THE TYPOLOGY AND DEVELOPMENT OF ATTITUDE TO PRIMARY SCIENCE EDUCATION.

ADELAIDE GRAY

A thesis submitted in partial fulfilment of the requirements of
The Nottingham Trent University for the degree of Doctor of Philosophy

May 2001

Acknowledgements.

With thanks to:
Mary Hayes, John Bastiani, Jane Johnston, Nigel Snow and Matheu Smith:
There from Beginning to End.

All schools that have participated and especially all the anonymous respondents.

Andrew and Margaret Gray:
for support in every way possible.

We shall not cease from exploration
And the end of all our exploring
Will be to arrive where we started
And know the place for the first time.

T.S.Eliot
Little Gidding

GLP

CONTENTS

ABSTRACT

The introduction and development of science within the primary curriculum has been a challenge to teachers, parents and children and a highly politicised decision. Augmenting any difficulties are the images of science within popular culture and the traditions of scientific inquiry that have maintained the Western, male elitist hierarchy of the Vienna circle throughout the last millennium. The Royal Society's committee on the public understanding of science has recognised the difficulty in recruiting students to higher-level science study and embarked on a programme of sponsorship to address this. At the same time major governmental policy changes have provided a new 'market' model of education that has encouraged parental involvement in schools and enforced a new 'transparency' of evaluation on schools through league tables and Ofsted.

Set against this backdrop, this research explores the development of attitudes to science and science education in the parent's of primary school aged children. It examines the perceptions of science and science education through the narrative of the parent's and their understanding of the interaction between different areas of science. The use of key events within narrative as a method of exploring attitude and conceptual development is novel to this research and through this exploration the concept of attitude itself is examined and criticised developing a new concept of attitude as process-based rather than static or crystallised. This reconceptualisation allows a more operational understanding of attitude that overcomes the difficulties of the traditional concept, which has only a limited theoretical basis on which to examine behaviour.

The research generates a typology for views of science and the more operational compliment to this, stance to science. This framework allows a greater understanding of attitude formation, how science is perceived and how this perception is actualised. It is particularly interesting given the current interest in increasing parental involvement in the education of their children, as this may lead to a greater impact of parental attitude on children. This study argues that the affective component of attitude is of paramount important in the developing science experiences children and the narrative nature of knowledge transmission can illuminate how parents relate to their children's experiences at school.

Chapter 1

"Do we wish to join that procession? On what terms shall we join that procession? Where is it leading us to, the procession of educated men?"
Virginia Woolf, Three Guineas

INTRODUCTION

This chapter is contextual. It 'sets the scene' for this research and explores some of the developments in science education and the involvement of parents in their children's education.

The chapter has the following aims;

- To introduce the reader to the study
- To contextualise the research
- To explain the starting reasons for my research in this area
- To define the aims of the work
- To define the research questions;

thus giving an idea of both the range and scope of this work.

The introduction and development of science in the primary curriculum has been a challenge to both teachers and parents of primary aged children. Teachers lacking understanding of its nature and educational purposes have struggled to implement the curriculum. Fundamental to these difficulties has been the negative images associated with science both in the current milieu and previously. The drive to increase the positive profile of science has coincided with several education policy changes. Parents have been reconceptualised as 'partners' or clients within the new market model of education and as such have a direct involvement in their child's education. Teaching strategies have been changed to accommodate innovations such as the literacy hour (introduced in 1988) and core curriculum subjects. Even the structure of the teaching profession has changed with the advent of 'super teachers' (Advanced skills teachers also introduced in 1988).

In this study I investigate the development of parent's attitudes to science and science education, more specifically primary science education. This study was initiated in September 1995. It describes my understanding as illuminated through narrative interviews and involvement with a project aimed at improving the attitudes to science and understanding of the parents of primary aged children. This research is set firmly within the context of a period of change for both science and education.

1.1 Context: Personal/Professional.

After completing a degree in psychology I applied for a research studentship using my psychology experience to research on the social interactions involved in an on-going project at Nottingham Trent University. The project was partially funded by the Committee on the Public Understanding of Science and aimed at developing the attitudes to science of the parents of primary aged children. I believed that studying the interactions involved was a task too large for comprehensive coverage in a Ph.D. and possibly would not provide the illumination hoped for. However, given the nature of the project it would be wise to focus on the development of attitudes to science and relate this to the nature of the project and other contemporary issues. The study also arose from my personal interests as a science student and my concerns about public perceptions. I felt that current models of attitude (Ajzen and Fishbein (1980) Shrigley (1990)) were outdated and an insufficient model on which to base action. I was also aware of the apparent 'failure' to recruit to scientific careers and being one of the 'drop outs' wished to investigate my own motivations for rejecting a scientific career as well as other's motivations.

1.2 Context: National.

The first national curriculum had been implemented in August 1990. Schools struggled to come to terms with its requirements including the introduction of science at a primary level. Nationally this introduction of science was worrying, causing much confusion and dismay in teaching (T.E.S 1990a, 1990b).

In identifying the difficulties with introduction of the national curriculum account needs to be taken of its nature and structure. The curriculum provided guidance but not plans for teaching. Decisions on exactly how to teach to fulfil the requirements for the attainment targets was dependent on the teacher's subject knowledge and stance toward the nature of scientific knowledge. It also assumed they would have a repertoire of suitable teaching techniques. In primary science this has proved problematic for many teachers. Their personal experience of science teaching may have been minimal.

The increase of 'parental choice' engendered by the late years of the Conservative government has meant schools have wanted to increase the involvement of parents in their administration and pedagogical issues. Changes of this nature, however, have been carried out without fundamental alteration to the structure of education. Parents have been given a wider choice of schools but no rights over how the child is taught within this school's curricular experience. This has led to an increase in the rhetoric of parental involvement[1].

[1] For further discussion on parental choice see section 2.6.

Science has been trying to raise its profile since the dramatic declines in numbers of children taking the subject in the 1970's. The British Association has put its energies into a Science, Engineering and Technology week that has been running since 1987. Efforts have been put into involving school children in science activities outside of formal education but also adult 're-education' has been very much increased with a view to affecting children before they enter education.

The ultimate aim of this study is to enhance understanding of the development of attitudes to science so that both others and myself can use it as a framework for exploring issues to do with science education.

In pursuing these aims my study led me to the progressive definition of a number of research questions. These provided a structure for planning the study and guided the many decisions about the key issues to explore or extraneous issues to disregard. In keeping with the ideas of grounded theory on which the methodology of this study is based, these research questions evolved, expanded, were refined and then tested in a very organic process.

The first set of research questions is;

- What stances are there toward science and science education?
- What view of the nature of science does this stance indicate?
- How is science and science education perceived to be related in each of these stances?
- What factors influence the development of these stances?
- What factors can affect changes on these stances and views?

So having identified these questions emerging from the context of the research we must now consider the process of the research itself.

1.3 The Process of the Research.

My work is intensely personal. However, it is hoped that by expressing ideas in an accessible manner and at different levels they become available to others to explore in their own work. It is the study of many singularities - each school involved and each person a discreet event not related necessarily to any others. It exemplifies principles through description and analysis of specific instances so that others can see the genesis of ideas and judge for themselves the significance.

The research paradigm within which this study resides is that of 'Grounded research' (see for example -Glaser and Strauss 1967). The research was iterative, interactive and dynamic. I acted as researcher within the study to test theories and develop the framework of findings. Further discussion of grounded theory can be found in section 3.1.

The focus for my study was the primary classroom. In establishing my study as based within the school it was deliberately exploring parent's ideas of science in relation to this. It provided a transparent rationale for my study for parents and teachers involved in research. Though the actual study has explored the issues using the primary classroom as a focus the theoretical nature of the study has made it paradoxically more accessible for anybody engaged in academic study in this area. Unfortunately it has also become less useful for those seeking guidelines or advice on how to proceed in involving parents in primary science education or developing positive attitudes to science in a classroom situation. The study can inform and provide topics for discussion but not a clear framework on which to base science education of any sort. Indeed, it would be contrary to the nature of this study and my intentions, philosophical standpoint and view of science education to use it in this way (See Chapter Three).

In finding ways to present the study, words are the natural medium. The use of narrative lends itself to a general 'story' format of presentation and the small vignettes used within the story of this study will act as pictures giving additional insight where it is difficult to imagine the situation from the text. I have relied greatly on the use of these vignettes and material from interviews with the findings as to establish trustworthiness (Lincoln and Guba, 1985:290) is a necessary characteristic. Vignettes were selected to illustrate various points in the study but necessarily do not give a full picture of the situation.

> *"A vignette has the status of a sketch as compared to a fully worked picture. Invariably interpretative, it is founded on the act of selection of a subject for the vignette which itself constitutes and interpretation, and the illumination of the observation, situation or event by the selection of event by the author's interpretative stance."* (Stenhouse 1982:269)

My writing style throughout this study is varied and deliberately so. Some sections have been generated from in-depth academic study and are very narrow and involved. To express the ideas involved in these sections has required detailed, esoteric language and is not an 'easy read'. However, it is not anticipated that the issues involved in these sections would be of interest to those not deeply involved. Sections that cover issues that could interest others outside specific fields have been written with a less defined audience in mind. This gives the thesis a fragmented appearance but I feel that a glossy coherence would deny the underlying fragmentary nature of research. It would also contradict my epistemological standpoint that involves a diffuse view of knowledge and self.

I have attempted to be clear in explanations and systematic in my approach. However, the organic genesis of this study makes audits difficult. A quote used at the end of a study may not have originated at the end of the research but from the beginning or even the pilot study. I have not excluded any comments because they were not said at an appropriate time or outside the research situation. This has caused a lot of difficulty rigorously and comprehensively referencing the original data and analysis. However, it is hoped that if the reader so desired, they could trace a comment back to the original source. This is not to say they will agree with the interpretation placed on it. These are mine and the emphasis placed on events may not be shared. However, it is hoped that the claims have veracity that can be substantiated without limiting the data used. The appendices add substantially to peripheral details that substantiate and illuminate any statements made in the text.

Having examined the national and personal contexts surrounded the research and outlined the research process it is important to consider the conceptual background to science education. An understanding of the various schooling mechanism generated by the national context gives a much needed historical and philosophical basis for the study before moving onto the more detailed ideas outline in the research concepts themselves.

Chapter 2
CONCEPTUAL BACKGROUND

This section describes briefly apexes of the history of science education and explores my personal experiences in the subject. The ideological stance held at the beginning of this study is then described. This is a statement of belief about the subject together with pedagogical issues. It also explores the concepts surrounding parental involvement in education. It traces the phenomenon of public understanding of science and how this relates directly to education.

2.1 Science: A Natural Activity?

We often think of science as being central to our progression as a species. Many of our greatest achievements have been linked to grand scientific minds and have been the key to our success. Indeed it has been lauded as the basis of human knowledge.

"Science is the best way to understand the world." Wolpert 1997:9

The idea that it is value -free, accessible to all and the simplest and most elegant way to express ideas about the world is a perennial view of Western science, along with its capacity to find the 'truth'.

I would maintain that the roots of science are in each individual and are an essential part of being human and are not in the 'unnatural science' of popular science writing. It is the social construction of science that has removed it from the sphere of public knowledge into the private, elitist domain and it is this that has caused public misconceptions about the nature of science. However, I will later argue, on the basis of this research that the misconceptions about the nature of science reside in the scientific community as strongly as the laity and there is a mis-match between what the scientific community think the misconceptions are and what they actually appear to be.

Science as a primary school subject aims to foster the skill and attitudes associated with one particular view of the nature of science. The subject has been the focus of many debates. Identified below are some of the significant features in its development.

2.2 The School Subject of Science: Significant Points.

The introduction of science into the curriculum (DES 1988)[2] formalised the role of science in primary schools. However, the subject has a long and diverse history. Traditionally combined with maths and technology, the affirmation of the educational value of practical science came as early as the 1880's. During the industrial and economic change of this time the role of elementary education was also in debate (Gregg 1965). It challenged the traditional elite subjects such as literature and arts for intellectual supremacy as it became separate from the 'technological' education and less linked with practical solutions for human problems; more of an intellectual endeavour.

In the socialist climate of the 1880's and the reform act of 1884 the working man was a vote to be courted. So education for the masses became a focus for political agendas (Lawson and Silver ibid.) and the changing approaches to education heralded a new interest in studying the child. The scientific method of teaching; the 'Montessori' method gave new foundations to teaching (Manzer 1980). Technical subjects and science not only found a place in school but were the focus of new thinking about education.

The economic pressures of the 1940's produced another shift in the profile of science education. Despite resistance to the expansion of University science, the number of graduate scientists being produced trebled in the fifteen years after the end of the Second World War. In the late 1960's a second close look at science in schools was taken and the 1965 Dainton Committee suggested there had been a swing away from science at a secondary level.

At the end of the decade, the Royal society, and other research foundations to investigating possible improvements in the teaching of science at all levels gave more support. In the late 1960's there were many debates over the amount of uniformity needed within the curriculum, as the 1944 Act had made only religious education compulsory. With the introduction of the National Curriculum Science became a 'core subject' that schools were legally obliged to teach in state schools.

2.3 Science Education at Primary Level.

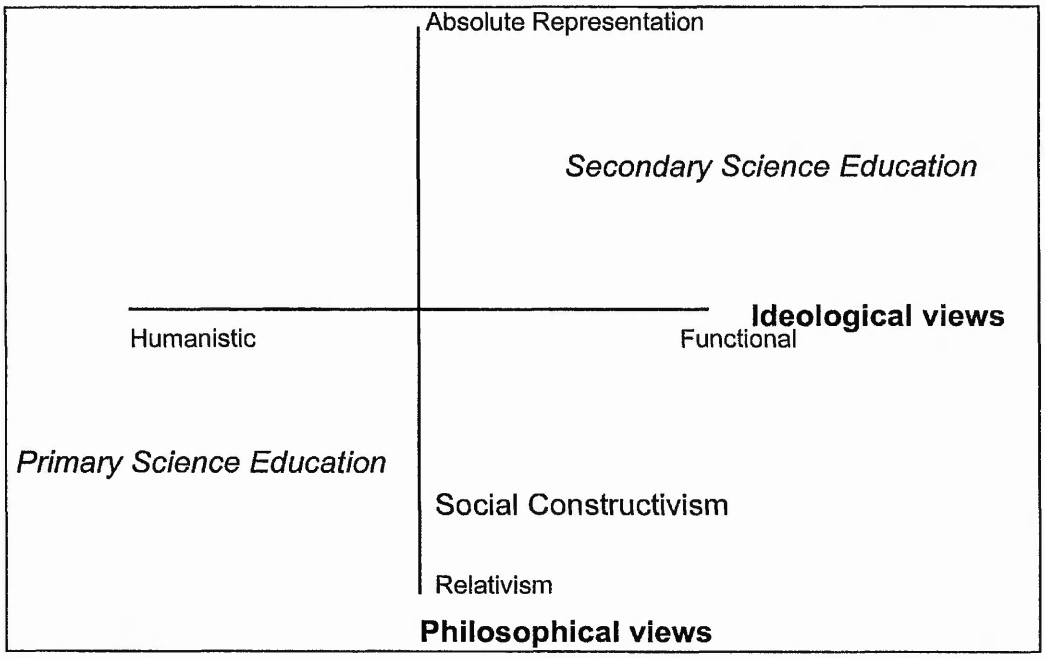
The pedagogical foundation of science in primary school seems to be based on an idealised view of science, concentrating on ways of thinking rather than subject knowledge. It also links science with everyday living and does not divide it into disciplines.

Looking at secondary science teaching the recent (1992) move toward integrated science still hasn't broken down disciplinary boundaries and discreet subjects are taught that are knowledge and skills based. Pedagogical argument often polarises ideological positions e.g. for or against science teaching in primary schools- regardless of internal organisational characteristics of the school or family and advocates one particular view. This is a simplistic view. Many people would recognise the benefits of middle views or entirely alternative views. I would suggest that if

---

[2] This Act is chosen as the legal starting point of numeracy and literacy strategies embodied by the national curriculum.

views of science could be expressed along a continuum from a relativistic, social constructionist view to a radical positivist view then primary and secondary science education would be in opposing quadrants of this chart.



1. Graphic Representation of Positioning of Primary and Secondary Education with regard to Philosophy and Ideology.[3]

The distinction between philosophy and ideology is perhaps not abundantly clear on first inspection. I would argue that philosophical views are based on epistemological views rather than political ideals. To expand, within this illustration I have suggested that it is possible to share the view that knowledge is value laden with the ideology that education is also vocational. These positions are potentially unlikely to be combined but as an illustration serve this purpose. An individual's philosophy should encompass their idea of how reality is ordered whereas an ideology encompasses their ideas and beliefs of how reality should be developed or pursued. Bruner (1990) identifies this type of dichotomy as a continuum. He argued that the focus of scientific inquiry has shifted from product to process and rather than a single truth, inquiry focuses on a number of possible worlds. This links with the idea of a shift in focus from primary to secondary school, a narrowing of focus from many possible worlds to one 'scientifically correct' world. Bruner also suggests that children should be encouraged to act a 'social scientists' making use inquiry about their world, which compliments ideas about constructivism in primary science education.

Perhaps it has been the former that has been to the fore in primary education with aesthetics also emphasised but this has faded ironically since the introduction of science as a specific subject within the primary curriculum. Before this primary science was treated as a special case much like

[3] This graphic is presented as a visual representation of an idea. It is not intended that Ideology and Philosophy should be presented as a diametrically opposed, however the use of the axes do not suggest the overlap and grading that is very much in the spirit of this study.

primary art. Comparison to external points of reference was moot, as there is a special quality to the activities that were designed to promote awe and wonder at the natural world rather than reductionist attempts to express this elegantly. The notion of science as cross-curricular was a strength within the primary context as many teachers worked in this way.

