
| Ex | 0 | 5 | 58 | 21 | 11 | 5 |
| A | 0 | 5 | 47 | 37 | 5 | 5 |
| L | 0 | 5 | 0 | 58 | 32 | 5 |
| C | 0 | 5 | 53 | 26 | 16 | 0 |
| P | 0 | 5 | 63 | 21 | 11 | 0 |
| Ev | 0 | 5 | 63 | 16 | 11 | 5 |

### Suitcase

| Focus | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| G | 0 | 13 | 57 | 22 | 9 | 0 |
| Ex | 0 | 0 | 52 | 48 | 0 | 0 |
| A | 0 | 9 | 52 | 13 | 22 | 4 |
| L | 0 | 4 | 9 | 52 | 30 | 4 |
| C | 0 | 0 | 70 | 13 | 13 | 4 |
| P | 0 | 0 | 70 | 9 | 13 | 9 |
| Ev | 0 | 0 | 17 | 57 | 22 | 4 |
| M | 0 | 13 | 26 | 39 | 22 | 0 |

| Comparison | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| G | 0 | 0 | 38 | 38 | 24 | 0 |
| Ex | 0 | 5 | 71 | 14 | 10 | 0 |
| A | 0 | 29 | 52 | 5 | 14 | 0 |
| L | 0 | 48 | 14 | 24 | 14 | 0 |
| C | 0 | 10 | 62 | 10 | 10 | 10 |
| P | 0 | 10 | 57 | 10 | 19 | 5 |
| Ev | 0 | 5 | 48 | 29 | 19 | 0 |
| M | 0 | 24 | 38 | 24 | 14 | 0 |

### Maze

| Focus | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| G | 0 | 0 | 37 | 32 | 26 | 5 |
| Ex | 0 | 5 | 60 | 30 | 5 | 0 |
| A | 0 | 21 | 37 | 21 | 16 | 5 |
| C | 0 | 0 | 63 | 21 | 16 | 0 |
| P | 0 | 0 | 53 | 42 | 5 | 0 |
| Ev | 0 | 0 | 53 | 32 | 11 | 5 |
| M | 0 | 37 | 21 | 26 | 16 | 0 |

| Comparison | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| G | 0 | 5 | 45 | 50 | 0 | 0 |
| Ex | 0 | 0 | 47 | 47 | 5 | 0 |
| A | 0 | 30 | 40 | 30 | 0 | 0 |
| C | 0 | 5 | 80 | 15 | 0 | 0 |
| P | 0 | 5 | 45 | 50 | 0 | 0 |
| Ev | 0 | 5 | 45 | 50 | 0 | 0 |
| M | 0 | 45 | 20 | 35 | 0 | 0 |

# APPENDIX O
# Quantitative Data

## AO 1.5 Ticksheet Data

### Sheet 1 : Generation & Development of Ideas

| | Focus Class: Pizza | Frosty | Easter | Card | Suitcas | Maze | Comparison Class: Pizza | Frosty | Easter | Card | Suitcas | Maze |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| single drawing of a product to be mad | 45.00 | 65.22 | 0.00 | 13.04 | 8.70 | 36.84 | 60.00 | 33.33 | 33.33 | 42.11 | 23.81 | 35.00 |
| single idea recorded as working drawi | 0.00 | 0.00 | 4.55 | 17.39 | 4.35 | 0.00 | 0.00 | 5.56 | 19.05 | 5.26 | 0.00 | 5.00 |
| more than one attempt at drawing sam | 20.00 | 0.00 | 22.73 | 26.09 | 8.70 | 10.53 | 20.00 | 11.11 | 28.57 | 5.26 | 19.05 | 5.00 |
| develops single idea into a working dra | 0.00 | 0.00 | 40.91 | 26.09 | 21.74 | 10.53 | 0.00 | 0.00 | 28.57 | 26.32 | 23.81 | 0.00 |
| range of ideas recorded as quick sket | 35.00 | 30.43 | 31.82 | 39.13 | 60.87 | 47.37 | 20.00 | 50.00 | 9.52 | 26.32 | 33.33 | 60.00 |
| range of ideas, one developed towards | 0.00 | 0.00 | 4.55 | 8.70 | 17.39 | 0.00 | 0.00 | 5.56 | 0.00 | 10.53 | 4.76 | 0.00 |
| range of ideas, some developed towar | 0.00 | 0.00 | 4.55 | 0.00 | 0.00 | 0.00 | 0.00 | 5.56 | 4.76 | 5.26 | 4.76 | 0.00 |
| progression of ideas across drawings | 0.00 | 4.35 | 50.00 | 39.13 | 30.43 | 10.53 | 0.00 | 5.56 | 9.52 | 21.05 | 19.05 | 0.00 |
| using drawing to develop design soluti | 0.00 | 4.35 | 54.55 | 47.83 | 34.78 | 31.58 | 0.00 | 11.11 | 33.33 | 42.11 | 33.33 | 5.00 |
| drawings combined to generate new ic | 0.00 | 0.00 | 4.55 | 8.70 | 4.35 | 0.00 | 0.00 | 0.00 | 0.00 | 5.26 | 0.00 | 0.00 |
| combines ideas to produce best soluti | 0.00 | 0.00 | 4.55 | 0.00 | 4.35 | 0.00 | 0.00 | 0.00 | 0.00 | 5.26 | 0.00 | 0.00 |

### Sheet 2: Annotation of drawings

| | Focus Class: Pizza | Frosty | Easter | Card | Suitcas | Maze | Comparison Class: Pizza | Frosty | Easter | Card | Suitcas | Maze |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| pictures only | #### | 91.30 | 50.00 | 13.04 | 60.87 | 36.84 | 100.00 | 88.89 | 28.57 | 10.53 | 61.90 | 60.00 |
| single words or phrases relatiing to pic | 0.00 | 8.70 | 0.00 | 52.17 | 21.74 | 52.63 | 0.00 | 5.56 | 19.05 | 21.05 | 19.05 | 30.00 |
| labelled diagram (with) arrows or lines | 0.00 | 0.00 | 22.73 | 13.04 | 17.39 | 21.05 | 0.00 | 5.56 | 33.33 | 10.53 | 4.76 | 0.00 |
| list (e.g. of materials) | 0.00 | 0.00 | 0.00 | 17.39 | 0.00 | 10.53 | 0.00 | 0.00 | 0.00 | 15.79 | 0.00 | 0.00 |
| full sentences to describe planned pro | 0.00 | 0.00 | 36.36 | 47.83 | 8.70 | 5.26 | 0.00 | 0.00 | 14.29 | 57.89 | 14.29 | 15.00 |
| words & pictures used interactively | 0.00 | 0.00 | 9.09 | 4.35 | 8.70 | 10.53 | 0.00 | 0.00 | 4.76 | 0.00 | 9.52 | 0.00 |

### Sheet 3: Level of detail

| | Focus Class: Easter | Card | Suitcase | Comparison Class: Easter | Card | Suitcase |
|---|---|---|---|---|---|---|
| various viewpoints | 18.18 | 78.26 | 17.39 | 23.81 | 47.37 | 14.29 |
| expansions to show small details | 22.73 | 8.70 | 8.70 | 0.00 | 5.26 | 0.00 |
| cut away diagram to show inside of pr | 36.36 | 73.91 | 4.35 | 0.00 | 0.00 | 0.00 |
| indicates how parts will fit together | 36.36 | 17.39 | 17.39 | 28.57 | 15.79 | 23.81 |

### Sheet 4: Decorative features

| | Focus Class: Easter | Card | Suitcase | Comparison Class: Easter | Card | Suitcase |
|---|---|---|---|---|---|---|
| indicates picture, pattern or motif | 40.91 | 69.57 | 60.87 | 33.33 | 94.74 | 42.86 |
| indicates colour | 9.09 | 60.87 | 47.83 | 14.29 | 89.47 | 28.57 |
| considers more than one finish | 13.64 | 21.74 | 30.43 | 4.76 | 15.79 | 14.29 |

### Sheet 5: Recording Materials & Co

| | Focus Class: Pizza | Frosty | Easter | Card | Suitcas | Maze | Comparison Class: Pizza | Frosty | Easter | Card | Suitcas | Maze |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| materials | 0.00 | 0.00 | 31.82 | 60.87 | 17.39 | 26.32 | 0.00 | 5.56 | 61.90 | 42.11 | 19.05 | 10.00 |
| construction | 0.00 | 0.00 | 52.17 | 52.17 | 30.43 | | 0.00 | 5.56 | 38.10 | 52.63 | 33.33 | |
| *materials:* | | | | | | | | | | | | |
| list | 0.00 | 0.00 | 0.00 | 30.43 | 0.00 | 10.53 | 0.00 | 0.00 | 0.00 | 15.79 | 0.00 | 0.00 |
| sentences | 0.00 | 0.00 | 18.18 | 26.09 | 8.70 | 0.00 | 0.00 | 0.00 | 19.05 | 10.53 | 9.52 | 5.00 |
| drawing | 0.00 | 0.00 | 9.09 | 0.00 | 0.00 | 5.26 | 0.00 | 0.00 | 14.29 | 10.53 | 0.00 | 0.00 |
| labelling | 0.00 | 0.00 | 13.64 | 4.35 | 8.70 | 15.79 | 0.00 | 5.56 | 38.10 | 5.26 | 9.52 | 5.00 |
| *construction:* | | | | | | | | | | | | |
| cuts, folds, fixings | 0.00 | 0.00 | 27.27 | 56.52 | 8.70 | 0.00 | 0.00 | 0.00 | 19.05 | 26.32 | 19.05 | 0.00 |
| measurements | 0.00 | 0.00 | 0.00 | 0.00 | 26.09 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| equipment | 0.00 | 0.00 | 9.09 | 26.09 | 0.00 | 0.00 | 0.00 | 5.56 | 4.76 | 31.58 | 14.29 | 0.00 |
| parts | 0.00 | 0.00 | 45.45 | 30.43 | 26.09 | 0.00 | 0.00 | 0.00 | 28.57 | 26.32 | 33.33 | 0.00 |

### Sheet 6: Evaluation whilst Drawing

| | Focus Class: Pizza | Frosty | Easter | Card | Suitcas | Maze | Comparison Class: Pizza | Frosty | Easter | Card | Suitcas | Maze |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| attempts to improve drawing of single | 20.00 | 0.00 | 18.18 | 17.39 | 4.35 | 10.53 | 20.00 | 0.00 | 28.57 | 42.11 | 14.29 | 5.00 |
| considered a range of ideas | 32.50 | 30.43 | 18.18 | 26.09 | 56.52 | 47.37 | 22.50 | 50.00 | 14.29 | 26.32 | 33.33 | 60.00 |
| development of single initial idea | 0.00 | 4.35 | 50.00 | 39.13 | 21.74 | 10.53 | 0.00 | 0.00 | 33.33 | 10.53 | 23.81 | 0.00 |
| developing one of two/several ideas | 0.00 | 0.00 | 13.64 | 0.00 | 8.70 | 5.26 | 0.00 | 5.56 | 0.00 | 0.00 | 4.76 | 0.00 |
| combination of ideas | 0.00 | 0.00 | 0.00 | 8.70 | 4.35 | 0.00 | 0.00 | 0.00 | 0.00 | 5.26 | 0.00 | 0.00 |
| | | | | | | | | | | | | |
| changes related to appearance of proc | 32.50 | 0.00 | 0.00 | 17.39 | 17.39 | 5.26 | 22.50 | 0.00 | 0.00 | 0.00 | 5.26 | 14.29 |
| changes related to task specification | 0.00 | 4.35 | 31.82 | 34.78 | 34.78 | 10.53 | 0.00 | 0.00 | 0.00 | 19.05 | 10.53 | 19.05 |
| changes related to client/user needs | 0.00 | 4.35 | 31.82 | 39.13 | 39.13 | 15.79 | 0.00 | 0.00 | 0.00 | 14.29 | 10.53 | 0.00 |
| changes related to material constraint | 0.00 | 0.00 | 9.09 | 4.35 | 4.35 | 5.26 | 0.00 | 0.00 | 0.00 | 0.00 | 10.53 | 14.29 |
| changes related to construction issue | 0.00 | 0.00 | 22.73 | 17.39 | 17.39 | 5.26 | 0.00 | 0.00 | 0.00 | 9.52 | 0.00 | 0.00 |

### Sheet & : Relationship to Product

| | Focus Class: Pizza | Frosty | Easter | Suitcas | Maze | Comparison Class: Pizza | Frosty | Easter | Suitcas | Maze |
|---|---|---|---|---|---|---|---|---|---|---|
| Different | 35.00 | 30.43 | 13.64 | 26.09 | 42.11 | 30.00 | 33.33 | 38.10 | 9.52 | 50.00 |
| Same | 45.00 | 39.13 | 50.00 | 43.48 | 10.53 | 40.00 | 22.22 | 33.33 | 61.90 | 30.00 |
| Adapted | 15.00 | 34.78 | 45.45 | 34.78 | 47.37 | 20.00 | 44.44 | 33.33 | 33.33 | 25.00 |

# APPENDIX O
# Quantitative Data
## AO2.1 Collation Sheets

### Focus Class

#### Girls

| **Lisa** | *PIZZA* | *FROS* | *EAST* | *CARD* | *SUITC* | *MAZE* |
|---|---|---|---|---|---|---|
| PURPOSE | 2 | 3 | 5 | 5 | 4 | 3 |
| GEN& DEV IDEA | 2 | 3 | 4 | 4 | 4 | 4 |
| EXPL THE PROB | 3 | 3 | 4 | 3 | 2 | 2 |
| ADDR TASK REC | 3 | 3 | 3 | 4 | 4 | 4 |
| PLANNING LOOK | 2 X | | 4 | 3 | 3 X | |
| COMM IDEAS | 2 | 2 | 5 | 4 | 3 | 4 |
| PLAN CONSTR | 2 | 2 | 5 | 5 | 4 | 3 |
| EVAL W DRAW | 3 | 3 | 4 | 4 | 4 | 3 |
| BASIS FOR MAKI | 1 | 3 | 4 X | | 4 | 1 |