2.4 The Tension between Science and Science Education.

Science education is not a simple lead into scientific knowledge. The natural sciences search for universal truths, seek to reduce the complexities of nature through strict observation and objectivity. There is a prevailing dominance of science in academia induced by the power of scientific research to generate money and the intellectual credibility that is produced when people claim to know the truth of a matter. Because there is this dominance in and out of formal education establishments it influences how education is understood and practised. But education seeks to improve knowledge, value all types of knowledge and removes distortions caused by power distributions. To quote from Foucault (1980), "power is knowledge" and in a pluralist society science education seeks to provide children with both knowledge and the epistemology of that knowledge.

A theory of difference is required and Bauman (1994) suggests that post-modernism has that element of emancipatory power within it. He argues that because it is "exceedingly anxiety prone" that it has a chance at providing a celebration of diversity and contingency, without the uniformity demanded by modernism. The drive for public understanding of science is torn, as the science institutions strive to increase the 'public' knowledge about science without changing the established hierarchy. In this circumstance, public knowledge would include the latest technological developments or discovery. Education seeks to inform the public of the more 'private' knowledge of science; where it has developed from, what are the problems with it and what alternative paradigms there are.

The tension between science and science education is seen more clearly here as education moves leaving no intellectual detritus. As thinking in society shifts, education reflects this with changing views of people in society. Science is unlike this in that it is an accumulation of a body of facts and this has slowed science education down when following other subjects. As education moves into post-modern interpretations of knowledge, science education battles with its subject matter. It is difficult to teach a subject that, since the national curriculum, has become more and more about learning facts whilst claiming there is no single foundational knowledge, which is true for everyone. It is impossible for science education to work within the narrow paradigms in traditional academic boundaries, as it is education and a fast moving field. Science works on an epistemology founded in Descartes (1968) and Kant (1933). It is an epistemology founded on a quest for certainty and includes no reference to politics or power.

Post modernists such as Lyotard (1984), Derrida (1967) and Foucault (1980) challenge the supposed neutrality of this traditional epistemology by arguing that the fundamental categories of 'truth' and 'knowledge' were not only irreducibly complex and ambiguous but saturated with politics. Science education has simultaneously tried to embrace both science and education but as education is an inherently political, ideological activity this is becoming more and more awkward.

The difference has been emphasised particularly to the scientific community through the research on the public understanding of science. Turney's (1997) finding that an increase in scientific knowledge does not always lead to acceptance of science is a surprise to no one but scientists. Education for some while has argued that "understanding' invariably goes beyond facts and figures and includes evaluative judgements. The difficulty is this: You cannot teach children science in a way that embraces post-modern ideals without teaching them about science. This has been uneasy partly because it is unclear how much common ground there is between science and science education and also because the partnership is not one of equals.

The constructivist view of science education is a more open view of science moving toward post-modern principles. This approach, which Edmondson and Novak (1993) call constructivist "posits a view of knowledge as a construction based on previous knowledge that continually evolves and does not exist independently of human experience". Constructivist science allows the teacher to present the children with the opportunity to address larger questions regarding the nature and permanence of truth, the role and origins of theories, and the dominance of scientific knowledge with other forms of knowing, such as feminist and post-modern theory.

Work by Solomon et al (1994) suggested including more historical matter in science courses to embed discoveries in the context and thus show new ideas about the nature of scientific knowledge to young children. I would argue this approach is intensely problematic as it replicates the value system embedded within science discourse. Science stories are generally idealised and are mainly based in European, white male discourse. It is not challenging the Vienna Circle and Marxist power structures in which the white, middle-class male holds economic power and scientist hold knowledge-power. The master narrative reflected in this approach to science education is not truly moving away from modernism or the enlightenment paradigm. This could be a sort of Post-modern fragmentation (Harding 1991) that proposes a standpoint epistemology in which it is argued that the subjectivity of the individual is integral to their work.

To conclude we all work within a post-modern, media ridden society, that is superficial yet highly political. The tension between science and science education is not one that can be resolved or should be resolved. In unresolved tension there is much thinking and surely this is what both science and science education should be about. To be post-modern is not to be different but to look at things differently. It is easy to argue that to take a post modern view of science would lead to anarchy in the child's education yet is too easy to stagnate in a modernist framework. In true post modernist fashion we cannot do anything to resolve the situation but neither can we do nothing. It resists closure in a way that the natural sciences never do and so will be a perpetual challenge to our thinking.

Having looked at these tensions between science and science education and how these are articulated in the British school system, we can now examine how the government has dealt with science education and the involvement of parents. The curriculum is of paramount importance with home-school projects also considered.

2.5 The National Curriculum.

One of the most influential decisions to date about science education was made in the context of governmental dissatisfaction with the education system. It was in 1985 that the conservative government made clear its particular interest in science when the DES published Science 5-16 which began " *Science should have a place in the education of all pupils of compulsory school age, whether or not they are likely to go on to follow a career in science or technology*"(DES 1985,p1). This was the first policy document to be published covering a curriculum area and the choice of science indicated the priority attached to it.

The Secretary of State for Education at that time, Keith Joseph, made the decision to implement a National Curriculum that was to include science as a core subject at primary level. Before this primary science had been carried out on rather an ad hoc basis. Leading up to the national curriculum there had however, been improvements in science education considering in 1978 the HMI report stated that *"few primary schools...have effective programmes for teaching science."* and *"The work in observational and experimental science was less well matched to children's capabilities than work in any other area of the curriculum".*

Several national initiatives were set up in the later years of the 1980's. The Learning through Science project that had grown out of the Science 5-13 project produced supporting books for science teaching. The Assessment and Performance Unit improved general awareness of good primary science practice and by 1986 the education support grant system had provided almost all LEA's in Britain with advisory teachers. In 1986 the Association for Science Education started the Primary Science Review Journal. Despite these advances an HMI report for the DES and Welsh Office found that there was 'still a lack of confidence' (DES 1988:3) in teaching science in primary schools.

The Secretary of State for Education (1987) announced the setting up of the Working Group under Jeff Thompson including popular choices such as Wynne Harlen (Chair of the primary group) and Ros Driver. It was generally agreed that primary science should not be a watered down version of secondary science. The Working Group took a constructivist view of primary science, which was supported by the scientific community in general (Driver and Oldham 1986). The general tenets of constructivist teaching are that existing ideas are elicited, tested and challenged through classroom activity and then the learner is given opportunities to reconstruct and articulate the ideas and concepts. The interim report produced in July 1987 and was based on existing good practice. It called for a "*holistic development of skills and ideas in a way that is enhanced by development of positive attitudes to learning*" (Working Group 1987:8). However, it was criticised for having practical elements based too much within the secondary paradigm that contradicted its basic theory. In August 1988 the final report was produced and was generally greeted as an excellent overview of science education.

Kenneth Baker however, the then Secretary of State for Education wanted a more knowledge based curriculum that met with opposition from those actually involved in the education system. The National Curriculum Council consultation report produced in December 1988 bore a frightening resemblance to the curriculum as envisaged by Baker and thus left many teachers feeling cynical about the consultation process and opposed to the curriculum.

2.6 Parental involvement in Education.

The role of parents in education has changed significantly with the introduction of the national curriculum. Before this the 1944 Education Act stated that children should be educated 'in accordance to the wishes of the parents', but otherwise it was not made explicit what the relationship between schools and parents should be. As Local Education Authorities provided education as a service to the community, as they had done since 1902, school places and finances were allocated over the district as a whole. The LEA's would also draw up individual syllabuses to cater for their area. Parents would send their child to the school whose catchment area included their home unless for religious or special needs reasons the child was allocated a place at another school. Parents did not figure in education other than as a support for the school (Chitty 1992) and were the passive recipient of this service (Jessop 1994). The Plowden report was an attempt to change this situation, and was part of several such initiatives (Deem et al 1995).

Parental involvement in their children's education particularly when under achievement is likely, appears to be unquestioned as valuable. Merttens (1993) describes it as 'a flag we salute whenever it is hoisted'. Attention began to be given to parental influence when attention was focused on the child's learning, and can possibly be traced back to the 1970's (Tizard et al. 1981).

Parents began to be involved more fully in their child's education with the start of a modernist interest in the child's learning process (Tizard et al 1981). In the 1970's the Plowden report said it was good practice to involve parents and there was a lot of interest in working class parents[4] (Baron 1989). However, as teachers have a professional claim to knowledge they have a command over the partnership. This deficit model of parenting made school- home partnerships become a way of co-opting parental support for the school. The Taylor report of 1977 that called for parents to be involved in all governing bodies in schools gave rise to a series of parental groups that supported the school through fund raisers. In the main parents were perceived as passive recipients rather than active in creating partnership policies, and working class parents as problems to be overcome by teacher professionalism.

The restructuring of the education system in the 1980's and 90's with the repositioning of parents as consumers was to break the monopoly of the LEA's and provide parents with more choice. However this expansion of choice was only apparent to those parents who had the ability to access the resources and this is determined by social position.

The rhetoric concerning partnership in schools has now more recently given way to more controlling discourse. Once a parent has exercised their choice in selecting a suitable school for their child they are expected to support the schools policy and the school largely determines what level of control the parents have to aspects of their children's education. The Parents charter (DfEE 1991:1994 pp25-26) for examples suggests that once the school choice has been made the parents should offer support through ensuring their child's discipline and attendance. Parents

[4] The work of the 1930's Home School Council for example and other state professionals who have given advice on the 'correct' way of parenting.

involved in the governance of schools find themselves in new managerialism (Ball and Vincent 1996) and are integrated into a governing body rather than representing a specialist interest group (Deem 1989).

The resurgence of controlling discourse in home school liaison has been fuelled by various moral panics (Cohen 1980) involving discipline in schools[5]. Home-school contracts have become a guarantor of children's behaviour and greater parent accountability (Bastiani 1993). This is not necessarily without the parent's consent. Home-school agreements are also based in the rhetoric of partnership; formulated by consultation and consensus of the parents who *are already involved in school governance.* Vincent and Tomlinson (1997) go further by suggesting home-school contracts herald a return to discourse promoting 'good' parenting as outlined by people in power but also tacitly supported by the parents. Parent choice, once the school itself has been chosen, is often expressed by the removal of their child rather than interaction with the school. Further, some teachers have welcomed the home-school contract as a way of restoring the perceived erosion of parent's respect for teachers. David Hart of the National Association of Head teachers (NAHT 1990; as quoted by Vincent and Tomlinson 1997) suggested that the introduction of home school contracts would

> *"reinforce the position of the head and staff in hearing before governors, local authorities or independent appeals panels in cases where pupils are being permanently excluded...No parent has anything to fear from signing it* - ***Only parents who want to be difficult.***" (emphasis as given by Vincent and Tomlinson).

With the introduction of the national curriculum, parents were reconceptualised as consumers of education and the LEAs portrayed as monopolies in a market economy. This emphasis on market forces was seen as potentially damaging by many educationalists and inappropriate for education. (Wragg 1988). Parents were interested in education in their role as consumer with a private interest in getting the best possible. Ideas of education for social reform or improvement of the Nation were largely abandoned. Only the superficial ideas of partnership have been retained (Vincent 1996).

Not only have parents been reconceptualised as consumers but also they have been given a further role as 'monitors' of their child's school. This can be traced back to the Taylor report of 1977, which recommended parental participation on school governing bodies, seeing parents a legitimate interest group in the management of schools. The accountability of schools through performance league tables was intended to allow parents to make educated decisions about their child's school choice. However, it has also given parents the role of 'policing' school standards in direct comparison to other schools and so identifies whether they are getting 'value'. Parents are encouraged to sit on governing bodies of schools, to have a say in the setting of individual curricula and budgets. This may give an illusion of parental involvement in the running of schools that is not apparent in reality. Deem et al (1995) found that parents on governing bodies did not feel they had a right to express their views unless they had directly relevant experience such as running or managing a business. As I shall discuss later, and has been shown by this research, the

---

[5] For example:The Ridings Secondary School in Yorkshire, the assault of Philip Lawrence and the discipline problems in Kirklees Secondary School all in the media during 1996.

awareness of the business model within school management has made parents wary of the introduction of business-school links despite encouragement for this sort of contact from governments.

As mentioned before, in school the idea of parents as partners still dominates despite the move toward consumerism. The ideas of partnership have been criticised widely (for summary see Vincent and Tomlinson 1997) mainly because they have failed to recognise the power structures within such a relationship. The school has a position of power because of its location within an institution but also because of its professional knowledge. The involvement of parents in a school is a way of guaranteeing their support and controlling this participation. The parents are introduced to the school's way of working and included subsequently if they continue to support this.

The 'Let's investigate' Science workshops featured in this research were designed for the convenience of schools for the edification of parents. It was in danger of adding to the controlling discourse and treating parents as insufficient. It was also funded by the Royal Societies Committee on the Public Understanding of Science so could be accused of working purely on the promotion of science and science education.

Of the two charges the latter is more easily dismissed. As will be discussed later the workshop was working within the educational view of science and therefore more concerned with making sure the issues involved with science were open for discussion. It was also keen to expose the nature of science and the pragmatic nature of some 'unscientific' thinking for example the idea that heavier things fall faster than light things. This is incorrect because gravity acts with equal force on all things but because it is not open to direct observation during everyday living it is widely misunderstood. It is air resistance that causes the variation in falling speeds and it is often light objects that are more affected by air resistance giving the illusion of substance to the claim. However, it is not an unpragmatic rule of thumb and it is perfectly possible to make correct predictions from this rule in a majority of cases.

The charge of adding to the 'deficit' model of parenting is more difficult to dismiss. The workshop was created to address the difficulty of stereotypical images attached to science and the problems this causes recruiting science students. Apart from the media the other source of information about science is parents and so it was to parents that the workshop was aimed. Within the workshop it was not thought that parents were not providing their children with stimulating scientific engagement at home but rather they were failing to identify these as science, and maybe had only a vague idea about what science in the primary classroom was. Therefore the workshop attempted to identify the broad nature of science, give examples of good primary science practice and allow parents to experience these. So the workshop didn't aim to 'inform' the parents and show them how to encourage their children in science, but open science in the primary classroom up for discussion and raise awareness of the science learning that already goes on in the home.

2.7 Home-School Projects.

The influence and importance of the home context on learning has been recognised for many years. The socio-economic background of the child is the largest predictor of school achievement (Clark 1987, Ballentine and Henderson 1987) but does not take into account individual variation. Support at home makes a difference too. As children spend over half their waking time outside school (Rutter 1979, Bastiani 1995) educationalists have made attempts to involve parents to a greater level in their child's education. National and local projects within this sphere have produced a considerable amount of evidence in support of home-school co-operation (Topping and Wolfendale 1985, Solomon and Lee 1991).

To concentrate on some modern initiatives School-Home Investigations in Primary Science (SHIPS), directed by Joan Solomon (1993) has provided parents with science material to work through with their children at home, that links in with school work. Maths and English have also had initiatives of this kind (Mertten and Vass 1990, Tizard et al. 1982). The most work in this area has been done in literacy and the National Foundation for Educational Research produced an evaluation of the Basic skills agency programmes aimed at increasing literacy in families. It was found to be a "great success." (Brooks et al: 1996). Most parental involvement programmes work by increasing motivation in children, understanding of both the material and the teaching methods in parents and enthusiasm in both parties. The ideas can include special events (Family Learning), an accreditation programme (Family Literacy), take home tasks (Impact maths) or shared reading diaries. The general level of contact and involvement in school is increased and also the purposeful contact time between parent and child. Research by Houston (1995) found that parents associated increased contact with teachers as one of the attributes of good teaching or good schools and so parental involvement gave teachers an image boost as well. It is interesting to note that primary teachers were generally considered more accessible than secondary teachers and thus were considered 'better' teachers overall.

Criticisms have been levelled at the parental involvement movement, which acknowledge its generally positive affects on child learning but draw attention to the lack of consideration being given to gender. The main thrust of the argument is that parenting in this country is gendered with the women taking the main caring role especially in the primary school where often these initiatives are aimed. Maclachlan (1996) suggests that because parental involvement in schools is so common place (David 1993, Wolfendale 1992) that pragmatic considerations by the school dominate much of the debate at the expense of ideology and equality. Walkerdine and Lucey (1989) present a feminist critique of parental involvement projects and state that the role of the mother has extended to make housework integral to such projects. This has happened by parental involvement initiatives suggesting that parents (mothers) turn household activities into learning opportunities or further, that the grounding for a good education comes from the child's experience of household activities. The arrangement of school home liaison opportunities is also timed so that mothers who have arranged themselves so that their child is the priority, at the convenience of the school are rewarded and affirmed by participation in activities. The mothers who have not arranged their lives to suit school hours are given negative feed back through not be able to attend and thus feel like inadequate parents. Within this research the dominance of women attending the science workshop can be seen and the issues surrounding this debate are explored (See Section 4.4 and 4.5).

Despite the emphasis placed on science within the National Curriculum, science and science education is harder to sell to parents than the other core subjects of English and Maths. The reasons for this lack of enthusiasm for science are explored later in this research, but there have been numerous attempts to encourage more active participation in science by the public. These efforts have been aimed at an encouraging more young people to take up science as a subject specialism for A' level and degrees. The next section outlines some of these.

2.8 The Public Understanding of Science.

Over the last ten years more and more people from varying scientific disciplines have been spending their time and money on contributing to the public understanding of science. The most eminent of these in the UK is the Committee on the Public Understanding of Science (COPUS) of the Royal Society, British Association for the Advancement of Science and the Royal Institution. They fund and run numerous science events around the country the most prominent of these being Science, engineering and technology week held every March since 1988. The Bodmer Report in 1985 marked the beginning of the Royal Society interest in the public understanding of science. This was particularly significant, as it was the first time this century that the UK's national academy and learned society for science formally recognised its responsibility for involving the wider public in the pursuit of scientific progress. The promotion of the public understanding of science received a boost in 1995 when the governmental White paper on science placed an emphasis on its importance.