| **Mia** | *PIZZA* | *ROST* | *ASTEF* | *CARD* | *IITCAS* | *MAZE* |
|---|---|---|---|---|---|---|
| PURPOSE | 3 | 2 | 2 | 2 | 3 | 0 |
| GEN& DEV IDEA | 1 | 2 | 2 | 2 | 3 | 0 |
| EXPL THE PROB | 2 | 2 | 2 | 2 | 3 | 0 |
| ADDR TASK REC | 2 | 2 | 2 | 2 | 2 | 0 |
| PLANNING LOOK | 1 X | | 1 | 3 | 4 X | |
| COMM IDEAS | 2 | 2 | 2 | 2 | 2 | 0 |
| PLAN CONSTR | 1 | 2 | 2 | 2 | 3 | 0 |
| EVAL W DRAW | 1 | 2 | 2 | 2 | 3 | 0 |
| BASIS FOR MAKI | 1 | 2 | 2 X | | 2 | 0 |

| **Louise** | *PIZZA* | *ROST* | *ASTEF* | *CARD* | *IITCAS* | *MAZE* |
|---|---|---|---|---|---|---|
| PURPOSE | 0 | 2 | 4 | 2 | 3 | 0 |
| GEN& DEV IDEA | 0 | 2 | 4 | 2 | 3 | 0 |
| EXPL THE PROB | 0 | 2 | 2 | 2 | 2 | 0 |
| ADDR TASK REC | 0 | 3 | 4 | 2 | 3 | 0 |
| PLANNING LOOK | 0 X | | 3 | 3 | 3 X | |
| COMM IDEAS | 0 | 2 | 3 | 3 | 3 | 0 |
| PLAN CONSTR | 0 | 3 | 2 | 3 | 3 | 0 |
| EVAL W DRAW | 0 | 2 | 4 | 2 | 2 | 0 |
| BASIS FOR MAKI | 0 | 3 | 3 X | | 3 | 0 |

| **Ellie** | *PIZZA* | *ROST* | *ASTEF* | *CARD* | *IITCAS* | *MAZE* |
|---|---|---|---|---|---|---|
| PURPOSE | 2 | 2 | 4 | 4 | 4 | 4 |
| GEN& DEV IDEA | 2 | 2 | 4 | 4 | 4 | 4 |
| EXPL THE PROB | 2 | 2 | 2 | 4 | 2 | 2 |
| ADDR TASK REC | 2 | 2 | 4 | 4 | 5 | 4 |
| PLANNING LOOK | 2 X | | 4 | 5 | 2 X | |
| COMM IDEAS | 2 | 2 | 5 | 4 | 4 | 3 |
| PLAN CONSTR | 2 | 2 | 5 | 4 | 4 | 3 |
| EVAL W DRAW | 2 | 2 | 4 | 4 | 4 | 3 |
| BASIS FOR MAKI | 1 | 3 | 4 X | | 4 | 2 |

| **Kate** | *PIZZA* | *ROST* | *ASTEF* | *CARD* | *IITCAS* | *MAZE* |
|---|---|---|---|---|---|---|
| PURPOSE | 2 | 2 | 3 | 3 | 2 | 0 |
| GEN& DEV IDEA | 2 | 2 | 4 | 2 | 2 | 0 |
| EXPL THE PROB | 2 | 2 | 2 | 2 | 2 | 0 |
| ADDR TASK REC | 2 | 2 | 4 | 3 | 2 | 0 |
| PLANNING LOOK | 2 X | | 4 | 3 | 3 X | |
| COMM IDEAS | 2 | 2 | 3 | 3 | 2 | 0 |
| PLAN CONSTR | 2 | 2 | 3 | 3 | 2 | 0 |
| EVAL W DRAW | 2 | 2 | 2 | 2 | 2 | 0 |
| BASIS FOR MAKI | 2 | 3 | 2 X | | 3 | 0 |

#### Boys

| **Craig** | *PIZZA* | *FROS* | *EAST* | *CARD* | *SUITC* | *MAZE* |
|---|---|---|---|---|---|---|
| PURPOSE | 3 | 3 | 4 | 4 | 3 | 3 |
| GEN& DEV IDEA | 2 | 3 | 4 | 4 | 3 | 2 |
| EXPL THE PROB | 2 | 3 | 2 | 3 | 2 | 3 |
| ADDR TASK REC | 2 | 3 | 4 | 4 | 2 | 3 |
| PLANNING LOOK | 2 X | | 4 | 5 | 1 X | |
| COMM IDEAS | 2 | 2 | 4 | 4 | 2 | 2 |
| PLAN CONSTR | 2 | 2 | 4 | 4 | 2 | 3 |
| EVAL W DRAW | 2 | 3 | 4 | 3 | 3 | 2 |
| BASIS FOR MAKI | 2 | 1 | 4 X | | 3 | 3 |

| **Carl** | *PIZZA* | *ROST* | *ASTEF* | *CARD* | *IITCAS* | *MAZE* |
|---|---|---|---|---|---|---|
| PURPOSE | 2 | 2 | 3 | 3 | 3 | 3 |
| GEN& DEV IDEA | 2 | 2 | 3 | 4 | 3 | 3 |
| EXPL THE PROB | 2 | 2 | 3 | 2 | 3 | 3 |
| ADDR TASK REC | 2 | 2 | 2 | 3 | 3 | 2 |
| PLANNING LOOK | 2 X | | 4 | 3 | 3 X | |
| COMM IDEAS | 2 | 2 | 2 | 2 | 2 | 3 |
| PLAN CONSTR | 2 | 2 | 2 | 2 | 2 | 2 |
| EVAL W DRAW | 2 | 2 | 3 | 2 | 3 | 3 |
| BASIS FOR MAKI | 3 | 2 | 1 X | | 1 | 3 |

| **Connor** | *PIZZA* | *ROST* | *ASTEF* | *CARD* | *IITCAS* | *MAZE* |
|---|---|---|---|---|---|---|
| PURPOSE | 2 | 1 | 3 | 3 | 3 | 2 |
| GEN& DEV IDEA | 2 | 1 | 3 | 3 | 3 | 2 |
| EXPL THE PROB | 3 | 1 | 4 | 3 | 3 | 4 |
| ADDR TASK REC | 2 | 1 | 3 | 3 | 2 | 1 |
| PLANNING LOOK | 2 X | | 3 | 3 | 3 X | |
| COMM IDEAS | 2 | 1 | 3 | 3 | 2 | 2 |
| PLAN CONSTR | 2 | 1 | 2 | 2 | 2 | 2 |
| EVAL W DRAW | 3 | 1 | 2 | 2 | 3 | 2 |
| BASIS FOR MAKI | 3 | 1 | 2 X | | 2 | 1 |

| **Damian** | *PIZZA* | *ROST* | *ASTEF* | *CARD* | *IITCAS* | *MAZE* |
|---|---|---|---|---|---|---|
| PURPOSE | 2 | 3 | 3 | 5 | 3 | 3 |
| GEN& DEV IDEA | 3 | 3 | 3 | 5 | 4 | 3 |
| EXPL THE PROB | 3 | 4 | 3 | 5 | 3 | 3 |
| ADDR TASK REC | 2 | 3 | 3 | 4 | 3 | 3 |
| PLANNING LOOK | 2 X | | 4 | 4 | 4 X | |
| COMM IDEAS | 2 | 2 | 2 | 5 | 2 | 2 |
| PLAN CONSTR | 2 | 2 | 2 | 5 | 2 | 2 |
| EVAL W DRAW | 3 | 3 | 3 | 5 | 3 | 3 |
| BASIS FOR MAKI | 3 | 2 | 3 X | | 3 | 2 |

| **Michael** | *PIZZA* | *ROST* | *ASTEF* | *CARD* | *IITCAS* | *MAZE* |
|---|---|---|---|---|---|---|
| PURPOSE | 0 | 2 | 2 | 3 | 2 | 2 |
| GEN& DEV IDEA | 0 | 2 | 2 | 3 | 2 | 2 |
| EXPL THE PROB | 0 | 2 | 2 | 3 | 2 | 2 |
| ADDR TASK REC | 0 | 2 | 2 | 2 | 1 | 1 |
| PLANNING LOOK | 0 X | | 2 | 3 | 3 X | |
| COMM IDEAS | 0 | 2 | 2 | 3 | 2 | 2 |
| PLAN CONSTR | 0 | 2 | 2 | 3 | 2 | 2 |
| EVAL W DRAW | 0 | 2 | 2 | 3 | 2 | 2 |
| BASIS FOR MAKI | 0 | 3 | 1 X | | 1 | 1 |

# APPENDIX O
# Quantitative Data

## Focus Class (Cont.)

### Girls

| Tasmin | PIZZAROST`ASTEFCARD IITCASMAZE | | | | | |
|---|---|---|---|---|---|---|
| PURPOSE | 2 | 2 | 2 | 3 | 3 | 3 |
| GEN& DEV IDEA | 2 | 2 | 2 | 3 | 3 | 3 |
| EXPL THE PROB | 2 | 2 | 2 | 3 | 2 | 2 |
| ADDR TASK REC | 2 | 2 | 2 | 2 | 2 | 2 |
| PLANNING LOOK | 2 X | | 1 | 4 | 4 X | |
| COMM IDEAS | 2 | 2 | 2 | 2 | 2 | 3 |
| PLAN CONSTR | 2 | 2 | 2 | 2 | 2 | 2 |
| EVAL W DRAW | 2 | 2 | 2 | 3 | 3 | 2 |
| BASIS FOR MAKI | 1 | 2 | 2 X | | 3 | 1 |

| Hayleigh | PIZZAROST`ASTEFCARD IITCASMAZE | | | | | |
|---|---|---|---|---|---|---|
| PURPOSE | 3 | 2 | 4 | 4 | 4 | 5 |
| GEN& DEV IDEA | 2 | 2 | 4 | 4 | 5 | 4 |
| EXPL THE PROB | 2 | 2 | 4 | 4 | 3 | 3 |
| ADDR TASK REC | 2 | 2 | 2 | 4 | 2 | 2 |
| PLANNING LOOK | 2 X | | 5 | 4 | 5 X | |
| COMM IDEAS | 2 | 2 | 4 | 4 | 2 | 3 |
| PLAN CONSTR | 2 | 2 | 4 | 4 | 2 | 3 |
| EVAL W DRAW | 2 | 2 | 4 | 4 | 5 | 4 |
| BASIS FOR MAKI | 2 | 2 | 4 X | | 4 | 4 |

| Jolene | PIZZAROST`ASTEFCARD IITCASMAZE | | | | | |
|---|---|---|---|---|---|---|
| PURPOSE | 2 | 3 | 5 | 4 | 5 | 5 |
| GEN& DEV IDEA | 2 | 3 | 5 | 4 | 5 | 5 |
| EXPL THE PROB | 3 | 3 | 4 | 3 | 3 | 3 |
| ADDR TASK REC | 2 | 3 | 3 | 3 | 4 | 5 |
| PLANNING LOOK | 2 X | | 5 | 3 | 4 X | |
| COMM IDEAS | 2 | 2 | 4 | 2 | 4 | 4 |
| PLAN CONSTR | 2 | 2 | 5 | 3 | 4 | 3 |
| EVAL W DRAW | 3 | 3 | 4 | 2 | 4 | 5 |
| BASIS FOR MAKI | 3 | 2 | 4 X | | 4 | 4 |

| Kara | PIZZAROST`ASTEFCARD IITCASMAZE | | | | | |
|---|---|---|---|---|---|---|
| PURPOSE | 3 | 2 | 3 | 3 | 3 | 2 |
| GEN& DEV IDEA | 2 | 2 | 3 | 3 | 3 | 2 |
| EXPL THE PROB | 2 | 2 | 3 | 3 | 3 | 2 |
| ADDR TASK REC | 2 | 2 | 2 | 3 | 4 | 1 |
| PLANNING LOOK | 2 X | | 3 | 3 | 4 X | |
| COMM IDEAS | 2 | 2 | 2 | 2 | 3 | 2 |
| PLAN CONSTR | 2 | 2 | 2 | 3 | 2 | 2 |
| EVAL W DRAW | 2 | 2 | 3 | 2 | 3 | 2 |
| BASIS FOR MAKI | 2 | 2 | 1 X | | 1 | 2 |

| Maria | PIZZAROST`ASTEFCARD IITCASMAZE | | | | | |
|---|---|---|---|---|---|---|
| PURPOSE | 2 | 3 | 4 | 2 | 4 | 2 |
| GEN& DEV IDEA | 2 | 3 | 4 | 3 | 4 | 2 |
| EXPL THE PROB | 3 | 3 | 2 | 2 | 2 | 2 |
| ADDR TASK REC | 2 | 3 | 2 | 3 | 4 | 2 |
| PLANNING LOOK | 2 X | | 1 | 3 | 4 X | |
| COMM IDEAS | 2 | 2 | 2 | 3 | 4 | 2 |
| PLAN CONSTR | 2 | 2 | 2 | 2 | 5 | 2 |
| EVAL W DRAW | 3 | 3 | 4 | 3 | 4 | 2 |
| BASIS FOR MAKI | 3 | 3 | 3 X | | 2 | 1 |

### Boys

| Martin | PIZZAROST`ASTEFCARD IITCASMAZE | | | | | |
|---|---|---|---|---|---|---|
| PURPOSE | | 3 | 4 | 5 | 5 | 4 |
| GEN& DEV IDEA | 3 | 3 | 4 | 5 | 4 | 4 |
| EXPL THE PROB | 3 | 3 | 3 | 4 | 2 | 3 |
| ADDR TASK REC | 3 | 3 | 2 | 4 | 4 | 4 |
| PLANNING LOOK | 2 X | | 4 | 2 | 4 X | |
| COMM IDEAS | 2 | 2 | 4 | 3 | 5 | 4 |
| PLAN CONSTR | 2 | 2 | 4 | 4 | 5 | 4 |
| EVAL W DRAW | 3 | 3 | 4 | 5 | 4 | 4 |
| BASIS FOR MAKI | 1 | 3 | 4 X | | 4 | 4 |