At this juncture it is appropriate to deconstruct the use of the word 'public' within the phrase 'public understanding of science' and contemplate the antithesis of its meaning; private. As the focus for this study is a particular section of the general public, discussion here will focus mainly on concepts of public and private that relate to the forms within this study. The public that is having its understanding of science enhanced appears to be unfocused. As attitude to science is a nebulous idea the targeting of public understanding has been diffuse[6]. The idea appears to be that those who are not involved with science in a work related context express ambivalence to the forms of science they are currently allowed to access, such as science through the media and education. I would suggest this could be thought of as the 'public' face of science. In other words, the public is not interested in publicly accessible science. The 'private' view of science is the science of commerce and politics. Science research is expected, as a body of professionals, to exert some form of moral control over working practice that should be beyond commercial demands. However, though this is desirable, to imagine science research and development to be above the market place could be considered naive. A commercially driven scientific community is not science fiction but economic reality; and as this science knowledge has a commercial value it is knowledge that is bought and sold and 'owned'. It is private science.

The emphasis within the public understanding of science has also fallen generally on increasing factual understanding rather than exploring issues in science. Basically it has been aimed at affording groups who would not traditionally come into contact with scientific experiments of any level, the opportunity to 'have a go'. These groups would be women or girls (where it is perceived

[6] There has been criticism of this approach: see section 6.6.

that boys dominate such activities in a school environment). The premise appears to have been that if these people are allowed to feel that they have successfully participated in a scientific experiment they will have a greater acceptance of higher level commercial and research science. It could be suggested that this is naive. Those who have limited science experience are not in any lacking in intelligence! They can see that 'real' scientists are not giving them insight into commercial research, what I have termed here 'private science'. Thus the efficacy of this approach is severely diluted.

Scientists are rarely portrayed as working commercially through this comprises the majority of their working environments. Not only this but the scientists that are most often available to the public are those already involved in publicly funded endeavour; University lecturers, National Health Service doctors, Government officers and so on. So not only are most scientists in the media shown as altruistic, their public face is indeed involved in publicly funded work and are in some respects are used to communicating with the public and are prepared to be held accountable ethically and financially.

So the public understanding of science is a limited concept if the movement continues to use the same pathways of communication traditionally open to it. 'More of the same' appears to be the rallying cry for the engagement of the public enlightenment. For this work it is almost an amusing conceit to be working from within a set of ideas that it ideologically opposed. However, as will argued later, it is these unresolved tensions that are perpetual challenges to our thinking and writing.

The conceptual background to this study has been outlined in terms of science, science education and the various public bodies and schemes that have been generated around these topics. The whole of this study is embedded within this context and the research concepts themselves overlay this and provide a lead into the discussion of the more complex issues of research methodology. Thus what follows is a simple description of research concepts, how they are generated and operationalised.

Chapter 3
RESEARCH CONCEPTS

3.1 Grounded Theory.

One of the important principles of qualitative research is that it is 'grounded' in interviews, observation, and other textual material. This is often associated with the qualitative methodology proposed by Glaser and Strauss (1967). This 'grounded theory' is linked epistemologically with qualitative research through considerations of the subjective and objective and the wider debate about human inquiry and the social construction of scientific knowledge (see Denzin and Lincoln 1994). In much the same way that quantification is an essential condition for quantitative research so understanding is for qualitative research and thus it tends to assume knowledge is generated within networks of social activities. As such the research is more sensitive to multiple interpretations of human behaviour and socially constituted meanings (Lincoln and Guba 1985).

3.1.1 The Choice of Grounded Research.

It has been suggested (Bryman 1988) that there may be two main reasons for choosing a grounded theory approach to research. The first is that technically, the research lends itself to the use of qualitative techniques. Some research requires questionnaires, experiments and other structured methods, such as this research require analysis of unstructured, non-numeric material such as interviewing and observation. The other reason for choosing grounded theory is epistemological. If meaning is socially constructed then the quantitative paradigm, which seeks to establish universal laws and absolute values is essentially flawed by the search for objective knowledge.

This research involves talking and listening to people and observing their interactions with activities. It is examining opinion; life-stores, emotion and other 'organic' phenomena that I would argue cannot be measured numerically. I would suggest that the attempts in this direction have been misguided and in some cases have clouded issues further, especially those involving attitude. I feel to impose numerical values on such rich and complex data would conceal more than it would reveal and be of little or no practical value, even for the purposes of discussion as it would mirror many other empirical studies. So even from purely pragmatic reasons a choice of grounded theory seems to be logical as it is tailored to handling complex unstructured material. It is ideally suited to narrative cognitions as the cyclical nature of data gathering echoes the cyclical and reflexive view of narrative recollection.

However, from an ethical point of view, it is also imperative. This research attempts to portray various views of science in an open manner. To impose a structure on this, to represent ideas about science in a scientific manner would run contrary to my ideas about fidelity and justice. A further rationale developing from these two is that this methodological stance, using narrative and a social constructionist view of self-concept to explore attitude development will go some way to my claim to knowledge for this research.

3.1.2 What is Grounded Theory?

Within the phrase 'grounded theory' there are two meanings. The first is that the research is 'grounded' in the work. No theory is imposed from the outside for the research to test. Theory is grounded in the experiences, accounts and contexts of the research. Theory emerges from it, is tested by it and expressed within its contexts. Thus it is theory building, rather than the confirmation of 'a priori' theory. Within this study, the newness of the theory generates an organic and continuing feel to the research.

The second meaning is as a method. It is a set of techniques for use with any form of unstructured material and a specific set of analytic strategies. Glaser and Strauss (ibid.) suggest that researchers should engage in close inspection of their material and look to extend and test it using theoretical sampling, but they suggest the techniques are aids to research not prescriptive methods to be followed rigidly. The method has been used and adapted by a number of researchers (Rennie et al 1988, Strauss and Corbin 1990). There are a number of qualitative handling techniques common to these and most grounded theory research. These include the generation of low-level categories, creating definitions and linkages between these categories and testing and contrasting any ideas through theoretical sampling. This process is quite rigorous and produces dense conceptual representation. The sampling allows a focus on key events to theoretically test any work building from them but also rigorously explore the research findings and the structure for development of attitude proposed in this study.

For this research however, the generation of a complete grounded theory is somewhat ambitious due to the complex nature of the area. Grounded theory however does allow more modest research achievements to be contemplated and it is those that suit the beginning nature of this study. Firstly it allows a development of basic taxonomies and these can be developed conceptually and fully explored. These categories can also be used for further analysis of the data. Glaser and Strauss use the word 'saturated' to describe the full exploration, which results in depth of vision. Secondly the exploration of negative examples and cyclical analysis and data collection should allow a greater theoretical scope for the study. It should also allow the method to become more developed as the research progresses. Though that sounds unbecoming to PhD level research for a field researcher method must emerge from contingency, strategic decisions, instrumental actions and so on. It is necessary to grounded theory to refashion the design in this way and can be used to illustrate the development of the research. It would be less honest to have a pre-formed view of methodology before entering the research. Undoubtedly all research plans are changed and developed as flaws and problems are discovered and a static research plan would hide the dynamism and responsiveness of the design to this difficulties. It also reflects the refining nature of narrative and how it changes with different focuses of the narrator.

3.1.3 Problems with Grounded Theory.

The most fundamental problem to grounded theory is the issue of the actual grounding. Theory cannot emerge from data without some interpreting agent and that agent is the researcher. Therefore it is imperative that the researcher becomes recognised as a context or influence on the study. Glaser and Strauss are aware of the problems with their work and encourage the researcher to be creative in the interpretation.

Feminist writers have explored the issues of grounding as they have an intense concern with grounding their knowledge in the participants' experiences. In other words, knowledge about women's experiences in women's worlds. The various interplays of subjectivity are also taken apart and examined, as the experiences cannot be taken at face value. It is not pure phenomenology as the meaning of social experience is always mediated. Feminist writers, for example Hollway (1989), urge the use of conscious subjectivity as a method of examining what people say but also your own interaction with them. The subjectivity involved in the tacit and declared understandings of the researcher and participant and the cultural structures (including the power dynamics) are thus laid open to view and analysis. This allows the multiple interpretations called for within the qualitative epistemology.

3.1.4 Constructionism and Grounded Theory.

By adopting a constructionist approach to grounded theory any researcher must make explicit their substantive interests and philosophical stance that provides their areas of 'sensitivity'. Charmaz (1990) identifies this as a perspective from which they seek to build their analyses. However, they should not merely apply it to the research. It adds a cautionary feel to the research process, the researcher always cautious that they are not replicating their own pre-existing perceptions. A constructionist view of grounded theory further acknowledges the multiplicity of interpretations and challenges the objectivity of research grounded in science. It is also in concordance with the theories of self utilised within this research and expounded in Section 3.4.

Within this research categories have been both generated from within the research and brought to the research from other work to widen the analysis and insight into the data. Some concepts such as learning styles and literary styles have been brought to the study to provide an interpretation of the data not based within the study. As introduced tools they have not been altered by the reflexivity of the research process, but have been related to the concepts and categories developed by this study. Other concepts such as attitude and self-identity were introduced into the study with a general orientation, for example 'social constructionist'. These ideas were altered by the reflexive process of the research and are more integral to the structure of the typologies developed by the research. They both shaped and were shaped by the research process.

For a discussion of the research concepts that were developed through analysis and used in the analysis see chapter 5.

3.2 Critical Incidents.

One practical approach to using grounded theory to examine narrative interview data is the examination of critical incidents. The use of points, or point, within a narrative as a basis to examine other structures within the narrative as well as reflecting on the nature of the critical incident itself is both reflexive and allows theory testing advocated by grounded theory.

The term 'critical incident' may be one that is familiar to many people in many lines of work. The lay-person may have an understanding of the term as its meaning is apparently explicit. However, in education, psychology and personnel management a critical incident can mean something subtly different and be used in an entirely different manner in each case. Indeed, even within these wide fields, individual disciplines may identify their own meaning for this phrase and specify the situations for use. There has been no systematic history of the use of this term and in reviewing the available literature it seems that the usage has been understandably scattered and the concept sometimes indistinct.

Within this study the concept of critical incidents (or as I will refer to them later for the purposes of distinction, key events) is of seminal importance. Common within narrative, these punctuating vignettes illustrate the motivations, decisions and other cognitive processes of the 'actor' within the story. As they are provided by the narrator for that very purpose they provide easy access and understanding. This has meant that critical incidents in various forms have been used access the thought processes of an actor within a variety of contexts and from various research paradigms. However, as the observation or retelling of a critical incident in embedded in the narrative of the event it is exceptionally well suited to social constructionist research.

Critical incidents have not been used to examine attitude previous to this study. Attitude research has generally focused on measurement (Latham 1979), prediction (Fishbein 1981) and attitude change (Festinger 1962) rather than the pathology of attitudes. Critical incidents provide an opportunity to study this neglected aspect and examine further the structures involved in attitude formation. However there must be an complete comprehension of what can be meant by 'critical incident' for without an understanding of the research technique itself, the messages of the data will surely be misinterpreted or lost. Thus it is important to firstly understand how critical incidents themselves have been conceptualised and used in previous research.

The first comprehensive use of the term found was by Flanagan in 1954. His use of 'critical incidents' came from psychological research into the activities and behaviours of pilots in the Second World War. This involved an interpretation by the individual pilots involved, of the skills and qualities needed to perform a task. This was placed along side an interpretation of the behaviours involved in the task made by an impartial observer. Flanagan suggests some of the five stages that should be used in the critical incident technique are as follows:

- Determination of the general aim of the activity.
- Development of plans and specifications for collecting factual incidents regarding the activity.
- Collection of Data
- Analysis of Data
- Interpretation and reporting of the statement of the requirements of the activity.

Here Flanagan emphasises the need for the researcher to report all biases in the report and any implications of decisions made during the course of the research. These stages are widely applicable to the use of critical incidents in job analysis and evaluation but perhaps not outside this field of study.

Flanagan defines a critical incident as "any observable human activity sufficiently complete in itself to permit inferences to be made about the person performing the act."

It may be argued, however, that this definition is open to several interpretations. 'sufficiently complete' is a vagary that could lead to many differing perceptions and perhaps has. My understanding of this term, influenced as it is by the knowledge of the context Flanagan and subsequent researchers have used the phrase 'critical incident', is that it is an exceptional incident, or an incident that involves, and thus gives an insight into, many facets of the individual (skill, thought processes, emotions, beliefs.) Such an incident could be for example, a natural disaster or an event that has become a moment of revelation. Questions may also be asked about what may constitute an 'activity'. Can any action that fulfils Flanagan's criteria be discreet and understandable viewed from outside its context? I would also argue that as verbal reports from the individual are treated as a legitimate source of data why should 'observable activity ' form one of the criteria. Internal incidents caused by cognitive development could also be the subject of verbal report which behavioural verification of affects taken by the observer after the event.

Flanagan mentions that there are several applications for the critical incident technique and it may be that not all stem directly from his work but are parallel developments. Among those listed are job design and ergonomics, measures of proficiency and training, and counselling and psychotherapy. I propose to examine three pathways that stem from this initial use of critical incidents. These will follow along the lines of the before mentioned topics. It is possible, in fact very likely, that there are other pathways and completely divergent uses of this term, but with this selection I hope to cover the majority of areas that could be relevant to education and the educational definitions of critical incident.

3.2.1 Job Analysis.

Job Analysis is one particular area of interest that has its roots in the work performed by Flanagan. In Flanagan's research he gained a list of qualities and skills that the pilots themselves deemed necessary for performing tasks that were essential to the job. It seems then an obvious step to take this list and apply it as criteria for future selection. In jobs where it is difficult to name specific skills and qualities of the individual due to the diffuse nature of the tasks performed in that role this seems and ideal way to select. Job analysis has been widely reported in research, the majority being carried out in the 1980's, possibly linked to the economic climate of that decade and the rise

of management and middle management, (Aamodt et al 1981). It can also act as a way to assess what training is required, in what areas the individual is lacking. Mc Gurk (1994) used critical incidents in this way to analyse job training needs in police detectives.

Within this study the ideas of certain competencies being judged appears in the discussion of boundaries Section 5.8. However, this is slightly different in that the competencies that must be displayed in job analysis have predetermined criteria. That is, they are not socially constructed criteria but skills based. The correct procedure must be carried out and certain files kept and the focus is on professional competencies rather than useful personal skills.

So it can be seen here that critical incidents are viewed as moments in time that, when analysed, will reveal all the competencies required in a job. The incidents occur naturally within the job situation and the working individual and an observer, who is in some way impartial, make the reports.

3.2.2 Training and Assessment.

As a broadly qualitative means of assessing job performance and training needs it is popular among the caring professions where there is no measurable product and any assessment would be largely subjective. The critical incident technique is used to pull apart the vital functions of the individual at work and analyse what is required in behavioural terms as well as the more explicit skills and knowledge (Latham et al (1979), Sigston and Stratford (1994)).

This introduces the second theme, that of training and assessment. Critical incidents that occur naturally during everyday work for carers, such as counsellors and nurses can be used in a variety of ways. For example in assessment of nurses an incident may occur during a period of observation that requires all the faculties, skills and knowledge that the nurse has, to ensure the patient receives the best possible treatment. The nurse will be assessed on the way they deal with the situation. In this way it is a 'critical incident'.

To take this theme of assessment further, the assessor to judge the competencies of the assessee has manufactured critical incidents. This stems from job analysis as criteria of judgement and incident is used to produce a 'display' of competency. This is then taken further to use 'manufactured' critical incidents as management training exercises and onto T-groups and the genre of psychodynamics to produce an impact on behaviours that are not directly skills related, such as team cohesion (Cohen and Smith (1976)). Such an incident would be a ' T-group', paint balling expedition or outward bound course.

Critical incidents occurring within counselling are very popular means of development and training. The counsellor is trained to recognise important points for the client and themselves and talked through difficult times in the session with a supervisor to analyse their reaction, the reaction of their clients and how they could improve their techniques. Guttman (1973) who studied the reduction of defensive behaviour in counsellors carried out such a study.[7]

---

[7]This research acknowledges the 'therapeutic' nature of talking through key events. See also Section 3.3.4.

3.2.3 Affective Learning.

Along this theme Jung has described critical incidents as an opportunity for affective learning. Affective here could best be interpreted as emotional and this point is quite important as it sums up an idea about critical incidents on which several definitions rest. It is that critical incidents have more than just a cognitive effect on those experiencing them. (Weiner, Russell and Lerman (1979)) The incident may make you more aware of your deficiencies and skills but it may also affect you through the emotions you feel and connect with the situation. Not only do you learn through the experience but also you learn through the feelings this experience engenders. Research in this field has mostly concentrated on perceptions of events and how this influences future behaviour (Drory and Romm (1988)). Schmelzer et al (1987) studied this in relation to the success of students at university and examined how failure in exams influences future performance. This also links with Post-Traumatic Stress Disorder where an individual learns to associate a strong emotional response with a stimulus due to a critical incident.

The discussion of critical incidents can form part of a framework to raise awareness of cultural differences and/or similarities or explore ethics (Clishner (1987) Gumaer (1982)). The incidents may be ones that have been encountered by group members, but may also be incidents that the group leader presents. Once again this links very strongly to the affective component in critical incident and this form of training is aimed at challenging prejudice and changing attitudes to other cultures, (LaLumia and Baglan (1981)).

The strong emotional component is extremely important when used in counselling. Critical moments in the client's life form the basis of a discussion with the counsellor. These are analysed and reinterpreted to help the individual work through a particular difficulty, whether connected with that event or not. Everly (1994) looked at adult onset of post traumatic stress disorder and Hymer (1984) looked at recurrent victims (see also McKenzie (1987), Kaczkowski(1984)). A more extreme form of this counselling is given in regression therapy. The subject under hypnosis will relive the traumatic events and work through them to deal with the underlying difficulties and reinterpret them in such a way as to come to terms with these past events. The counsellors involved may not use the term 'critical incident' but it seems appropriate when the impact of the event is realised.

The term 'affective learning' is particularly important when considering attitude development. The emotional component is not addressed within many learning theories and yet within the work on post traumatic stress and other counselling disciplines it is acknowledged as having a profound on cognitive schema and interpretation of events. This study seeks to expand the remit of 'critical incidents' that can result in such distressing behavioural difficulties and look more closely at how events, both positive and negative can result in affective learning and the behavioural repercussions of this.

3.2.4 Summary

Thus the definition of critical incident has split and varied from the original definition given by Flanagan. In this case what is significant is stated by the individual involved and added to by the observing party and the incident is deemed critical by the affect on the life of the individual involved. This is very close several other definitions used in the area of counselling and education. It has been removed form skill at work and has become involved with the definition of life events, still requiring all the faculties of that person to deal with them.

Critical incidents are by their nature somewhat challenging to the individual. Another method of critical incident counselling concentrates on emergency services, disaster victims and so on. This form of counselling is much as that associated with those interpreting past events and concentrates on talking through any trauma with the person in an effort to help them come to terms with the emotions and problems facing them.

At this point I feel it is important to draw together the underlying themes in all these interpretations and uses of critical incident techniques, before I move onto the use of this term in education.

Some striking points can be drawn from the wealth of literature and associated research about critical incidents. Job analysis uses critical incidents as a problem solving activity of grand proportions. The emotional aspect is reduced and used as an indication of what attitude and level of motivation are required for the job to be completed successfully. It is not the participant that decides what is critical but the employer and so I feel doubtful that these contrived critical incidents have any impact on the participant. I would argue that for an incident to be critical the event must be more than a problem to be solved using all the faculties available. It must involve an emotional and cognitive component that will produce a change in outlook on life or view of self. Even if the critical incident is presented in a problem format, it could provide this impetus as long as the response is analysed in sufficient depth to provoke rethinking and reassessment of the response. It is the significance of the incident to the person involved that renders it critical.

This last thought links the training of counsellors to the stress debriefing of traumatised emergency staff. A critical incident in this case presents a challenge to be met. It may be a challenge to your way of thinking or a challenge to your way of life but it leads to a change desirable or otherwise.

It is interesting that incidents may require analysis to become 'critical' but critical incidents that are naturally critical and unfortunately negative, require extensive counselling to reduce their critical status. To reduce a critical incident or make an incident (with potential) critical takes considerable effort.

3.2.5 Critical Incidents in Teaching.

Tripp's (1993) widely read book 'Critical incidents in Teaching' defines critical incidents as "an important changing point or turning point in a learners biography". He discusses a method for professional development in teachers that involves analysis of events in a teaching diary to identify conflicts and problems and develop good practice as he sees it. Once again, initial identification of incidents rests with the teacher themselves and I would suggest that if the teacher reports an event in the diary there must be something there they feel is significant. Tripp facilitates the analysis of the diary event to lead the teacher to question their professional practice and assess the match between values and behaviour. Thus if an incident is not seen as critical already by the teacher, it may become so through analysis. This approach to teacher training is currently (1999) under research by the Qualifications and Curriculum Authority (QCA).

Recent work by Nott and Wellington (1995) has taken a different angle on critical incidents, looking at them as a way of eliciting knowledge about the nature of science from teachers. By presenting them with a series of 'dilemma's' of the sort which may occur in the science classroom and analysing the solution offered by the teachers they take this as an indication of the teacher's views on the nature of science. I am not convinced this is the case, as though a teacher may be fully conversant with the nature of science as seen by Nott and Wellington they may not present this as the nature of the exercise is not made explicit. What they may present is a brief solution to the problem without much consideration. The incident is not critical, as it doesn't engage in further analysis to raise the significance of the presented event with the individual respondent. Research of this type seems to be of the job analysis genre and its place in using critical incident is diverse from Tripp in all ways other than the fact that they are using apparently real classroom incidents.

My own research is focusing on exploring the role of critical incidents within the development of attitude to science. I don't believe a critical incident is a problem to be solved that provides information about the participant, though this may have been the first definition. The usage has become so diffuse that I believe the term 'critical incident' should be reserved for those incidents that can be defined as critical because of the level of significance attached to it by the individual involved. This significance could be lent by involved analysis or by the sheer impact of the event itself, making it a memorable moment. In my research I have chosen to call what may be regarded as critical incidents, 'key events'. This will distinguish the events described from other definitions of critical incidents and I hope, clarify the position of the study. Where other research refers to what might be consider within this research a 'key event' by another name, that terminology will be maintained.

The element of being memorable is important. What is significant to an individual is variable and I feel that one of the ways to judge this is to explore how the individual recalls an incident and how they conceptualise their reactions to it.

This research indicates that a memorable event has an emotion attached to it and this is related to the cognitive component of self. It is something that has challenged an individual's ideas and in some way made them define themselves in relation to the event. It does not always have to have a massive impact. It can be the point of crystallisation of ideas for the individual. This comes along way from Flanagan but it retains the idea that a critical incident involves more that just feelings or thoughts but a combination of both.

3.3 Narrative Interviews; Narrative Data.

As a necessity for generating critical incidents narrative interviews must be carried out. This therefore requires a detailed look at narrative.

3.3.1 What is Narrative?

At its widest definition narrative is any type of prosaic discourse. It is a text, either written or oral that draws together a series of events and describes them temporally and gives purpose to human action. It is essentially everyday or natural linguistic expression uniquely suited to linking events together thematically and showing how they relate to an outcome.

The particular form of narrative I am most interested in for this research is narrative as a 'story'. Though this word has got some negative connotations (Polkinghorne 1995) it has become accepted practice for qualitative researchers (Josselson 1993) to use 'story' to describe an 'emplotted' narrative. This kind of narrative preserves the complexity of human action with its interrelationship of chance happenings, motivation, interpersonal and environmental contexts. Included in this type of narrative is life-history material such as biography and autobiography as well as case studies and works of fiction. As the subject matter of narrative stories is human action they are linguistic expressions of this experience of the connectedness of life (Ricoeur 1983). Bruner (1990) notes that *"People do not deal with the world event by event or with text sentence by sentence. They frame events and sentences in larger structures"* (1990: 64). For individuals this is expressed in the way they recount their life experiences, linking events and choices in their lives. The plot of their lives is linked to the idea of time being unilinear, so that the story is often contextualised retrospectively, the causality of events being known retrospectively (Freeman 1984). The significance of individual happenings is not always known until the climax[8].

Stories are not always presented in written or oral form, but can be presented through pictures, dance or film. This research gathers stories through interview and transcribes them into written form. Also the singularity of the plot is not guaranteed. There may be more than one plot through a biography as in post-modern society it must be recognised that experience is often fragmented and lacking in a single coherency.

[8]See section 3.2.3 for the therapeutic use of critical incidents and the impact of events on behaviour.

3.3.2 Knowledge in Narrative.

The knowledge contained in narrative is the knowledge of how humans understand actions, events and choices in their lives. It is fundamentally different from the knowledge promoted by Western Scientific tradition. 'True' knowledge has been held to be the province of a logical and formal type of discourse that removed the self as knower, from the discourse. A purely cognitive discourse. All other types of discourse were unfit to present clear true knowledge as it evoked emotion in efforts to move the listener along with the plot.

Bruner (1985) has challenged this duality of discourse in studies of cognitive psychology that stressed that narrative was more than emotive expression. He argued it was a legitimate form of reasoned knowing. He suggested that there were two forms of thought, paradigmatic thought and narrative thought and this inclusion of narrative modes of thinking into types of valid rationality are a significant contribution to discussion about ways of knowing. It recognises the paradigmatic and narrative types of cognition as part of the human cognitive repertoire for reasoning and finding out about the self as well as the physical world and relationships with others. As such it is grounded within human experience and thus grounded theory is an appropriate method to be grounded both theoretically in human experience and in the narratives of those experiences.

As this research is concentrating on narrative methodologically, yet looking at traditional Western science as a research subject, the types of cognition identified by Bruner bear some examination.

Paradigmatic Cognition.

This concentrates on identifying a particular instance as a part of a wider category. The category is defined by common attributes shared among its members. Once an item is categorised, cognition does not focus on what makes it different to other members of that category. For example, once a car has successfully been placed in the category of 'vehicles' the focus of attention does not rest on its colour or age. Its uniqueness is not a concern. The function of this kind of cognition is to allow people to interact with a 'new' object using knowledge gained from their last encounter. Thus I do not treat an apple as a 'new' apple each time though of course it is a unique item.

Narrative Cognition.

This focuses on human action and the understanding of human experience. Thus one experience cannot fully be substituted for another. Narrative cognition focuses on the unique. Narrative knowledge in contained in stories that *"[capture] in a special fashion the richness and the nuances of meaning in human affairs"* and *"this richness cannot be (expressed in) statement of fact or abstract propositions"* (Carter 1993:6). Narrative cognition acts as an explanatory device for understanding actions and providing analogy (but not a category for) other stories. These stories are maintained in a way that evoke emotion and empathy and provide understanding of the reason for the actions of others.

3.3.3 Narrative as a Research Method.

My choice of narrative as a research method has been influenced greatly by the epistemological questions surrounding traditional paradigmatic discourse. When examining values and ideas held about knowledge it becomes apparent that the logical scientific voice has become one divorced from the individual. According to Warman (1910) this came about largely due to the secretaries of scientists editing the writings to eliminate error and imaginative musings to make the scientists appear more intellectual than they were. I would add to this and suggest that the scientists themselves also attributed to this image through concealing errors and variation in results to make their findings more powerful, to impress others in the field (see Warman's 1910 account of Herschel for example). A discussion of the portrayal of scientists and their work can be found in the introduction.

The need to be cerebral also follows this pattern. In ancient Greek times it was frowned upon to experiment, the most prestigious scientists were mathematicians who worked solely with abstract figures. Whatever the origin of this writing style it is certainly well embedded in our culture that scientific discourse takes place outside the bounds of social determination. So where does this leave the writings of social scientists who struggle to find an accepted voice for knowledge outside the traditional bounds of conventional scientific rhetoric? It has been argued that as language shapes what is known (Vygotsky 1962), so language also shapes the identity of the user. So scientific language can disenfranchise the individual. How then to bring subjectivity back into science without distorting the actual nature of scientific knowledge?[9]

The essential dilemma is that if scientific knowledge is inextricably linked to the language it uses how can social science best find a discourse style that includes the individual voice without being forever caught in endless reflexivity or reaffirming traditional Western scientific power structures? I would agree with Emihovich (1993) that narrative offers a way of shaping meaning to reach a *"shared understanding of what is **known**."*(1993:38) (emphasis as original). From this point of shared understanding it should then be possible to go on to discuss the more academic issues of writer subjectivity. The idea of achieving shared meaning is also a defence against charges of post-modern nihilism. These charges rest in that, if there is a multitude of meanings and no correct interpretation, there is no way of achieving 'correct' reading of a text so no one interpretation is more valid than another. To achieve shared meaning it is imperative to strike a balance between the solipsistic and the sociological and consider the perspectives of life offered in narratives on gender and roles. Lyons (1990) suggests that narrative can be positioned within Foucault's (1973) 'archaeology of memory' and narratives are used as 'maps of knowledge' that are under review. Eco (1989) discusses this further. He suggests that narratives are saturated with explicit and implicit convention and by being sensitive to the deployment of these, boundaries can be found to what can be said about a text. I shall be addressing the perils of over-interpretation of text in a later section.

---

[9]See tension between science and science pedagogy in section 2.4.

My research therefore has taken on a double layered narrative approach with both the participants of the research and the researcher providing stories, narrative commentary on the issues. This should provide a personal 'voice' in the research, recognising the subjective and tentative nature of the research findings. The alternative forms of data from participants will lead to an organic generation of findings. These findings will be more contextualised and accessible due the kinds of knowledge expressed in the narrative and the narrative itself.

3.3.4 Difficulties with Narrative.

Like all research methods, narrative carries a set of problems and issues that have to be addressed particularly as it is unashamedly subjective and rejects orthodox foundational views of validity and reliability. This section attempts to deal with the issues surrounding judgement of 'good' narrative work.

Evaluating the Truth of Narrative.

Narrative has a range of definitions and includes fables, life histories, parables, autobiographies, and works of fiction to name a selection. The research inquirer is seeking to gather stories and elucidate structure, find patterns as in normal social science research, but also as a reconstruction of a person's experiences so that meanings are drawn out and a message conveyed.

Lincoln and Guba (1986) evaluate narrative both by trustworthiness and authenticity but these are largely bound to *"ethical and ideological problems"*. I would query whether these are essential for the evaluation of research even though they may be part of the researcher's agenda. However, Lincoln and Guba point out a dilemma in that the criteria set to judge narrative deal only with issues from a positivist viewpoint and neglect the context of the research. Grumet (1988) has addressed this problem in using fidelity rather than truth as the measure of stories. Truth here is conceptualised as what happened in the tale and fidelity as what the story *meant* to the individual recounting it. Fidelity is also a useful concept for the researcher as they must be faithful to the teller of the story in reproduction and intention, a sort of Kantian 'respect for persons'. They must pay attention both to the facts of the object and the subjective view of the teller.

This leads onto questions concerning the analysis of narrative data and the criterion of fidelity. The treatment of narrative data, the selection of stories and the presentation of the findings all need careful consideration as the data is being coded and recoded in the process of the inquiry.

Interpreting Narrative Data.

Narrative has a literary and a scientific side and in line with the ideas of paradigmatic and narrative cognition Polkinghorne (1993) has suggested there are two forms of interpreting narrative data. Narrative analysis is the synthesis of events into *"a story that unites and gives meaning to the data as contributors to a goal or purpose"* (1993:12). The research outcome is in storied form. Paradigmatic analysis which is more usual in qualitative research takes a narrative or a series of narratives and looks for patterns, structure, common themes and issues. These themes can either be imposed on the data from previous research or organically generated from within the data. It is to the latter type of analysis that this section shall address itself as it is this

'grounded' (Glaser and Strauss 1967) theory that this research generates. Other concepts and models are brought to the data as discussed in the section on grounded theory and further in the analysis. However, these are not imposed on the data but rather used to examine the data from a different viewpoint.

Paradigmatic analysis involves a circular movement from the data to theory and back again, each time testing theories and generating new theory, in the same way as grounded theory. Alteration occurs in each cycle until a best fit is achieved and once again this reflexivity is characteristic of grounded theory[10]. Qualitative researchers have used this technique to examine content and meaning in storied data (Mishler 1986, Sutton-Smith 1986) but also literary theorists have examined stories for form and structure. This does not preclude the use of pre-formed categories for stories such Romance, Tragedy, Comedy and Satire if they become useful but does not look for them in the data. As well as generating categories this type of analysis examines the relationships between them. For example, categories of stories may be placed along a dimension (Ruth and Ogberg 1992) or related temporally as different phases along a time-line (Gergin and Gergin 1987). The strength of this type of analysis is the capacity to generate commonalities between stories, find links and associations that illuminate meaning and structure. As it is a general knowledge it is more easily applied to stories outside of the research inquiry but by this necessity underplays the uniqueness of the stories that go into the analysis. This caveat can be addressed partially by identifying 'other' stories as similar to those in the categories rather than as that type. This provides a shift in focus away from stereotyping and toward the examination of differences.

The notion of fidelity itself provides some guidelines to interpretation of narrative that have been discussed in other areas. As I have mentioned before there are limits to what can be said about a text and Eco (1989) makes this point. He states that over interpretation of the text begins when the interpreter errs by deconstructing the storyteller's world knowledge by imposing the interpreters own world knowledge or ignoring the storytellers' intentions. For example in examining stories the interpreter may believe that a moral is being conveyed but in actuality the intention was to amuse. Tripp (1994) cautions against the use of narrative because of problems with truth and over-interpretation and presses for the use of critical incidents to work out geneses of meaning. Miles and Huberman (1984) advocate the use of schematics to facilitate access into narrative texts and lay open the workings of any interpretation by the researcher. Whatever vehicle is used the researcher must disclose their interaction and biography with the analysis to maintain fidelity. This does leave the researcher open to questions about interpretation but the actuality of the events or the story should not come into question.

Problems of the Self.

The difficulty of examining life history narratives is that they themselves may be agencies of domination. Social conventions and the media bound narrative retelling of lives and the political climate can feed these. The sponsorship of personal, practical and cultural discourses could reduce the amount of contextual and theoretical discourse leading to what Harvey (1989) refers to as a tyranny of the local. In other words, the local contexts can preclude wider theoretical examination.

---

[10] See section 3.1

Denzin (1992) has commented on the resurgence of the life history narrative.

> *"The cultural logics of late capitalism valorise the life story, autobiographical document because they keep the myth of the autonomous, free individual alive..*
> *The logic of confession reifies the concept of the self and turns it into a cultural commodity. The rise to power of the social sciences it the twentieth century corresponded to the rise of the modern Surveillance State. The State required information on its citizens. Social scientists, of both the qualitative and quantitative commitments, gathered information for this society. The recent return of the life story celebrates the importance of the individual under the conservative politics of late post-modernism."* (1992:9)

Strauss (1959) suggests the sense you make of your life rests upon what interpretations you bring to bear on the disorderly events of life. However it is best to be aware when engaging in research of this kind, that autocratic structures as well as culturally embedded metaphors and literary types could shape sense itself[11]. This may produce a hegemonic discourse, providing the teller with a false feeling of well being through confession (Goodson 1993). Also narrative is not culturally homogeneous in that not all narratives are temporally bound. I will not dwell on this point as discussion about cultural differences in narrative style will appear later (Section 5.7).

Ways have been suggested to examine narrative to identify the self and become aware of intrusions of media and state frameworks. Arguments in favour of collecting oral narrative rather than written narrative include its authenticity and spontaneity, in that conventional forms of writing do not bound the work.