| Noel | PIZZAROST`ASTEFCARD IITCASMAZE | | | | | |
|---|---|---|---|---|---|---|
| PURPOSE | 2 | 2 | 3 | 2 | 2 | 0 |
| GEN& DEV IDEA | 2 | 2 | 3 | 2 | 2 | 0 |
| EXPL THE PROB | 2 | 2 | 2 | 2 | 2 | 0 |
| ADDR TASK REC | 2 | 2 | 3 | 2 | 2 | 0 |
| PLANNING LOOK | 2 X | | 1 | 3 | 3 X | |
| COMM IDEAS | 2 | 2 | 3 | 2 | 2 | 0 |
| PLAN CONSTR | 2 | 2 | 3 | 2 | 2 | 0 |
| EVAL W DRAW | 2 | 2 | 2 | 2 | 3 | 0 |
| BASIS FOR MAKI | 1 | 1 | 3 X | | 3 | 0 |

| Lewis | PIZZAROST`ASTEFCARD IITCASMAZE | | | | | |
|---|---|---|---|---|---|---|
| PURPOSE | 3 | 2 | 4 | 3 | 3 | 3 |
| GEN& DEV IDEA | 2 | 2 | 4 | 3 | 3 | 3 |
| EXPL THE PROB | 2 | 2 | 2 | 2 | 3 | 2 |
| ADDR TASK REC | 1 | 2 | 4 | 3 | 2 | 2 |
| PLANNING LOOK | 2 X | | 4 | 4 | 3 X | |
| COMM IDEAS | 2 | 2 | 4 | 3 | 2 | 2 |
| PLAN CONSTR | 2 | 2 | 4 | 3 | 2 | 3 |
| EVAL W DRAW | 2 | 2 | 4 | 3 | 3 | 2 |
| BASIS FOR MAKI | 2 | 3 | 2 X | | 3 | 3 |

| Randal | PIZZAROST`ASTEFCARD IITCASMAZE | | | | | |
|---|---|---|---|---|---|---|
| PURPOSE | 2 | 3 | 3 | 3 | 3 | 2 |
| GEN& DEV IDEA | 2 | 3 | 3 | 3 | 3 | 2 |
| EXPL THE PROB | 2 | 3 | 3 | 3 | 3 | 2 |
| ADDR TASK REC | 2 | 3 | 2 | 1 | 1 | 3 |
| PLANNING LOOK | 2 X | | 4 | 3 | 2 X | |
| COMM IDEAS | 2 | 2 | 2 | 2 | 2 | 2 |
| PLAN CONSTR | 2 | 2 | 2 | 2 | 2 | 2 |
| EVAL W DRAW | 2 | 4 | 3 | 3 | 3 | 2 |
| BASIS FOR MAKI | 2 | 1 | 3 X | | 3 | 3 |

# APPENDIX O
# Quantitative Data

## Focus Class (Cont.)
### Girls

| **Natasha** | *PIZZA* | *ROST`* | *ASTEF* | *CARD I* | *ITCAS* | *MAZE* |
|---|---|---|---|---|---|---|
| PURPOSE | 3 | 3 | 4 | 4 | 3 | 3 |
| GEN& DEV IDEA | 2 | 3 | 4 | 4 | 3 | 3 |
| EXPL THE PROB | 2 | 3 | 4 | 4 | 2 | 2 |
| ADDR TASK REC | 2 | 4 | 2 | 4 | 2 | 3 |
| PLANNING LOOK | 2 X | | 5 | 4 | 3 X | |
| COMM IDEAS | 2 | 2 | 5 | 4 | 2 | 2 |
| PLAN CONSTR | 2 | 3 | 4 | 4 | 2 | 3 |
| EVAL W DRAW | 2 | 3 | 4 | 4 | 2 | 2 |
| BASIS FOR MAKI | 2 | 3 | 4 X | | 2 | 3 |

| **Stacey** | *PIZZA* | *ROST`* | *ASTEF* | *CARD I* | *ITCAS* | *MAZE* |
|---|---|---|---|---|---|---|
| PURPOSE | 2 | 2 | 4 | 4 | 3 | 2 |
| GEN& DEV IDEA | 2 | 2 | 4 | 4 | 3 | 2 |
| EXPL THE PROB | 2 | 2 | 4 | 3 | 2 | 2 |
| ADDR TASK REC | 1 | 2 | 4 | 4 | 2 | 1 |
| PLANNING LOOK | 1 X | | 4 | 4 | 3 X | |
| COMM IDEAS | 2 | 2 | 4 | 4 | 2 | 2 |
| PLAN CONSTR | 1 | 2 | 4 | 4 | 2 | 2 |
| EVAL W DRAW | 2 | 2 | 4 | 4 | 3 | 2 |
| BASIS FOR MAKI | 2 | 3 | 4 X | | 2 | 1 |

| **Emily** | *PIZZA* | *ROST`* | *ASTEF* | *CARD I* | *ITCAS* | *MAZE* |
|---|---|---|---|---|---|---|
| PURPOSE | 0 | 2 | 0 | 2 | 3 | 3 |
| GEN& DEV IDEA | 0 | 2 | 0 | 2 | 3 | 4 |
| EXPL THE PROB | 0 | 2 | 0 | 2 | 2 | 2 |
| ADDR TASK REC | 0 | 2 | 0 | 2 | 2 | 2 |
| PLANNING LOOK | 0 X | | 0 | 3 | 3 X | |
| COMM IDEAS | 0 | 2 | 0 | 2 | 2 | 2 |
| PLAN CONSTR | 0 | 2 | 0 | 2 | 2 | 2 |
| EVAL W DRAW | 0 | 2 | 0 | 2 | 3 | 3 |
| BASIS FOR MAKI | 0 | 3 | 0 X | | 2 | 1 |

| **Chloe** | *PIZZA* | *ROST`* | *ASTEF* | *CARD I* | *ITCAS* | *MAZE* |
|---|---|---|---|---|---|---|
| PURPOSE | 2 | 2 | 0 | 2 | 3 | 3 |
| GEN& DEV IDEA | 3 | 2 | 0 | 2 | 3 | 4 |
| EXPL THE PROB | 3 | 2 | 0 | 2 | 2 | 2 |
| ADDR TASK REC | 2 | 2 | 0 | 2 | 2 | 2 |
| PLANNING LOOK | 2 X | | 0 | 3 | 3 X | |
| COMM IDEAS | 2 | 2 | 0 | 2 | 2 | 2 |
| PLAN CONSTR | 2 | 2 | 0 | 2 | 2 | 2 |
| EVAL W DRAW | 3 | 2 | 0 | 2 | 3 | 3 |
| BASIS FOR MAKI | 3 | 3 | 0 X | | 2 | 1 |