The post structural position with relation to narrative raises some important issues. It highlights the tension between what is lived and what is told (Bruner 1984). It causes particular problems for narrative identity because many stories can be told of the same experiences depending on audience and time. Also we are constantly revising our stories to take into account new happenings. As Polkinghorne (1988) noted *"we are in the middle of our stories and cannot be sure how they will end"* (1988:150). The researcher's influence on the story must also be addressed because to be an objective researcher masks the researcher role in the story. Researchers need to monitor their involvement as well as the cultural influences on what is said in the story. As mentioned before, discourse convention shape how we present ourselves in narrative. To return to the problem of

---

[11] Personal metaphors are used to understand and integrate developmental processes. McKenna (1990) identifies women's use of metaphor as a way of explaining difficult changes in their life narratives.
Polkinghorne (1993) identifies various types of plots in narrative configuration and include the classics of romance, tragedy, satire and comedy. These classics are arguably universal but the denouement may be interpreted differently according to culture. Two examples of culturally diverse narrative inquiry include Etter-Lewis (1993), Radin (1926) and Shostak (1983).

life as lived, Denzin provides an illuminating summary of Derrida's deconstructionist ideas on narrative:

> *"Derrida (1972) has contributed to the understanding that there is no clear window into the inner life of a person, for any window is always filtered through the glaze of language, signs and the process of signification. And language, in both its written and spoken forms, is always inherently unstable, in flux, and made up of the traces of other signs and symbolic statements. Hence there can never be a clear, unambiguous statement of anything, including an intention or meaning"* (Denzin 1989:14).

So it is with these ideas in mind that the analysis of data is attempted. A post-structuralist interpretation of the data calls for the awareness of the partiality of knowledge and so pay attention to the stories and knowledge within them. Information is not weighted according to its presentation but according to the depth of information contained within it. This theme is developed within chapter 5 that examines the handling of different types of data and the reliability of conclusions drawn.

Having examined narrative in detail we must now begin to question how the data will relate to the individual recounting it. Truth and fidelity have been discussed but what does this mean unless it can be related to the self of the individual. What follows is a discussion of self-concept within a social constructionist framework, looking closely at how it relates to this study.

3.4 Issues of Self-Concept.

3.4.1 The Social Constructionist View of Self-Concept.

It would be wrong to give a broad characterisation of constructionism or offering a compact definition. This would be a profoundly anti-constructionist approach to this question and implies that constructionism can be neutrally and objectively described and defined. To give a definition would be a realist account of constructionism and as such rejected by it.

However, definitions can be useful for a better understanding. A definition of social constructionism is given by Shotter and Gergen (1994).

> *[Social constructionism] has given voice to range of new topics, such as the social construction of personal identities; the role of power in the social making of meanings; rhetoric and narrative in establishing sciences; the centrality of everyday activities; remembering and forgetting as socially constituted activities; reflexivity in method and theorizing. The common thread underlying all these topics is a concern with the processes by which human abilities, experiences, commonsense and scientific knowledge are both produced in, and reproduce, human communities (Shotter and Gergen, 1994: p. i).*

The quote implies a unity, but listing also shows mix and match of different theoretical perspectives.

One of the features of the approaches that have been called constructionist is that they often have developed at the margins of disciplines, in the spaces where psychology blurs into sociology, where literary studies borders on political science, where feminism and rhetoric intersect.

Constructionist approaches tend to be oppositional movements of one kind or another to traditional social science positions, and in particular their realist assumptions. They all tend to stress the way mind and action are culturally embedded. These approaches conceptualise minds as not having fixed essences but being built from the symbolic resources of a culture; indeed, in some constructionisms mind is not a mental entity at all, but a discursive move: a set of stories that people tell, or different discursive practices for dealing with one another as moral and accountable (Harré, 1992; Coulter, 1989). They all tend to treat discourse — variously theorized — as the central organizing principle of construction.

In psychology work has normally proceeded under the title *social* construct*ion*ism with concern being expressed that social construct*iv*ism could be confused with the artistic movement known as construct*iv*ism (Gergen, 1985). In contrast, in sociology of scientific knowledge construct*iv*ism is a well established perspective but constructivism (without the social) is increasingly favoured over *social* constructionism (Latour and Woolgar, 1986). One reason for this is that social construction is associated with rather limited perspectives which relate knowledge to scientists' social background and group allegiances. However, sociological constructionists often see such accounts as reductive (Mulkay, 1979). Although the term constructivism is used in referring to the same movement (social constructionism), the term 'constructionism' is used within this study to avoid confusion with the Piagetian theory and pedagogical view called constructivism, whose proponents include Driver (in Driver, Guesne and Tiberghien 1985) and Solomon (1993). It is also discussed in this study.

The general Western model of self or personhood involves a separate, independent, consistent, unitary and private self. Each person has a self-contained mind and consciousness. They are distinct from others. Each person has a personality that consists of a number of traits, preferences and abilities that go to comprise that person's uniqueness. People have access to their internal self-ness and these thoughts and feelings are expressed through language and actions. People have agency and attempt to realise their self-hood in the world. The social context may impinge on self-hood but it is an influence, not a shaping factor. Though no one theory of self encapsulates all these ideas, they are the basis for many and certainly comprise the general 'common sense' sense of self-found in the West.

Social constructionist such as Bruner and Harré see the self as continually shaped and reshaped through interaction with others and involvement in social and cultural activities. The person is not separate from their social context (Bruner 1990) and so a person's self-hood can not be easily separated from another's. As such it is social interaction that should be examined to achieve an idea of a person's self hood. It is the internalisation of strings of dialogues, interactions, associations and narratives that become our sense of self, become treated with a sense of property. A person's self cannot be found in a localised area, they are 'distributed'.

The social constructionist view of self takes a view of language that suggests that language is not transparent but constructs the world and self in the course its use. People are embedded in their conversations and so make sense of the world through narrative and stories (Sacks 1992). Harré

(1979) argues that if there is a fundamental or most basic social psychological activity then it is conversation and social interaction.

3.4.2 Self-Concept and this Study.

The social constructionist model of self-concept was chosen as a synthesis of several dilemmas arising within the research. These dilemmas have emerged through examination of the ethical issues of reporting and developing research conclusions. Primarily my concern as expressed in the discussion of narrative was to have fidelity to the respondents within the research. This involves reporting the spirit of the narrative as well as the substance. To do this involves reporting how the respondent has related science to themselves, what facet of their identity are involved in their ideas about science and science education. However, if I am to retain the individuality of each respondent then I cannot have a rigid view of the structure of self. A certain fluidity is required to allow self expression yet at the same time, a comprehensible model of self-concept must be use to allow relationships in the data to be explored. This led toward the adoption of social constructionist theories of self-concept.

Secondly, the dilemma concerning the nature of knowledge and whether it is possible to abstract knowledge from its social context is also addressed through social constructionist self-concept. The data within this research is grounded in the social context and therefore any theories developing from within it or brought to it should reflect the social relativity of this epistemology. So in response to the grounding of my data I have also grounded the theory surrounding it.

The third issue was explored obliquely by the section on narrative, that is the issue of social justice through research. If knowledge is partial and identity in flux, as in social constructionist theory, then it should be possible to create emanicipatory opportunities by paying attention to the knowledge expressed through socially embedded forms, such as stories.

The insufficiency of the current classic models of attitude to explain or explore the development of attitude, lack of predictive power associated with the models and provide naturalistic accounts of attitude meant that it was important to move beyond these[12]. The social constructionist view provides a model where attitude and mental states meld seamlessly with inner feelings. It is in the 'in-between space' of social interactions where identity emerges. Adoption of this position would provide a view of attitude that moves away from the tripartite view and to a more integrated theory of attitude.

This ties in with my ideological position of social constructionism in which knowledge is socially situated. Taking this ideological position means that usual views of attitude and attitude measurement are meaningless outside of their social context. This would explain the lack of predictive power, the lack of naturalistic application of theory and most importantly the lack of work on development of attitude. If attitude is formulated in a social context through internalisation of conversation, action and narrative, then any work that removes the social context is fundamentally flawed. It is not finding the 'in between space' in which the self is crystallised, it is producing a new social self in a new social situation and expecting consistency of self to emerge.

---

[12] see section 3.5

Social constructionism does have difficulty extending its theory to include reflexivity and individual differences. However, a collection of identities must show some internal consistency to allow the generating activity to take place. It must show some reflexivity, some awareness of how it is perceived by others otherwise it cannot interact socially and in effect shows insanity. A shattered, incoherent personality cannot be identified as a true personality and exhibits some psychosis as suggested by the American Psychiatric Association (1994).

By taking this view of self-concept the importance of narrative is brought into focus. Not only are narratives a natural part of social interaction, they also are the way that information about the development of the self and attitudes are transmitted. Narratives are a way of expressing feelings and guiding them to be expressed in culturally recognisable forms. I would argue that they are the heart of issues such as 'self' and 'attitude'. It is how we realise ourselves in narrative, how we relate the experiences both emotional and societal that gives shape to our identities that can be recognised as a 'person'.

> Rosaldo (1984: 143) suggests *"Feelings are not substances to be discovered in our blood but social practices organised by telling stories that we both enact and tell [feelings] are structured by our forms of understanding."*

The emphasis here falls on telling stories as forms of understanding. The sense we make of our feelings are expressed as attitudes through narrative. Feelings, as suggested by Rosaldo, are not absolutes but socially constructed in turn.

3.4.3 Self-concept and Analysis of Narrative.

Analysis of narrative is deeply affected by the view of self-concept. If a self is being brought into being by the social situation of interview then how does this affect the conclusions drawn by the interviewer regarding generality of findings? If the social situation is basically the same for each interview, then a comparison of similarities and differences between information transmitted is surely not too pointless? But how similar or different are the social circumstances in each case?[13] I would argue that though it is imperative to pay attention to such things, it is of greater interest to examine the expression of attitude toward science and narratives of its development, as this was the whole focus of the interaction. That the self-concept expressed by the interviewer and interviewee may well be formulated especially for the situation is an interesting but does not led to a pragmatic solution. The drive toward internal consistency toward a subject and how it is expressed through narrative however is socially strong and certainly provides strength for any conclusions drawn from this study[14].

---

[13] see section 4.5 for roles of the interviewer

[14] see section 6.1.1 'Against conclusion'

3.4 Attitude.

The final research concept to be discussed is attitude. As a concept well established in psychological tradition it was important to come to attitude last so that it did not set the tone for the other concepts. Indeed ideas of attitude must be related to what has gone before so that its positivist roots are exposed and subject to constructionist criticism. The scrutiny does, however, yield up some interesting ideas for enquiry later in the study and does embody the previous work in the area of attitude.

The model of attitude that is being used within this study was first proposed by Roseberg and Hovland (1960). They suggested that attitude was the intervening variable between, in classical behaviourist terms, stimuli and response. In this model attitude acts as a state of preparedness so that a situation could be dealt with without complex assessment every time it was encountered. This led to the idea that attitude was a 'memory set' that allows quick processing and judgements to be made, and is formed through experience. The process and mechanism in attitude development however is not outlined and does not account for attitudes that are acquired through cultural and social interaction; attitude formation through vicarious experience. This form of attitude is very important, as it is these vicarious attitudes that parents form in their children but are also picked up from peers and media sources. Indeed the investigation carried out by Peaker (1967) for the Plowden Committee with a sample of more than 3000 children showed that it was parental attitudes that most profoundly influenced achievement.

Within this model verbal reports are treated as a part in each of the three components. These three components are, affective (concerning feelings, evaluations and emotions), cognitive (concerned with beliefs about whether something is true or false, accurate or distorted) and behavioural (concerned with intentions and decisions to act)(Eiser and Van der Plight 1988). These three components are inter-related but distinguishable.

The focus of my study lies with the affective component of attitude. Attitude toward science is difficult to judge behaviourally as people may engage in a scientific task without displaying any feelings about it, and engage in a perceived 'non-scientific' activity in a scientific manner. Consider, for example, a painter who is pursues the perfect representation of light. They could explore previous work, try new methods, chronicle their attempts and even test them though public appreciation and sales. This disparity between going about something scientifically and seeing this activity as *therefore* scientific is tied to the idea that an activity can be classified through certain features. Later in this study, parents share their definitions of science and when questioned it becomes apparent that often the words and ideas we use everyday are not as well defined or shared as universally as we have previously thought. This could be compared to the perceived rift between home and school learning. As outlined in chapter four, school learning has distinctive features that do not occur in home learning and therefore it can be difficult to be aware of the existence of a home pedagogy.

This view of attitude has been influenced by Fazio and Zanna (1981) who suggested that consistency between behaviour and (the affective component of) attitude is likely to be higher for attitudes acquired through direct personal experience. This links strongly with the ideas that incidents influence attitude, and so behaviour, quite strongly, and then when no more incidents

occur this attitude remains relatively stable. However this does not account for the strong effects of 'learned' attitude on behaviour and perceptions of behaviour. Later work (Fazio 1986) suggested that attitude influences behaviour by selectively activating various thoughts stored in memory and hence producing a selective perception of the attitude object. I feel this fits quite closely to the idea an event's influence on attitude works through memory but also in part contributes to a theory where memory of information (such as vicarious attitudes) is the controlling factors in utilisation of attitude. Emphasis must be placed on functionality of attitude here because, as the evaluative component of belief, an attitude is not activated unless it comes in contact with the attitudinal object. For example, there is no problem in holding negative attitudes to science if it in no way affects your life or the life of others.

One prominent feature of research on attitudes has been the concern with the measurability of attitude. Concerns with attitude measurement are well documented, the seminal work being Mischel (1968). When dealing with a socially loaded subject such as science these factors are even more important. The criticism surrounding Likert type questionnaires, such as a tendency for middle judgements, the social desirability response and defensive answering is particularly pertinent when dealing with gender specific topics (Harding 1993). Also it has been shown that attitude assessed in this way does not provide the best indicators of behaviour (Fishbein 1981, Manstead, Profit and Smart 1983) and certainly does not give indication of how desired change could be achieved.

Therefore this research has attempted to formulate a fresh evaluation of the development of attitude and use the process of development as a key to attitude change. Work by Fishbein and Azjen seems to suggest that to produce attitude change you must address the experiences and information that have formed the memory set. An intensive examination of the types of experiences that affect attitude will provide valuable insight into the process of developing attitude and how desired attitude change can be effected.

3.5.1 Attitude to Science

Taking a more specific view of this research it is important to address what actually comprises 'attitude to science'. It has been suggested that attitudes to science split into three separate components and that it is important to distinguish between these. These components are

- Attitudes to school science
- Attitudes to science in the world
- Attitudes to scientifically based careers.

I would suggest this model has been under theorised in that it is the perception of science that dictates the attitude held to these components. Therefore to assess attitude to each of these as a separate being is to ignore a unifying understanding of science. Though individuals may have fragmented views of science it is naive to expect that they will not relate all of these views and rationalise them. Later, I will argue that it is the individuals' view of the nature of science that has most influence on their attitude to science at school, in the world and as a career. I will also suggest that creating a fragmented view of science for attitude research is accentuating a problem that this type of work seeks to alleviate, for the sake of convenience.

It is important at this stage to outline the distinction between scientific attitudes and attitudes to science. The latter are the subject of this inquiry, the feelings, beliefs and values held about science. The former involves a respect for logic, a questioning approach, and basically the adoption of attributes considered desirable or even essential for scientists (Gauld 1980). Once attitude to science has been identified it is still problematic due to the nature of the concept. Attitude to science is not a unitary construct but rather lots of constructs all contributing to the attitude. Studies (Gardner 1975, Omerod and Duckworth 1975, Talton and Simpson 1985, Woolnough, 1994 and Koballa 1995) have all included a range of components in their measure of attitude including some of the following.

- anxiety toward science
- value of science
- motivation towards science
- enjoyment of science
- attitude of peers and friends towards science
- attitude of parents toward science

Another problem in examining attitude, as mentioned previously, is the problem of how attitude relates to behaviour; or doesn't as the case may be. Consequently behaviour has often been the focus of investigation rather than affective attitudes themselves. However, when dealing with vicarious attitudes to science it is important to notice that it is mainly verbal transmission. If a parent has a negative attitude to science it is transmitted verbally because avoidance of scientific phenomena is difficult to transmit due to few encounters. The importance of behavioural aspects an attitude become more important when dealing with children making post 16 choices in science. Crawley, Coe and Koballa (1988) and Oliver and Simpson (1988) have successfully used Azjen and Fishbein's theory of reasoned action to examine the factors influencing post 16 subject choices. Ultimately doubt is cast on these general measures. Work by Potter and Wetherall (1987), show that attitude measures actually measure only the grossest manifestations of the attitude and that more specific qualitative investigation of attitude to science is needed from within context.

3.5.2 Measurement of Attitude

Attempts to measure attitude have mainly focused on quantitative measures based on questionnaires. As I have mentioned previously the perennial problems of quantitative attitude research are that questionnaires are very good at identifying the problem but give no way of discovering a solution or understanding the problem further. This has led to the need for more qualitative research. I have only been able to identify four studies which explore the issues of attitude to science through interview and these were all carried out with children (Ebenezer and Zollwe, 1993, Piburn 1993, Gogolin and Swartz 1992 and Woolnough 1994). Only Piburn's research relied solely on interview data but the richness provided ample justification against charges of non-generalisability.

Research studies have already identified a number of factors that influence attitude to science. The most significant of these is gender. This view is supported by meta-analyses performed by Becker (1989) and Weinburgh (1995). It was found that boys have consistently a more positive

attitude to science and the effect is weaker in biology. It is extremely clear from the literature that girls attitudes to science are significantly less positive than boys attitudes. (Hendley et al 1996, Erickson and Erickson 1984, Smial and Kelly 1984, Harding 1983). This has been largely ascribed to cultural socialisation (Kahle and Lakes 1983, Smial and Kelly 1984). Boys have more opportunity to experience scientific and technological phenomenon from an early age and girls lack of experience is quickly followed up by a lack of interest. School science education does little to remedy this so once again the emphasis falls on intervention pre-school to enhance attitude to science. More recent research (Havard 1996, Whitehead 1996) has found that it is not necessarily classic gender stereotyping that causes a negative attitude to science. Girls no longer consider science or maths as career options for men and in terms of achievement are quite on a par if not better than boys. What now remains is to find out why these confident achieving girls are not choosing science. That is beyond the scope of this research, however some discussion of possible answers will be put forward.

Cultural differences in studies of attitudes to science have shown to be more significant than gender (Greenfield 1995). Caucasians were found to have the most positive attitude to science followed by Japanese Americans who preferred scientific careers. Asians had a preference for medicine, engineering and maths. Woodrow (1996) has looked at the Asian career paths closely and found that generally they favour careers that have longer term advantages rather than the enjoyment factor which influences UK society. Woodrow points out that all the research performed so far has shown that different cultures hold different attitudes to science but none explore the nature of attitude to science amongst the adult population to try to understand these findings. This research attempts to address this gap in knowledge but as will be discussed later had difficulties due to the nature of the study.

Not surprisingly classroom environment has been found to be a strong influence on attitude to science (Talton and Simpson 1987, Myers and Fouts 1992). Piburn (1993) who used most convincing interview data reported that classroom environment, personal support, variety of teaching strategies and learning activities, are the key factors influencing attitude to science. These research findings provide support for anecdotal stories about teachers' influence on attitude to science. This links interestingly with research showing the curriculum chosen does not have a profound affect on attitude. Studies mainly carried out in America show that innovations in the classroom do not necessarily lead to an increase in positive attitude (Gardner 1994). Other factors that have been posited as variables affecting attitude are social-economic class. The relationship remains unclear with conflicting findings (Breakwell 1992, McEwen 1986). Peer pressure is also a factor and seems to be linked with striving to establish a self-identity (Head 1985).

3.5.3 Summary

In summary the relationship between attitude and achievement is not clearly shown by the research body to date. It is not entirely clear whether achievement influences attitude or vice versa. It has been suggested that an attitude of learned helplessness begins to influence performance in science during the early years of secondary school, as more traditional science education begins. The research does not suggest that a positive attitude is prerequisite for success in science. For example, girls are now achieving a higher level of attainment in science and yet display persistently negative attitudes toward the material. However, when considering 'school science' as a discrete subject, negative attitude affects subject choice.

Having now considered fully attitude and attitude to science, along with the other concepts underlying this study the relationship must be drawn between these and the research methodology. The research methodology is generated through consideration of the issues raised previously along with some personal view outlined within the next section. It outlines the research strategy to the methods of the research and data types generated. The 'how' and 'what' was done is outlined with commentary and discussion.

Chapter 4
RESEARCH METHODOLOGY

4.1 Selecting Methodology.

The overall research strategy and choice of methods developed as an expression of my intentions in research. Initially I took no conscious decision to follow a pattern of methods, but knowing what I didn't want to do helped introduce me to alternative means of carrying out research.

Whilst engaging in the preliminary stages of this research I identified a set of personal questions that developed along side the research questions and so spent some time in personal reflection on my own science biography and the affects it was having on the conduct and focus of my research. The 'answers' to these personal questions became embedded in my methodology as I struggled to address the issues surrounding the research topic for both the people and myself involved in my research.

So in affect I began to plan this methodology before I even started my first degree, as the events that happened then developed my views of the world as I experience it now, within the context of my research.

The positivist framework of beliefs developed during early exams was encouraged by the elegance and satisfaction to be found in 'correct' answers to experiments. The principles of positivism were not laid open to inquiry. I developed, as a consequence, assumptions about the limits of useful knowledge. There was a distrust and almost open hostility to metaphysics and as these things were not implicit they could not be questioned and so they were swallowed whole and unconsciously. The true burden of what passes between a teacher and a student are the assumptions, prejudices and implicit metaphors. Facts and skills, in comparison, are ephemera.

When I started at university I began to query some of these beliefs. The scientists seemed very socially naive and I began to question why the faculties, and even the university, had developed as they had. The a priori view held by the science faculty seemed to be that confusion disappeared if the object was viewed with sufficient dispassion. Even within the faculty there seemed to be a hierarchy with the pure looking down on the applied, the physical on the biological and all combining to look down upon the social scientists who are hardly scientists at all. The ideal is to work with the head rather than the hands, to be conceptually neat, rather than messy.

This perhaps is best illustrated through the B.A.-BSc. split that can be seen in faculties on the 'cusp' of science. Subjects like psychology and geography will often offer both BA.s and BSc's to students on the course depending purely on what subsidiary or option subjects they study. For example, I was able to get a BSc. in psychology because in my first year I chose computing science as an option. Later there was nothing to distinguish me from other students as far as psychology subjects were concerned. It seems as if the distinction between Arts and Science at this level is 'state of mind'. If you are arts based and take arts subsidiaries then you may not be a Bachelor of Science despite your main topic purporting to be the science of human behaviour. If you are of a scientific frame of mind then you may have a BSc. even if you spend the rest of your time in psychology studying social interaction in a qualitative fashion.

In psychology and social sciences, high status persons work in a laboratory on one aspect of human skill, low status persons work in the field studying humans in their full complexity. To achieve the highest status, you must abandon study and join the methodologists, where one can criticise the weaknesses of others' research without the risks of doing any yourself. This intellectual snobbery supports itself through the claim that the weaker students unfortunately tend to go into the social sciences. The young ladies with an interest in people and the lower seconds. This leaves the more 'tender minded' in the embarrassing position of knowing that discrimination is being practised against them but because individuals who are in a position to say what is valued, say that it is not, the social scientists are not convinced it is unjustified.

Psychology is self consciously scientific. Trying to escape a past, reminiscent of Victorian mesmerism it encourages orthodoxy to the extreme. It did not, as I had imagined, endeavour to plumb the depths of the human psyche or attempt to look at psychic powers or other unconventional subjects such as sex or religion. To be unorthodox was to hold out-moded beliefs and ideas. So along with other students I sorted cards, flashed lights and watched disconsolate white mice groom themselves, in the hope of lending a theory conditional support.

So the university process brought into focus several questions for me and the concern surrounding the 'mismeasure of man' (Gould, 1981) and the resurgence of interest in the paranormal encouraged me once again to review my ideas about science and society. I moved to a social constructionist position where society itself defines the nature of being and meanings are not 'truths' to be discovered but constructs to be explored and expanded.

So as an expression of the belief that people construct their world and an attempt to broaden the area of research I rejected all attempts to measure. It would be incorrect to suggest that there is no meaning or pattern to the sense individuals make of research inquiries but would suggest that the process involved in quantitative measurement of humans falsifies the response. Measurement constrains the depth of material and strangles frees expression. Thus it misses all the subconscious or creative links in the data that display the complexity of human experience.

4.1.1 The Choice of Narrative.

The choice of narrative interview as a vehicle for data collection rose out of the desire to let people express freely their views and ideas about their science biographies and attitudes to science. I didn't wish to invalidate anyone's experience by conducting very scientific research attempting to increase the public understanding of science. In a completely contrary view I wished to encourage discussion about the nature of science and how it relates to them in society. Narrative interview allows the interviewee to self disclose and not only provide the interviewer with insight into the process of thought but also allows the interviewee to gain insight into their own interaction with science in society if they wish to engage in self reflection.

4.2 Let's Investigate Science: Workshop.

The workshop was the vehicle of this study by necessity. It also provided a forum for discussion ideas and theories as well as gathering data. As an intervention program designed to promote a positive attitude to science in the parents of primary aged children it had some ideological views that were not necessarily harmonious with this research. In this section the workshop is discussed and the positive and negative points of its use as a vehicle for research are explored.

4.2.1 The Development of the Workshop.

The 'Let's investigate' Science workshop was a programme set up in 1993 by members of the Primary Science Education department of Nottingham Trent University. Funded by a seed grant from the Royal Societies Committee on the Public Understanding of Science it aimed to;

> *" ..develop a positive image of Science*
> *...to develop an understanding of Primary Science in the National Curriculum*
> *...to develop skills and knowledge of Science."*
> (in primary school parents and governors).

Application document project title " Improving Attitudes to, and an Understanding of Science in Primary School Parents and Governors" (Johnston 1993).

The workshop consisted of thirty activities based around topics of light, energy, electricity, materials and forces. The activities were physics based as it was felt by the workshop co-ordinators that physics was the less 'popular' aspect of science (Whitfield 1979). Of these thirty activities ten would be chosen to be used in a school that had requested a workshop. The school would request a workshop on a mutually agreed date and at an agreed time, request a 'topic' for the activities or leave the selection up to the co-ordinators. In this case the selection was of activities that had been popular at previous schools.

The workshop was developed in response to the rapid increase of interest in primary science since the introduction of science into the primary curriculum, (D.E.S. 1989) and the subsequent availability of public and private sector funding for initiatives in this area. Within the institution other initiatives of a similar nature were running such as Women into Science and Engineering (W.I.S.E) that concentrated on secondary schools and Trent International Centre for Science and Technology (T.I.C.S.T.). These contributed ideas and support for the 'Let's Investigate!' workshop.

The workshop was intended to provide a 'pre-formed curriculum evening' on the topic of science. This was because it was perceived by the progenitors that it was difficult for schools to organise and run such events successfully due to the resourcing and technical support required for just one evening. If the event was run over a number of schools by an external agency that had prepared the event previously then it would allow the primary science curriculum to become a more accessible area to parents. This was a subversion of the initial outline of the project, as though the grant was provided for increasing public understanding of science, the workshop was aimed an

providing information about primary science to parents; a more home -school liaison approach. More will be said of this later.

The activities were designed with a constructivist approach to science that began in the 1980's with the work of Ros Driver and the Children's Learning in Science (CLIS) project and complemented by the work of Wynne Harlen in the Science Processes and Concept Exploration project (SPACE). This view of science was based on children constructing their own understanding of science though exploration and theory building and testing[15]. This did mean once again there was a subversion of purpose because the image of science posited in the workshops did not necessarily reflect the image of science portrayed by the science intelligentsia

The constructivist view of science, predominate in primary science education is a more open view of science moving toward post-modern principles. This approach, which Edmondson and Novak (1993) call constructivist *"posits a view of knowledge as a construction based on previous knowledge that continually evolves and does not exist independently of human experience*". Constructivist science allows the teacher to present the children with the opportunity to address larger questions regarding the nature and permanence of truth, the role and origins of theories, and the dominance of scientific knowledge with other forms of knowing, such as feminist and post-modern theory. But this skirts the slippery slopes of what could be argued to be the inevitable rift between science and science education. To begin to seriously examine the differences between science and science pedagogy calls into question the whole place of science in the curriculum and once again what we teach science for.

It was initially intended that the workshop would run on a loan basis after the first two years. These first years would allow the co-ordinators of the workshop to deal with any difficulties and report any successes back to the aiding body and the University that was also supporting the project. After this time the workshop activities would be available for schools to use to run their own parents evening.

Throughout 1994 and 1995 the project developed a set of five booklets based on the workshop activities and these were offered for sale to schools. It was expected that these would provide additional income for the project and allow development of the activities. However, as the workshops were free and the booklets were offered at an additional cost, most schools decided not to take the booklets. It was hoped that the project would be able to develop additional activities to cover biology and chemistry but the development grant proposal for 1995-1997 was rejected. It was reported to team members however that *"research work related to the development of the project will continue with the help of the University."*

This minimal funding left the project with a shortage of money so research work was developed that brought in funding and raised the profile of the workshop. This meant that involvement in the workshop by the co-ordinators had to be maintained and so the plans for loaning the workshop were delayed. In 1995 the application to have a research student attached to the project was accepted and 'I' the author was engaged. The University support for the project was reduced at this time and it became imperative for my research and the continuation of the project to have a full programme of workshops. It was also decided to make a charge for the workshop but include a set

[15]This view of science is one that almost exclusively resides in education.

of booklets. In effect the schools were having a compulsory purchase of booklets imposed. However, this did not diminish interest in the workshops but in fact seemed to increase the uptake. The only rationale available to explain this is that schools were suspicious of a free workshop, thinking there must be a catch, and when a small fee was imposed they felt that the workshop was a bargain.

Generally, the evenings were attended by 15-25 parents, less in low-income areas, more in higher income areas. Usually there was a 1:4 ratio in favour of women generally female, mothers and grandmothers of pupils attending (Johnston 1996). A preliminary activity to raise awareness of science was followed by an hour-long exploration of activities. To end, there was a plenary session concentrating on the questions raised by the experiences the parents have had in their education, home-life, job and during the evening.

In 1996 the loan workshop scheme was implemented as funding for the running of supervised workshops was running out despite income from research and charges made to schools. Interest was low, mainly I believe, due to the availability of supervised workshops and the inconvenience in collecting and returning the activity materials. It was also felt that the materials were readily available in schools and it was the organisation and running of the workshop that was the main difficulty so a loan workshop did not address this. The co-ordinators also felt the importance of interaction between facilitators and parents in the workshop had been under-estimated so that the workshop would not actually fulfil its aims of challenging parent's ideas about science in primary schools without interaction with facilitators.

The workshops stopped at the end of 1997 when the progenitor left the University. The loan system has never fully developed and interest was very poor.

The workshop funded by a scientific body but based firmly in education provides an interesting dichotomy with which to examine the tensions between science and science pedagogy.

4.2.2 The Structure of the Workshops.

So the Let's Investigate workshop had dual roles. It sought to increase parents' knowledge of science and also scientific knowledge but also knowledge of *primary science* and the epistemology it was grounded in. Presented as a package, the workshop did not draw differences between them and the under-lying implication that these two are related was not explored and it may have been inappropriate to do so. Though the social dynamic varied greatly from school to school the idea that the parents were there to be informed rather than to query was dominant. The workshop aimed to work within established social boundaries but present information in such as way as to increase the perceived overlap between science, science education and home learning.

Working within this taut framework the evening concentrated on the following themes.

- Images of scientists
- The abstract nature of scientific knowledge and accessibility
- Current primary science education
- The development of primary science education
- The everyday nature of scientific phenomena
- Social implications of science
- Learning science at home

A typical workshop would follow a format as follows;

[Parents arrive, have refreshments if provided and children removed to crèche if present]
Draw a scientist.
This is an adaptation of Goodenough's (1926) Draw a man test that has been further adapted in several studies, and finally into a Draw a scientist. This was used as a fun 'ice-breaking' activity to get the parents to think about stereotypical images of scientists and how this affects the thinking of both themselves and their children. For examples of this activity see appendix 1.

[Discussion over where children gain their stereotypical ideas and how important parents are in encouraging an open mind towards all subjects]

Though it may be easy at this point to imagine a the workshop as co-opting parental support for the school the angle taken was slightly more radical than some of the parents events reported by Bastiani (1993). Parents were encouraged to think of themselves as true co-educators. Emphasis was placed on learning within the family and the value of parental experience to inspire and encourage children. There were few links deliberately drawn with the national curriculum because of the curriculum changes that happened during the span of 1992-1997 but also because the philosophy of the workshop was on links between home learning and school learning. The national curriculum was related to the workshop only by request of the school or enquiry of the parents attending.

The Paper Aeroplane Activity.

This activity was designed to give parents additional insight into the abstract and contradictory nature of scientific knowledge. Parents were show two pieces of flat paper falling horizontally, both having been released at the same time. The parents were asked to predict which sheet of paper would hit the ground first. Then one sheet of paper was scrunched up and the other left flat and the parents were asked to predict which one would fall first. This was aimed at opening up conversation about gravity and air resistance, weight and surface area. The parents were then shown a cork and a 100gram brass weight of identical size and shape and invited to predict on the basis of the conclusions they had drawn from the paper dropping activity which object would fall first. This produces some tension in the parents as though they may have concluded that weight is not a factor in the rate of something falling and air resistance is the primary variable, experience has led them to believe that heavy things fall faster. Seeing the cork and the weight fall together

and impact together is often a cause for discussion. Often the parents or the co-ordinator would recall the moon landing footage of a hammer and a feather being dropped on the moon and falling at the same rate due to lack of air resistance.

The parents are then given a small task to be performed in groups, pairs or individually. The task is to make a 'paper aeroplane' or something similar that will stay in the air as long as possible. These aeroplanes are tested and the results discussed with reference to lift and aerodynamics. The thrust of this set of activities is to communicate how difficult it can be to achieve a scientific understanding of phenomena, how experiences do not always lead onto the 'correct' answer but are still perfectly functional for most circumstances and how many variables influence scientific experiments. It also provides an opportunity for discussing how children learn from their very first experiences and how they form their early 'scientific' theories.

The Activities.

At this point the parents are free to explore the six or ten activities around the room. The instructions given to the parents are basically to look around and have a go on the activities though they are encouraged to pick one activity to engage with for some length of time.

Question cards are provided on the table if the parents feel the need for some structure or guidance to their experience. The questions are aimed to guide the parents through three phases of experience.

Exploratory Phase
This is non-guided discovery. The workshop accompanying publication explains this phase as

> *"very important exactly because it is not programmed. Our minds can act on the phenomena, in our own way. We may see something, some connection, that no one has truly seen and then examined before."* (Eland et al 1995; 3)

Focusing Phase
This involves asking questions about phenomena we have observed.

Investigative Phase
This phase is the experimental phase where one aspect of the phenomena is scrutinised.