# APPENDIX O
# Quantitative Data

## Comparison Class

### Girls

| Rhiannon | *PIZZA* | *FROS* | *EAST* | *CARD* | *SUITC* | *MAZE* |
|---|---|---|---|---|---|---|
| PURPOSE | 2 | 3 | 2 | 3 | 4 | 3 |
| GEN& DEV | 2 | 3 | 2 | 3 | 4 | 3 |
| EXPL THE | 2 | 2 | 2 | 2 | 2 | 3 |
| ADDR TAS | 2 | 3 | 2 | 2 | 4 | 2 |
| PLANNING | 3 X | | 3 | 4 | 1 X | |
| COMM IDE | 2 | 2 | 2 | 3 | 5 | 2 |
| PLAN CON | 2 | 2 | 2 | 2 | 5 | 2 |
| EVAL W DI | 2 | 3 | 2 | 4 | 4 | 2 |
| BASIS FOF | 3 | 3 | 1 X | | 4 | 2 |

| Sophie | *PIZZA* | *FROS* | *EAST* | *CARD* | *SUITC* | *MAZE* |
|---|---|---|---|---|---|---|
| PURPOSE | 0 | 3 | 2 | 2 | 2 | 3 |
| GEN& DEV | 0 | 3 | 2 | 2 | 2 | 3 |
| EXPL THE | 0 | 3 | 2 | 2 | 2 | 2 |
| ADDR TAS | 0 | 3 | 2 | 3 | 1 | 3 |
| PLANNING | 0 X | | 1 | 3 | 2 X | |
| COMM IDE | 0 | 2 | 2 | 2 | 2 | 2 |
| PLAN CON | 0 | 2 | 3 | 2 | 2 | 3 |
| EVAL W DI | 0 | 3 | 2 | 2 | 2 | 3 |
| BASIS FOF | 0 | 3 | 3 X | | 3 | 1 |

| Cassy | *PIZZA* | *FROS* | *EAST* | *CARD* | *SUITC* | *MAZE* |
|---|---|---|---|---|---|---|
| PURPOSE | 3 | 3 | 2 | 2 | 2 | 3 |
| GEN& DEV | 3 | 3 | 2 | 2 | 2 | 3 |
| EXPL THE | 3 | 4 | 2 | 2 | 2 | 4 |
| ADDR TAS | 3 | 3 | 2 | 2 | 2 | 3 |
| PLANNING | 3 X | | 2 | 3 | 1 X | |
| COMM IDE | 2 | 2 | 4 | 2 | 2 | 2 |
| PLAN CON | 2 | 2 | 4 | 2 | 2 | 3 |
| EVAL W DI | 3 | 3 | 2 | 2 | 2 | 3 |
| BASIS FOF | 1 | 2 | 2 X | | 2 | 3 |

| Chloe | *PIZZA* | *FROS* | *EAST* | *CARD* | *SUITC* | *MAZE* |
|---|---|---|---|---|---|---|
| PURPOSE | 2 | 0 | 2 | 2 | 2 | 2 |
| GEN& DEV | 2 | 0 | 2 | 2 | 2 | 2 |
| EXPL THE | 2 | 0 | 2 | 2 | 2 | 2 |
| ADDR TAS | 2 | 0 | 2 | 2 | 1 | 1 |
| PLANNING | 2 X | | 3 | 3 | 1 X | |
| COMM IDE | 2 | 0 | 2 | 2 | 2 | 2 |
| PLAN CON | 2 | 0 | 2 | 2 | 2 | 2 |
| EVAL W DI | 2 | 0 | 2 | 2 | 2 | 3 |
| BASIS FOF | 1 | 0 | 2 X | | 3 | 1 |

| Emma | *PIZZA* | *FROS* | *EAST* | *CARD* | *SUITC* | *MAZE* |
|---|---|---|---|---|---|---|
| PURPOSE | 3 | 4 | 3 | 5 | 2 | 3 |
| GEN& DEV | 3 | 4 | 4 | 5 | 3 | 3 |
| EXPL THE | 3 | 4 | 2 | 5 | 2 | 3 |
| ADDR TAS | 3 | 4 | 2 | 5 | 1 | 1 |
| PLANNING | 3 X | | 4 | 5 | 2 X | |
| COMM IDE | 2 | 4 | 3 | 4 | 3 | 2 |
| PLAN CON | 2 | 4 | 3 | 4 | 1 | 3 |
| EVAL W DI | 3 | 4 | 3 | 5 | 2 | 3 |
| BASIS FOF | 2 | 4 | 2 X | | 2 | 3 |

### Boys

| **Alistair** | *PIZZA* | *FROS* | *EAST* | *CARD* | *SUITC* | *MAZE* |
|---|---|---|---|---|---|---|
| PURPOSE | | 1 | 3 | 2 | 2 | 2 |
| GEN& DEV | 2 | 1 | 3 | 2 | 2 | 2 |
| EXPL THE | 2 | 1 | 2 | 3 | 2 | 2 |
| ADDR TAS | 2 | 1 | 3 | 2 | 2 | 2 |
| PLANNING | 3 X | | 2 | 3 | 3 X | |
| COMM IDE | 2 | 2 | 4 | 2 | 2 | 3 |
| PLAN CON | 2 | 1 | 4 | 2 | 2 | 3 |
| EVAL W DI | 2 | 1 | 2 | 2 | 2 | 2 |
| BASIS FOF | 1 | 2 | 3 X | | 2 | 3 |

| Garth | *PIZZA* | *FROS* | *EAST* | *CARD* | *SUITC* | *MAZE* |
|---|---|---|---|---|---|---|
| PURPOSE | | 2 | 4 | 2 | 3 | 2 |
| GEN& DEV | 2 | 2 | 4 | 2 | 3 | 2 |
| EXPL THE | 2 | 2 | 2 | 2 | 2 | 2 |
| ADDR TAS | 2 | 2 | 3 | 3 | 2 | 2 |
| PLANNING | 3 X | | 1 | 3 | 1 X | |
| COMM IDE | 2 | 2 | 3 | 2 | 2 | 2 |
| PLAN CON | 2 | 2 | 4 | 2 | 2 | 3 |
| EVAL W DI | 2 | 2 | 2 | 2 | 3 | 2 |
| BASIS FOF | 2 | 1 | 3 X | | 2 | 3 |

| Jordan | *PIZZA* | *FROS* | *EAST* | *CARD* | *SUITC* | *MAZE* |
|---|---|---|---|---|---|---|
| PURPOSE | | 1 | 3 | 2 | 3 | 2 |
| GEN& DEV | 1 | 1 | 3 | 2 | 3 | 2 |
| EXPL THE | 2 | 1 | 4 | 2 | 3 | 2 |
| ADDR TAS | 2 | 1 | 1 | 2 | 2 | 3 |
| PLANNING | 1 X | | 1 | 3 | 4 X | |
| COMM IDE | 1 | 1 | 2 | 2 | 2 | 3 |
| PLAN CON | 1 | 1 | 3 | 2 | 2 | 3 |
| EVAL W DI | 1 | 1 | 3 | 2 | 3 | 2 |
| BASIS FOF | 1 | 1 | 2 X | | 1 | 1 |

| Lee | *PIZZA* | *FROS* | *EAST* | *CARD* | *SUITC* | *MAZE* |
|---|---|---|---|---|---|---|
| PURPOSE | | 2 | 2 | 2 | 3 | 3 |
| GEN& DEV | 2 | 2 | 2 | 2 | 3 | 3 |
| EXPL THE | 2 | 2 | 2 | 2 | 3 | 3 |
| ADDR TAS | 2 | 2 | 1 | 2 | 2 | 3 |
| PLANNING | 1 X | | 1 | 3 | 1 X | |
| COMM IDE | 2 | 2 | 1 | 2 | 1 | 2 |
| PLAN CON | 1 | 2 | 2 | 3 | 2 | 3 |
| EVAL W DI | 2 | 2 | 2 | 2 | 3 | 3 |
| BASIS FOF | 1 | 1 | 1 X | | 1 | 3 |

| Matthew | *PIZZA* | *FROS* | *EAST* | *CARD* | *SUITC* | *MAZE* |
|---|---|---|---|---|---|---|
| PURPOSE | | 2 | 4 | 2 | 4 | 0 |
| GEN& DEV | 2 | 2 | 4 | 2 | 4 | 0 |
| EXPL THE | 2 | 2 | 2 | 2 | 2 | 0 |
| ADDR TAS | 2 | 2 | 2 | 2 | 1 | 0 |
| PLANNING | 2 X | | 4 | 3 | 1 X | |
| COMM IDE | 2 | 2 | 3 | 2 | 3 | 0 |
| PLAN CON | 2 | 2 | 4 | 2 | 4 | 0 |
| EVAL W DI | 2 | 2 | 4 | 2 | 2 | 0 |
| BASIS FOF | 1 | 1 | 2 X | | 3 | 0 |