The activities themselves use household objects or objects that are readily available from hardware or electrical shops. The activities were designed to be *"non-threatening, motivating and not obviously 'scientific'."* (Ibid; 5)

The activities were shaped to model home learning as much as possible in a school environment so that the parallels between home and school learning were apparent. Hannon (1992) has outlined the possible characteristics of children's learning at home and at school. Using these listed characteristics it is possible to outline the aspects of the activity that mirrored home learning and which resembled school learning. It is interesting to note that these categories do not include 'home-work' set by the school that could possibly bear resemblance to both groups and yet be

distinctly different from the activities offered in the workshop. I would like to suggest at this point that there is a distinct need for work examining the different types of learning engendered by school and home as a simple dichotomy does not account for variation in school regime and home environs. This is especially pertinent in light of the recent guidelines from the DfEE concerning homework in primary schools. The guidelines which are undergoing the consultative process at the moment (April 1998) (see Section 2.3 for teachers views on consultation) recommends that "a sensible programme of home activities for children in Key Stage 1 should be designed to take, on average, about 10 minutes a day, *in addition* to 10-20 minutes a day reading with their parents or carers." (DfEE 1998: 5)[16].

Using the work carried out by Hannon (1992) as a basis for analysis the workshop activities can be examined. Firstly, activities provided by the workshop are neither shaped by interest (home learning) or by curricular objects (school learning). The activities were funded by an outside agency interested in promotion of one subject and aimed at increase access to a private domain, that of education. They were distinctly shaped as a curriculum subject but strict adherence to the curriculum was not maintained. There was no assessment formal or otherwise of the success of the parents. Primarily, this meant to reflect the 'free learning' style of the activities in there was no 'problem' to be solved. This links with the child-centred, social constructivist view of scientific learning adopted in primary schools, as suggested in the introduction. Suggestions were made of what could be investigated but no effort was made to monitor parents' progress toward completion. A more secondary motive was the desire to recognise achievement other than those valued by school or science. For example a task ostensibly set up for the exploration of weighing machines once became an investigation into catapults. This meant the problem was more natural and also achievement was rated by the parents own expectations based on themselves and the previous performance of their peers. The element of competition in some activities was noted to be quite motivational[17].

Special resources for these activities were avoided and materials readily available from most homes were used. It was felt that, especially in science, learning was equated with complex school based material or equipment and adequate learning could only occur with access to these resources. The activities were designed therefore, not only to provide some ideas for home learning and links between home and school learning but also an idea that knowledge considered in the private domain of educationalist and scientists was equally accessible for parents. Socially, the parents were left to devise their own working groups and roles in that group.

The activities can also be examined in terms of learning style (Johnston 1996, Entwhistle 1988). It is desirable to examine the activities in this way to provide an alternative and external view of their nature. As mentioned previously the initial intention of this research was to examine interaction and engagement with tasks and it was felt that learning style could be an important factor in this. Therefore the progenitors of the workshop were assessing Johnston's model of learning styles when I first arrived. It seemed natural and sensible to use this as one of the 'external' methods for examining facets of the workshop. I felt however that it was generally a useful tool rather than an essential component of the study as it developed.

---

[16] Emphasis added.

[17] The factors involved in increasing engagement with activities and the link with development of attitudes will be discussed later.

Using Johnston's (1996) model of learning style with four types of learning preference it is possible to assess which learning styles the activities catered for. Johnston lists the four learning styles as;

- Confluent [creative, spontaneous, see the jointedness of life and experience]
- Technical [pragmatic, physically involved, solitary workers]
- Precise [exacting, detailed, data gatherers]
- Sequential [meticulous, methodical, organised]

These styles are cognitive processing schemata that are available to all learners depending on the learning situation[18]. However, one or two styles may be preferred and so dominate. A learning style may also be preferred for one academic subject and the topic matter encourages this with the subject. For example a technical processor would be at an advantage in design classes but perhaps be encouraged to use confluent styles for English or Art. Whether they can access this style easily could be a measure of how much they enjoy the subject.

As the activities were designed to encourage exploration and free learning it was felt by the progenitors of the project that there were many 'ways in' to the activities. It is interesting to note that on surface appearance the team was made up from one sequential processor, one confluent processor, one confluent/precise processor and the technical support from a technical processor. Though only two of these were confirmed using Johnston tool for assessment of learning styles, the other two had learning styles that were very apparent. They were the 'creative' but not organisational workers and the day to day running of the workshops was not necessarily of interest to them. They enjoyed the first stages of setting up and modifying the workshop but had lost impetus and perhaps interest when I first arrived. The activities they had worked on were often intricate, imaginative and complex but sometimes when actualised didn't work because of external variables.

Because the activities were designed with access for learning styles in mind they are more 'free planned' than many science activities. All allowed for free exploration of the materials and none had a dominating focus. However, most activities favoured one type of processing. For example people exhibiting a sequential learning style favoured the activity involving testing common glues. Lists were often drawn-up and charts made. The activity that involved weighing a grain of rice involved lots of precise processing and in contrast the activity involving magnets was favoured in a confluent manner with much creative exploration. Technical processors seemed to favour design activities such as building a strong paper tower or a helicopter.

After forty minutes or an hour the group is reconvened to discuss issues rising from the activities. Things they have enjoyed, disliked, found interesting. Discussion here focuses on what children might think about the activities and what parents felt about the activities and how they related to experiences the children might have at home. There is some discussion about what the parent's experiences of science education were and what influenced their ideas about science.

---

[18] Discussed fully in a developmental context by Piaget. See works such as Piaget (1965)

Finally there is an activity that focuses on the everyday scientific knowledge involved in jobs and daily tasks. This was designed to emphasise the accessibility to scientific knowledge of people even if they feel they do not use science in their lives. The point has hotly been debated, as it is dependent on a person's view of the nature of knowledge. If knowledge is declarative and not procedural than it could be argued that a person's knowledge of science is limited. If scientific knowledge can be purely procedural then it could be argued that all those who can ride a bicycle (or similar) are exhibiting scientific knowledge. This difference in types of knowledge, knowing how and knowing what is linked to the discussion of the differences between secondary and primary pedagogy explored in the introduction. But further to this it is also an issue in science itself.

The two polar views are that science is a body of facts and science is a method of discovery. Obviously there are positions between these views but this dichotomy is linked also with a philosophy of science. The knowing how is linked to technical knowledge. As such it perhaps is held in less esteem than the 'body of facts' part of science. But it could also be argued and indeed the exposition by Appleyard (1992) states this case quite clearly, that it is advances in method that lead to advancement in knowledge and that science is the art of drawing the obvious conclusion from the data produced by revolutionary techniques. In the workshop this task was not espousing one particular epistemological standpoint but trying to open the nature of scientific knowledge up for debate and allow parent's an entry point through their own experiences.

The workshop was the vehicle for this research but this affected the strategy and tactics of the study. In the next section these implications are discussed and the research methods generated from this strategy outlined. Due to the cyclical nature of the research and reflexive nature of the study, this thesis will cycle around the issue areas several times and in the next section there is further discussion of interviews and the workshop context.

4.3 Strategy.

The main strategies used for developing theories about individual experiences of science and attitude to science in this project were listening and observation. These methods were be tailored to take into account the different ways of transmitting information about science and differing perspectives on attitudes to science. The methods kept the data naturalistic so that fine detail and relevance to individuals was not lost. With varying perspectives on science education available the research gathered data from many sources, taking both wide and narrow views of the affects of attitude to science.

As this research was working in three areas, those of science, education and home-school liaison it was important for me to identify the stance that would be taken towards the study and those contributing to it. As the project the research was involved with was funded by the Royal Societies Committee on the Public Understanding of Science the initial drive could have been one of examining how best to affect a positive change in attitude to science. Though this now forms one facet of the study it took a more developmental approach from the early stages. This happened through the synthesis of research in home-school liaison (Merttens 1993, Vincent and Tomlinson 1997) and my own ambivalent feeling toward science which informed my view of 'public understanding' and prohibited simplistic deficit model of parent's understanding of science.

In selecting to interview parents on their views about science and science education I felt I was choosing to listen rather than to 'probe'. It is unusual for an adult to receive uninterrupted time to talk about themselves to another interested party and so a narrative approach to interviewing was taken. This allowed the focus of the interview to vary with the aspects of science salient for the respondent. Interviewing parents in this free style also allowed them to give alternative stories about teaching and the education system. These act as counterweights to disclosures drawing from positions of power and school policymaking. To illustrate this point it is best to consider who gets to make statements about policy and curriculum matters in school. It tends to be those who hold the power in such circumstances such as head teachers or members of Ofsted or government ministers. So it is a contrast to gain the opinions of parents because they are not necessarily in a position to make decisions about school matters other than to withdraw their child.

The narrative style interview is so intimate and friendly it also carries with it some heavy ethical demands on the researcher. Measor and Sikes (1992) suggest that listening to stories is one respectable way of indulging our wish to have evidence from the lives of other that we are not alone in our difficulties, pleasures and needs. Thus the ethical burden of using life stories for research is in some part alleviated because it is culturally embedded to share and receive stories.

It is the element of sharing stories that I find particularly difficult as to receive a story without sharing your own is an intrusion and to use the story for personal gain (for a PhD thesis) without any collaboration is extremely ethically problematic. Kantian notions of 'respect for persons' dominate the messages about interviewing in this manner. The purpose of the research must be such that there is no 'betrayal' of the respondents. Some researchers (Griffiths 1998) have remarked upon the difficulties of collaborative research when the power distribution is so unequal, such as that between respondent and researcher. For example a researcher involved within the school could be seen as having an interest in certain types of information that could be fed back. The parent could feel constrained to make only positive remarks lest this spoil the relationship that they have with the school[19]. It seems best to acknowledge the unequal distribution of power in such relationships and work with 'fidelity' to both the purpose and the respondent. Fidelity of meaning for the respondent is particularly important as unless the project is entirely collaborative the respondent may feel the meaning was lost or subverted to suit the purpose of the research. In the case of this research I was not connected with the school and the school would not hear about any of the interviews. However, the research was 'mine' and I would decide what went into the final report and what conclusions were drawn. I did not want to misrepresent the parents views involved and so once again the fidelity of the study is my criteria for its worthiness, both as a piece of academic research and as a representation of the experiences of parents.

To this end of 'fidelity', interviews were conducted with the informed consent of each participant. This meant I did not over represent the importance of my study and undertook to represent their opinions faithfully. This does not mean limiting analysis or interpretation but emphasising meaning and intention rather than structure or linguistic content. The use of grounded theory for generating patterns and categories throughout this research also allowed for fidelity to the respondent. Any theory generated could be tested out and altered in collaboration. Holding each theory up for scrutiny in this way allowed additional information to be introduced to some ideas and the flaws exposed in others. It also provided a 'policing' of intention, so that the theories

[19] For further discussion of power and interviewer effects Section 4.5

generated would not be replicating autocratic power structures[20]. In actuality this meant allowing the parents to read any transcripts but also sharing with them, as my research developed, any thoughts and getting feed back.

When approaching parents I was careful not to align myself with any power group other than 'researcher in education from the university' which I could not avoid. Such power groups included the school or more explicitly the teacher who had organised the workshop event, the government and any scientific organisation such as the Royal Society. Though this was the funder of the project I was associated with my research was not associated with them and I had no incentive to target my research for that purpose. Information of this nature, however, did not always influence the respondent's interpretation of my role or purpose as will be discussed later. Interviews were held whenever and wherever the respondent felt convenient. This was in a conscious effort not to give a 'test' situation to the interview. The influence of context on the interview material will be discussed later.

By using discussion groups in and observation during the workshops I intended to provide my research with additional material. I shared my observations and notes from the workshops with the interviewees to gain a shared meaning for the events but also as a stimulus for discussion. I hoped that the respondent could inform my interpretation of behaviour in the workshop and provide additional insight into the behaviour/ feeling/-thinking interface. In other words to maintain fidelity in reporting I required an alternative analysis. This was to prove especially significant when examining the influence of politics in school and its affect on parent attitudes.

Observing and recording discussion and activity at the workshop was particularly difficult. I did not wish to covertly record parent activity as I would discuss their activity with them later and did not want to lose trust by appearing to 'spy' on them. Video cameras and overt note taking also produced avoidance behaviour or often annoyance and the feeling of being 'used'. Any data collected in the initial stages of this study through these techniques are not used, both for the above mentioned reasons and that the behaviour of the participants was so stilted by the recording method as to be unusable as research data. Participant-observer was chosen as though parents were aware of my research objectives both them and I were most comfortable with that situation. Note taking was done hastily during times when I was not required. Though I was uncomfortable with the idea that I was observing almost surreptitiously parents were aware of what I was doing. Over the first interviews parents were quite willing to discuss my observations about their behaviour and none showed any surprise. I would suggest that this might be because of the context in which they were observed. In school a child might be observed and questioned about their behaviour at a later stage and perhaps this format was being replicated by the research. When I tried videoing or non-participant observation it felt more like a test situation.

[20]Though deconstruction of the research text was never performed perhaps this could have been a useful tool to examine the power relationships portrayed there.

4.4 Collecting Data.

4.4.1 Interviewing.

By adopting an approach to interviewing that encourages narrative, key experiences influencing parent's ideas and attitudes to science were elicited. The narrative approach to interviewing as used by Josselson and Lieblich (1995) concentrates on an informant led covering of a general topic, such as experiences and thoughts about science. The benefits of this technique are the quality and richness of the data.

The narrative approach was particularly suitable for study of this nature as it allowed parents to identify key events in the formation of their attitudes and illustrated the affect it has on their subsequent ideas. This informed any inferences I drew from observation or discussion and by using a form of triangulation, or cyclical response confirmed any ideas and starting hypotheses. This triangulation involved sharing observations made at the workshop and any thoughts raised by the interview with the interviewee so that three perspectives could be reconciled; that of observer, participant and interviewer. This type of triangulation has also been discussed by Cohen and Manion (1994) to examine data relating to complex phenomena with broader perspectives.

The interviewing technique was chosen after preliminary interviews. Initial interviews were semi-structured informant based (Powney and Watts 1987). Around twenty initial interviews were carried out with an opportunity sample of parents and P.G.C.E students. The interviews were taped and annotated with a few field notes.

The interviewees were briefed on purpose of the research and were assured that any tapes would be transcribed and shared only with persons directly involved with the research such as supervisors. At the end of the research the tapes and any notes pertaining to them would be destroyed. A contact number was given in case the interviewee wished to contact the interviewer. If the interviewee did not wish to be taped the taper recorder was not used and notes were written immediately after the interview. This was done to allow the interviewee to speak naturally and the interviewer to give natural responds as well as attend closely to what was being said. It was felt that as long as the meaning of what was being said was attended to then minutiae of the actually words were not so important. It was meaning that was confirmed at any second interviews or follow up phone calls.

These initial interviews identified the research area. The focus was chosen to be incidents pivotal in the development of attitudes to science. These interviews also led to the extension of taking field notes as it was found that any detail helped recall of the interview, even if considered inconsequential at the time. Notes aided recall of body language, any points said after the interview and any points that the interviewer felt had not been picked up by the tape.

Taping was kept where appropriate. These 'Depth' interviews (Patton 1987) allow a holistic understanding of participant's point of view and give an inner perspective to outward behaviour. Neutrality was carefully maintained during the interview and perceptions of the interviewer will form an important factor in analysis. An additional focus was chosen to be perceptions of science.

Interviews were carried out in three waves after the preliminary interviews. The first set of interviews was carried out in Spring 1996 with fifteen parents, four men and eleven women. All were parents. The second set was carried out in Autumn 1996 with another ten parents being interviewed, this time two men and eight women, two of which were grandmothers. This set of interviews additionally contained three sets of Pakistani parents and two Pakistani fathers. At this time also, some additional interviews were done with five women not selected from the workshop and who did not have primary age children. This was to provide a gauge for how broadly the views and perspectives expressed by the parents taking part in the research were held by other parents. Three follow up interviews were made with the first set of interviewees and two telephone calls, all with mothers.

The third set of interviews was held during Summer 1997 after an initial set of theories and ideas had been generated. These interviews were quite tightly focused in some respects. Five men and twelve women were interviewed. One man was an Uncle. After this point the analysis of the data began and only three other interviews were carried out in Winter 1997 and they were all second interviews with Pakistani families.

DATE	INTERVIEW TYPE	FEMALES	MALES		
Winter1995	20 preliminary	17	3		
Spring 1996	15 initial	11 mothers	4 fathers		
Autumn 1996	10 initial	6 mothers 2 g-mothers	2 fathers		
Autumn 1996	4 (Pakistani)		2 fathers	2 sets of parents	
Autumn 1996	5 initial	5			
Spring 1997	3 follow up	3 mothers:			2 through phone calls
Summer 1997	7 initial	5 mothers	1 father 1 uncle	1 uncle	
Summer 1997	2 follow up (Pakistani)		1 Pakistani Father	1 set of parents	

4.4.2 Observation.

As mentioned previously, observation was one of the most difficult matters to organise. It was felt to be essential to the interpretation of both the discussion and the interviewing as a manifestation of attitude. The difficulties in recording behaviour highlighted the intricacy of the variables influencing human social behaviour and influenced profoundly the analysis of the interview data.

Observations worked on two levels. Observations on a broader level gave ideas to supplement a entire view of group behaviours in the science event. This included which activities seemed most

popular, whether the parents and teachers grouped together or mingled freely, the general level of engagement and so on.

Observation of individuals selected for interview was used to supplement the interpretation of their feelings about the activities, and as discussion material with the interviewees as mentioned before.

A note sheet that records school's reactions to the science programme and expectations and outside variables such as weather and time of day facilitated observation[21].This was used to give a more comprehensive view of the programme and account for variances in behaviour of parents in the wider field.

Observations of individuals engaged with particular activities were entered into a field notebook. As participant observer research this led to some behaviours being missed. However the gains in quality of observation where the individual in behaving naturally, out weighed the disadvantages in the situation. There were two forms of notes taken; purely observational detail and inferential notes. These inferential notes were treated with caution, as it is important not to confuse what was actually observed with the interpretation of what was observed (Patton 1987).

Observation of the whole group involved recording which activities were most popular, did parents engage, linger, drift off and so on, giving a general picture of the event. Observations made in the field notes were used to supplement a picture of behaviour of the individuals and aid, in the first part a holistic description of the workshop, and in the second with analysis of data and categories.