# APPENDIX O
# Quantitative Data

## Comparison Class (Cont.)

### Girls

| Wendy | PIZZA | FROS | EASTI | CARD | SUITC | MAZE |
|---|---|---|---|---|---|---|
| PURPOSE | 2 | 2 | 2 | 0 | 3 | 3 |
| GEN& DEV | 2 | 2 | 2 | 0 | 3 | 3 |
| EXPL THE | 2 | 2 | 2 | 0 | 4 | 2 |
| ADDR TAS | 2 | 2 | 1 | 0 | 1 | 1 |
| PLANNING | 2 X | | 1 | 0 | 2 X | |
| COMM IDE | 2 | 2 | 2 | 0 | 2 | 2 |
| PLAN CON | 2 | 2 | 3 | 0 | 2 | 2 |
| EVAL W DI | 2 | 2 | 1 | 0 | 3 | 3 |
| BASIS FOF | 2 | 3 | 1 X | | 3 | 1 |

| Carys | PIZZA | FROS | EASTI | CARD | SUITC | MAZE |
|---|---|---|---|---|---|---|
| PURPOSE | 2 | 2 | 2 | 4 | 2 | 2 |
| GEN& DEV | 2 | 2 | 2 | 4 | 2 | 2 |
| EXPL THE | 2 | 2 | 2 | 3 | 2 | 2 |
| ADDR TAS | 2 | 3 | 2 | 2 | 2 | 2 |
| PLANNING | 2 X | | 3 | 4 | 3 X | |
| COMM IDE | 2 | 2 | 2 | 4 | 2 | 2 |
| PLAN CON | 2 | 2 | 2 | 3 | 2 | 2 |
| EVAL W DI | 2 | 2 | 2 | 4 | 2 | 2 |
| BASIS FOF | 2 | 3 | 2 X | | 1 | 1 |

| Ellis | PIZZA | FROS | EASTI | CARD | SUITC | MAZE |
|---|---|---|---|---|---|---|
| PURPOSE | 2 | 3 | 4 | 0 | 2 | 2 |
| GEN& DEV | 2 | 3 | 4 | 0 | 3 | 2 |
| EXPL THE | 2 | 3 | 2 | 0 | 2 | 2 |
| ADDR TAS | 2 | 3 | 4 | 0 | 2 | 2 |
| PLANNING | 2 X | | 1 | 0 | 3 X | |
| COMM IDE | 2 | 3 | 4 | 0 | 2 | 3 |
| PLAN CON | 2 | 3 | 4 | 0 | 3 | 3 |
| EVAL W DI | 2 | 3 | 4 | 0 | 2 | 2 |
| BASIS FOF | 2 | 3 | 2 X | | 2 | 1 |

| Holly | PIZZA | FROS | EASTI | CARD | SUITC | MAZE |
|---|---|---|---|---|---|---|
| PURPOSE | 3 | 2 | 2 | 2 | 4 | 2 |
| GEN& DEV | 3 | 2 | 2 | 2 | 4 | 2 |
| EXPL THE | 3 | 2 | 2 | 2 | 2 | 2 |
| ADDR TAS | 2 | 3 | 1 | 3 | 4 | 3 |
| PLANNING | 3 X | | 1 | 3 | 4 X | |
| COMM IDE | 2 | 2 | 3 | 3 | 5 | 2 |
| PLAN CON | 2 | 2 | 3 | 3 | 4 | 3 |
| EVAL W DI | 3 | 2 | 2 | 2 | 4 | 2 |
| BASIS FOF | 3 | 1 | 3 X | | 4 | 3 |

| Alice | PIZZA | FROS | EASTI | CARD | SUITC | MAZE |
|---|---|---|---|---|---|---|
| PURPOSE | 3 | 0 | 4 | 3 | 3 | 3 |
| GEN& DEV | 3 | 0 | 4 | 3 | 3 | 3 |
| EXPL THE | 3 | 0 | 4 | 4 | 3 | 3 |
| ADDR TAS | 2 | 0 | 4 | 3 | 2 | 3 |
| PLANNING | 3 X | | 1 | 4 | 3 X | |
| COMM IDE | 2 | 0 | 3 | 3 | 2 | 2 |
| PLAN CON | 2 | 0 | 4 | 3 | 2 | 3 |
| EVAL W DI | 2 | 0 | 4 | 3 | 3 | 3 |
| BASIS FOF | 3 | 0 | 3 X | | 2 | 2 |

### Boys

| Peter | PIZZA | FROS | EASTI | CARD | SUITC | MAZE |
|---|---|---|---|---|---|---|
| PURPOSE | | 2 | 0 | 0 | 2 | 2 |
| GEN& DEV | 2 | 2 | 0 | 0 | 2 | 2 |
| EXPL THE | 2 | 2 | 1 | 1 | 2 | 2 |
| ADDR TAS | 2 | 2 | 1 | 1 | 2 | 2 |
| PLANNING | 2 X | | 1 | 1 | 1 X | |
| COMM IDE | 2 | 2 | 1 | 1 | 2 | 2 |
| PLAN CON | 2 | 2 | 1 | 1 | 3 | 2 |
| EVAL W DI | 2 | 2 | 1 | 1 | 2 | 2 |
| BASIS FOF | 1 | 2 | 1 X | | 2 | 1 |

| Robert | PIZZA | FROS | EASTI | CARD | SUITC | MAZE |
|---|---|---|---|---|---|---|
| PURPOSE | | 1 | 2 | 3 | 1 | 1 |
| GEN& DEV | 2 | 1 | 3 | 3 | 2 | 1 |
| EXPL THE | 2 | 1 | 2 | 3 | 1 | 1 |
| ADDR TAS | 2 | 1 | 1 | 3 | 1 | 1 |
| PLANNING | 3 X | | 1 | 4 | 1 X | |
| COMM IDE | 2 | 1 | 3 | 2 | 1 | 1 |
| PLAN CON | 2 | 1 | 3 | 2 | 1 | 1 |
| EVAL W DI | 2 | 1 | 2 | 3 | 1 | 1 |
| BASIS FOF | 2 | 1 | 3 X | | 1 | 1 |

# APPENDIX O
# Quantitative Data

## Comparison Class (Cont.)
### Girls

| Kathy | PIZZA | FROS | EAST | CARD | SUITC | MAZE |
|---|---|---|---|---|---|---|
| PURPOSE | 2 | 0 | 2 | 2 | 2 | 3 |
| GEN& DEV | 2 | 0 | 2 | 2 | 2 | 3 |
| EXPL THE | 2 | 0 | 2 | 2 | 2 | 2 |
| ADDR TAS | 3 | 0 | 1 | 2 | 2 | 2 |
| PLANNING | 3 X | | 1 | 3 | 3 X | |
| COMM IDE | 2 | 0 | 2 | 2 | 2 | 2 |
| PLAN CON | 2 | 0 | 3 | 2 | 2 | 2 |
| EVAL W DI | 2 | 0 | 1 | 2 | 2 | 3 |
| BASIS FOF | 2 | 0 | 1 X | | 2 | 1 |

| Nicola | PIZZA | FROS | EAST | CARD | SUITC | MAZE |
|---|---|---|---|---|---|---|
| PURPOSE | 2 | 3 | 4 | 4 | 4 | 3 |
| GEN& DEV | 2 | 3 | 4 | 4 | 4 | 3 |
| EXPL THE | 2 | 3 | 2 | 4 | 2 | 3 |
| ADDR TAS | 2 | 3 | 2 | 4 | 3 | 2 |
| PLANNING | 2 X | | 1 | 4 | 1 X | |
| COMM IDE | 2 | 2 | 4 | 4 | 4 | 2 |
| PLAN CON | 2 | 3 | 4 | 4 | 4 | 2 |
| EVAL W DI | 2 | 3 | 2 | 2 | 4 | 3 |
| BASIS FOF | 2 | 3 | 2 X | | 3 | 2 |

| Zara | PIZZA | FROS | EAST | CARD | SUITC | MAZE |
|---|---|---|---|---|---|---|
| PURPOSE | 2 | 2 | 4 | 3 | 4 | 3 |
| GEN& DEV | 1 | 2 | 4 | 3 | 4 | 3 |
| EXPL THE | 2 | 2 | 4 | 3 | 4 | 3 |
| ADDR TAS | 1 | 2 | 4 | 3 | 4 | 1 |
| PLANNING | 2 X | | 1 | 4 | 1 X | |
| COMM IDE | 1 | 2 | 4 | 3 | 4 | 2 |
| PLAN CON | 2 | 2 | 4 | 2 | 4 | 2 |
| EVAL W DI | 2 | 2 | 4 | 3 | 4 | 3 |
| BASIS FOF | 3 | 1 | 4 X | | 4 | 3 |

| Kirsty | PIZZA | FROS | EAST | CARD | SUITC | MAZE |
|---|---|---|---|---|---|---|
| PURPOSE | 2 | 3 | 2 | 2 | 3 | 2 |
| GEN& DEV | 2 | 3 | 2 | 2 | 3 | 2 |
| EXPL THE | 2 | 3 | 2 | 2 | 2 | 2 |
| ADDR TAS | 2 | 3 | 2 | 3 | 2 | 1 |
| PLANNING | 2 X | | 3 | 3 | 4 X | |
| COMM IDE | 2 | 2 | 2 | 3 | 2 | 2 |
| PLAN CON | 2 | 2 | 2 | 2 | 2 | 2 |
| EVAL W DI | 2 | 3 | 2 | 2 | 3 | 2 |
| BASIS FOF | 2 | 3 | 2 X | | 1 | 2 |

# APPENDIX P
# Publications arising from the Research

## *Journal Articles:*

Summer 2000: *Beyond their Capability: Drawing, Designing and the Young Child*; The Journal of Design and Technology Education, Vol.5, No.2; Wellesbourne; DATA

Autumn 2001: *Taking Ideas on a Journey called Designing* The Journal of Design and Technology Education; Vol.6. No.3 Wellesbourne; DATA (originally presented as a paper for the Design and Technology International Conference, Coventry, July 2001)

January 2003: *The Process of Solving Problems: young children exploring the rules of the game in science, mathematics and technology* in The Curriculum Journal

## *Conferences for which Proceedings were published:*

April 2000: *Beyond "Draw one & Make it"* Design and Technology International Millennium Conference (DATA); London

August 2000: *Why Draw Anyway? The Role of Drawing in the Child's Design Tool Box*; International Design and Technology Educational Research Conference (IDATER 2001); Loughborogh

June 2001: *The Emergence of Understanding of the Relationship between Planning and Designing amongst Young Children*; The Third International Primary Design and Technology Conference (CRIPT); Birmingham

July 2001: *Taking Ideas on a Journey called Designing*; Design and Technology International Conference (DATA), Coventry (subsequently published in DATA Journal, see above)

August 2001: *Participant Research from the Perspective of a Participant Researcher*; International Design and Technology Educational Research Conference (IDATER 2001); Loughborogh

July 2002: *Questioning the Design and Technology Paradigm*; Design and Technology International Conference (DATA); Coventry (extensive reference was made to this paper in Kimbell, R. **(2003) Reflections on the DATA** Conference "Paradigm" Debate; in The Journal of Design & Technology Education, Vol. 8 No.1.**; Wellesbourne; DATA**

June 2003: *A Holistic View of Assessing Young Children's Designing;* The Third International Primary Design and Technology Conference (CRIPT); Birmingham

## *Conferences without Published Proceedings:*

April 2002: Learning something new: Problem-solving and the development of knowledge; Commonwealth Association for Science, Technology and Mathematics Education; St. Juliens, Malta

September 2002: *Ideas on a Journey: Design and Research*; British Educational Research Association (BERA); Exeter (published on-line)

September 2003: *Taking Ideas on a Journey : a model to support young children's thinking processes;* British Educational Research Association (BERA); Exeter (published on-line and also this paper is to be included in a published collection by the Centre for Educational Research, Canterbury Christ Church University College)

# APPENDIX P
# Publications arising from the Research

## ***Requests to use Published Work in other contexts:***

*Re. Beyond "Draw one & Make it"*

TORQUE is the quarterly bulletin of the Technology Association of South Africa. We are small fry - we have about 200 members. I would very much like to publish a precis of the paper in our bulletin. I would also like to use it at Stellenbosch University where I lecture to the B Ed students on Technology (our version of your D&T).

Andre Goosen
Technology Association
49 Newlands Road
Claremont, 7708
South Africa

I have recently received a request from the Open University to publish a copy of your article "Beyond Draw One and Make it - Developing Better Strategies for the Use of Drawing for Design in Key Stages 1 and 2", which was presented at the Millennium DATA Conference. The OU wish to publish this on their Teach and Learn website. The Teach and Learn project is one of the Open University's current major initiatives, involving the on-line delivery of continuing professional development for teachers and other educational staff in primary and secondary schools. The web site will present a customised learning environment which will include a comprehensive range of both generic and subject-specific resources to support staff in their professional development.

Lucy Rose, Editorial Administrative Officer DATA, 16 Wellesbourne House, Walton Road, Wellesbourne, Warwickshire,

## ***Web Publishing:***

*www.designdrawing.net* - personal website, established with intention that it should become forum for discussion of design drawing development

*www.kented.org.uk/ngfl/primary.html* - The Kent National Grid for Learning Site. I have a Design & Technology site within this much larger web space, for which I was allocated funding and time. The Stan series of lessons are on this site.

## ***Book To be published:***

*Teaching Design & Technology 3-11;* with Continuum Publishers; series editor: Mark O'Hara. This is to form part of the "Reaching the Standards" Series. Manuscript submission date: Dec.2003