This methods detailed above was supplemented by tools to provide a range of perspectives. A questionnaire was used during the programme with the individuals selected for further interviewing. Though this was initially designed to help identify learning styles, it was used to give more information about individuals learning preferences and lend a little bit of character.

The researcher completed an information sheet on each school so that details about the workshop and the school would be able to inform the analysis. The sheet gives a more holistic view of each event and its main characteristics, so larger perspective variables will not be lost in the analysis.

4.4.3 Sampling.

When taking a research sample, bias is most difficult to control when dealing with people. The thrust of this study is to examine the development of attitude to science within the parents of primary aged children with a view to the implications that these attitudes might have on their ideas of science and their children's interpretation of their science experiences in school. Therefore, naturally the study is limited to a small demographic range but further by the high level of involvement of women at this stage of their child's education. As the 'Let's Investigate' workshops were used as a vehicle to approach individuals for this study a further bias of self-selection is introduced. Working with these limitations, however, interviewees were selected so

[21] See appendix 2.

that individuals who have not participated in the intervention programme will be questioned on their experiences and their attitude to science as well as those who have attended an evening. These prevented interviewees being taken from one particular source and maybe allow a broader range of people to contribute their experiences to the development of the categories.

A selection of sampling techniques was used to avoid consistent bias. If a participant in the science programme was identified through initial discussion as having strongly negative or positive feelings about science they may be selected to test a grounded theory (Glaser and Strauss 1967) such as 'men have positive attitudes to science'. Other theoretical sampling was used as theories are generated from the data and the role of parents and attitudes to science were explored.

Other sampling techniques included selecting an individual whom first engages with a pre-selected activity or an individual who was considered representative of the group (including gender).

Cohort affects on attitude were investigated by searching for images from the relevant decades and used to add another dimension to the context of data given. Not only was this illuminating regarding images of science but also images of education and the processes people experience as they travel through the a fundamentally dynamic education system.

4.4.4 Discussion

Discussion about science experiences and held views took place in an open forum after a workshop. Individual incidents recounted by the parents were recorded in note form-verbatim or tape-recorded. This was particularly important for 'group' impressions. If there was one particularly strong speaker present then it was imperative to record their views so that during analysis this view was not ascribed to the group generally or more than one speaker. Also if the group had a discrete age range they may have found that many of them had had similar experiences.

Investigation into the impact of science activities took place in three forms.
Discussion in an open forum was tape recorded or verbatim notes taken to give an impression of how the activities had been received. Further information was gained through involving parents in discussion about contemporary issues concerning both science education and the nature of science.[22] Raising ideas of their own experiences and how they differed from the workshop experiences stimulated this discussion. This was complemented with observation of reactions to, and behaviour whilst engaged in constructivist science activities.

A wider view of the status of science within the curriculum and science within society was explored. This was related to the more general data achieved through discussion and interview and so illuminated issues of concern in the sub-text. As the topic of this study was largely undefined it was of vital importance to collect all the 'small' data that adds richness to the description of the development of attitude and the repercussions of attitude. Therefore, to

[22]Such as further discussion on the nature of science and the tensions between education pedagogy and philosophies of science.

supplement this other subsidiary means of data collection to support initial data and aid analysis included;

a) Likert type questionnaire
These were administered to whole workshops to give an overall picture of attitude to science as measured by a formal instrument.

b) Comment sheet
These were used in a selection of schools so that comments on the success of the intervention programme can be gained from less vocal participants so that a fuller picture of audience reaction can be gained.
However, these informed analysis and were not used as an independent source of research data.

The end of workshop discussion focuses on science experiences and thoughts and feelings about the activities. Notes were taken to record recounted key events and reactions to the activities. These inform the data to give a crude indication of patterns in key events and add conceptual density to typologies.

4.5 Roles and Interviewing.

Much has been written about the protocols of interviewing and how the interview is a singularity that can never be repeated (see Hammersley (1993), Cohen and Manion (1994)). The ethics of this research are strongly tied to the epistemological views of the researcher. Aware of the delicate nature of the subject matter interviews were conducted in a way that allowed full disclose about the research and partial disclosure from the researcher.

4.5.1 Selection of Interviewees.

Selection of interviewees was extremely problematic. Random selection followed by selection for theory testing was theoretically suitable sampling. However, if, to gain a random sample, a person or person is approached because they are number 12 for example to enter a room, this is not entirely without meaning in itself. It is likely that persons engaged in coming to a school based event time their entrance to some degree. There are always those who arrive early, those who arrive late. By a number sampling technique this is ignored and could become a systematic bias. The same is true with numbering chairs so that the chair they chose to sit on selects a person. Once again this could ignore agency in seat selection. In fact I would suggest that sampling randomly is difficult as individuals do not act randomly themselves.

The sample of interviewees was therefore a biased sample of a biased sample in that the parents attending the workshop do not include those parents who were not there. These parents could be important as they could represent those who have very negative feelings about science, education or home school liaison activities. This was compensated for by interviewing a small convenience sample of parents (not of primary aged children) who did not attend any science workshop and also a small sample of parents (not of primary aged children) who have attended a science workshop. The final sample is displayed in table 1 below. The preliminary interviews are not reflected in this table but where preliminary interview material is used it is clearly labelled.

sampling through	**Random**	**Convenience**	**Theoretical**
Mothers	15	7	15
Fathers	2	4	5
Others	9		

All the interviewees gave their consent for the interview at the time of approach. Their name and telephone number was taken and they were contacted within four weeks of the initial approach. A time was agreed for the interview and a place was negotiated. Interviews were carried out in a public library, in the homes of the respondents, in schools, in cafes and in workplaces. The room was always 'private' in that it either contained just the interviewer and respondent or so full of people that it provided anonymity to the satisfaction of the respondent.

The respondent was given an information sheet (see appendix 3) and time to read it. I felt it important to give the respondent time to read all the details and be aware of the possibility of the interview being used in public material. The interviews ranged in length from half and hour to two hours. After this time the respondent was offered the opportunity to have a transcript posted to them. This was so they could check what they had said and identify any misrepresentations in the words. This effort toward fidelity to the individual rather than the material of the interview was not an option that many respondents took advance of. Only two wanted a transcript and they did not return the transcript or give any amendments.

This disinterest was surprising in that it displayed an unlooked for tendency not to be worried about one's opinion of science or who might be aware of it. I would suggest this could be interpreted as not having a stance to science as a central factor in their concept of self. Alternatively their expressed desire to scrutinise their words was the fulfilment of a desire for knowledge of the self rather than a desire for control.

4.5.2 Interviews and Conceptualisations of the Self.

Traditional conceptualisations of the self have express the view that there is a 'core' self that can be discovered and referred to through beliefs, desires and attitudes. This view is essentially psychological and lends itself to psychometrics. This linking theory of self-concept is explored by Freud (1940), Cattell (1975) and Rogers (1951) but these psychologists still suffer from the problem that behaviour is not able to be predicted from measures or other formal assessment of self-concept with any reliability. This implies that these theories of self suffer the same problems as trait theory (Cattell 1979) in that on the surface 'self' the most public part of the self is examined. As Burns (1979) notes, it isn't difficult to discover the public part of most people's self-concepts: They're usually quite ready to talk about themselves, sometimes at tedious length.

The definition of self as a concept is not too clear. The self can have two separate meanings. The self as object can be expressed as an attitude to self (Rosenberg 1965) or self as agent that involves a certain level of meta-cognition separate to the Freudian Id. Whichever view is preferred, using a core self model requires the individual to have access to all information stored within them. It denies the subconscious.

To relate this view of self-concept to science and science education suggests that there is no shifting in view of science and science education from the moment the self crystallised, around adolescence. Therefore their view of self in relation to science could be central but not unavailable for scrutiny. This view is supported through ideas of linking science to race and gender that are distinctly at ground zero for self-concept (Griffiths 1998).

An alternative view of self-concept is that there is no distinct self. Memories comprise an illusion of self that is made consistent through selection and the formation of schemata. In reality there is no internal core being and thus behaviour can never be predicted from knowledge of the self. In relation to this it matters not whether science is related to a self. The individuals reaction is exactly that; an individual reaction. In reflection on an earlier comment about lack of desire to scrutinise transcripts it might be suggested if there is not a core self little can be gained by analysing their lack of sense of possession over their words.

Rather than follow one theme of self throughout this research each individual was taken as a case to illustrate relationships of science to the self, whatever that might be. I think it is imprudent to adopt a static view of self, even if that view is a postmodern ambiguous view, as individuals will narrate their relationship of science to their personal conceptualisations of self. So if I were to use a discordant conceptualisation of self it would place an erroneous interpretation on their words.

Therefore each stance to science gives a slightly different view of how science has been related to the self if that person has indeed related it to their identity in any way. The difference is a subtle one. It can be expressed through stating that they are giving their opinion about science and science education or by giving a definitive view.

4.5.3 Perceptions of the Role of Interviewer-Researcher.

Disclosure.

To interpret the interviews it is necessary to examine both the interviewees responses to the questions asked but also to the interviewer. The interviewee's must make assumptions about the interviewer so they can relate to them in a social context. It is this perception that the interviewer has limited access to and limited control over. For example a female interviewer could not be perceived or responded to as a male interviewer without a high level of deceit that would pose difficult ethical problems. Full disclosure by the interviewer however provides another set of problems.

Full disclosure involves telling the interviewee the answer to every question they might have, fully and with no reservation. In some parts this requires the interviewee to collaborate with the researcher, sharing observations and insights into the study. The aim of this is to gain richer, less reserved information from the interviewee but also give them some control over how they are represented in the research. The researcher may also feel they are giving the interviewee a 'voice' or 'empowering' them in some way. This has been harshly criticised (Griffiths 1998) and the illusion of equality of power and friendship this form of research involves has been demoted to self fraudulent and in some cases spurious. The researcher always has final control and this power dynamic cannot be removed. The motives for research are never simply altruistic for the researcher. In the case of this research if the interviewees had chosen not to share information

then the task of achieving a claim to knowledge within this study may have become untenable. In other cases it may involve funding or future work.

Zero disclosure would be an entirely discreet investigation in which the subjects are either unaware of the research or unaware of the purposes of the research. Such research does provide naturalistic observation but involves a high level of deceit that may not be acceptable. It can also lead to a misinterpretation of the research data. Concealing the motives and power dynamics of the research does not prevent the subjects of the research drawing their own conclusions about the nature and purpose of the research. This can lead to difficulty interpreting the data.

Neither of these full-blown options are suitable for this research. It was necessary for the interviewees both to know what the research was about but not gain too much insight into the interviewers opinions regarding the subject in case it acting as a source of bias. Regarding this research I made the following decisions about disclosure and presentation. Primarily I decided to present myself as a researcher, associated with the education department of the Nottingham Trent University. I did not say I was a research student or say I was studying for a Ph.D. In the first part I felt that being perceived as a student, which can have negative connotations for local people, would not help me recruit interviewees. I also felt say 'research' would sound more important than studying. If asked I would disclose that I was a student studying for a Ph.D. but would not offer this information.

I dressed 'smart but casual' for all interviews. This involved a long skirt and jacket and a courier bag. I felt this would disguise to a certain degree, my age, my status within the university, how formal I felt the interview to be and also how I viewed the interviewee themselves. I did not wear a wedding ring but did wear a ring on my engagement finger, though not one that could be obviously construed as an engagement ring. In some way I was attempting to make my appearance ambiguous and open to interpretation but this of course is severely limited by my physical appearance and manner.

Information regarding the research was provided as mentioned earlier but I purposely avoided stating my own opinion regarding my science experiences or science in general. If asked I would hedge or bluster, which I felt, was acceptable considering the nature of my study. Any disclosure of this nature may have irrevocably altered the narrative during this delicate social interaction. My age was an advantage with this as I felt that my natural lack of confidence could easily encompass some deliberate blustering.

Disclosure about personal facts I also kept to a minimum unless directly asked. I did not discuss my partner, future plans or position within the university unless asked a direct question. Awareness, however, of the perceptions of interviewees was very useful in examining the interview data to see what type of information was given depending on the role ascribed to the researcher, myself.

The perceptions of myself by the interviewee as I have interpreted them do not actually in any way affect the analysis of the data, but it does affect the type of data given. This was gendered but also influenced by the age of the interviewee and their educational level. In one case the information given was affected due to a regional perception.

The following vignettes are not expanded as their purpose is to illustrate the forms of narration, not the information within them, which comprises the claim to knowledge of this research. Female respondents are indicated by M, male respondents by F and respondents where no gender need be given, are indicated by R. The interviewer is always indicated by I.

Gendered information

M *Well, I really enjoyed it (the science workshop). If I couldn't do anything well, (my husband) was there to help out.*

I *You found it useful to have him there?*

M *Well, you know how men are. I think he like showing me what to do.*

I *Didn't you mind?*

M *You get used to it, don't you?*

(RM-2-F2)

This interaction was hinged on the premise that women could share insight into male behaviour and thus understood each other better. I would understand that her husband enjoyed giving advice and she didn't mind as it was making him happy, because I was in the same position. Other women interviewees have responded to during interview with gendered material through consideration of children.

M *I was never really worried about my own science education or really education at all until (my son) started at (the local primary school). Then all of a sudden I was really interested to know what the school was doing for him and I was concerned about education and the curriculum. It's funny how children focus your mind. I'm sure you'll understand.*

(JB-1-F1)

This was information given to me as a woman who is too young to have children of my own, but would have some at a later point, though the interviewee had no idea of my home situation.

Men have given gendered information of a different type in that they didn't seem to respond with any ideas about my home life in mind. However they often gave information in a way that I would interpret as 'to a young girl'. Though this could be faintly patronising and in retrospect irritating, at the time of the interview lack of confidence on my part made it easy to accept and use this perception as a way to gain quality information. Encouraging the male interviewees to tell me of their opinion because I needed their advice and guidance was a way to gain non-threatening access to their thoughts on science and science education.

There are no particular quotes or vignettes to illustrate this. It was the more frequent use of 'in speech' endearments such as love, dear and duck and solicitousness after my travel arrangements and research progress that typified this reaction. Most of these things occurred before or after taping.

Narrative or other communication was given in a way that was not gendered but still closely linked to the perception of the role of researcher-interviewer. These perceptions were linked to assessment of area of expertise. Just as though interviewees who responded with a gendered narrative made an assessment that I had additional insight by being female, so other interviewee's assessed my area of expertise as 'primary education', 'primary science' or 'science'. In some cases after a direct question, the interviewee would know I had a degree in psychology and so the material offered would include some slant toward behaviour.

4.5.4 Research Process

The research process, the actually 'doing' of the research was by necessity flexible and varied. However, having outlined the data collection techniques some discussion of the process itself is required. Within one workshop, generally two or three individuals were selected (see discussion on selection of interviewees earlier in this chapter). These individuals were observed within the activity session and approached to see if they would be willing to be interviewed at a later date about their views of science education. If they expressed a willingness to be interviewed a date was organised. On arrival the respondent was given a sheet to outline the nature of the interview and what the data would be used for. It outlined confidentiality and so on. During the interview itself a very lose structure was used to maximise the narrative content of the interview. This involved questions such as 'What is the earliest thing you remember from primary school', 'how did you find science at secondary school?' or 'what brought you to become (whatever the job of the respondent was)'. No particular interview techniques were used, though often pauses by the respondent were left unfilled by myself to encourage them to speak further or the last few words that the respondent said were repeated as a question to prompt them to illuminate the point further. Any further probes were simple such as 'Then what happened?' or 'could you tell me a bit more about that?' and encouragement was given to the respondent that I found what they were telling me interesting.

At the end of the interview the respondent was thanked and asked if they would like to see a transcript of the material. In many cases they did not feel that they wanted to see what they had said and as previously mentioned when a transcript was provided, often no comment would ensure.

Having considered the data collection, strategy and tactics, in the next chapter the analysis of data is discussed. Once again the study refers back to the types of data collected but then moves on to consider the findings of the work and how they may be interpreted and inter-related.

Chapter 5
ANALYSIS OF DATA

5.1.1 Data Types.

The kinds of data gathered throughout this research vary. As outlined in the previous chapter, the main data is expressed as narratives of science biographies. Interview material also focused on the intervention workshop and the thoughts about science education this stimulated. Observation and discussion material was used as subsidiary information as is any data collected through activity sheets. The cyclical nature of data collection and analysis allowed the integration of additional data sources as they emerged. It must be stressed that due to the emergent format of the workshop that it was not possible to have a consistent set of activity sheets for the workshops.

Data collection and analysis was based on the grounded theory approach (Glaser and Strauss 1967). As the epistemological basis of this research rests on the search for meaning and understanding rather than abstract laws the paradigm is incommensurable with a quantitative approach. The gathering and analysis of non-numerical data is deemed to be desirable within the qualitative paradigm because it allows the researcher to be sensitive to a multitude of meanings for behaviour when viewed in context and the full complexity (Lincoln and Guba 1985). Grounded theory invokes the notion of grounding the research in experience but also is a method. It involves strategies for analysis that are formulated especially to handle what can be ill-structured interview data. For further discussion on grounded theory, see grounded theory Section 3.1.

5.1.2 Analysis.

The data was analysed using content analysis, outlined by Krippendorff (1991). This technique decodes the text into categories, relying on the shared code of the interviewer and interviewee when communicating. The assumption of a shared code is not so great when used with narrative interviews because of the story-telling nature of the interview. The interviewee recounts in a style they perceive provides relevant details to the interviewer. This includes using experiences shared with the interviewer and referring to the interviewer in a number of roles[23]. Content analysis decodes the intentions, meanings and overt and covert experiences encoded within the recounting. From field notes and perceptions of the interview contexts were constructed from which to draw inferences from the data. Many contexts were constructed but not all were be equally credible and this is also true for typologies. Each deserved some consideration.

Analysis of discussion was carried out in the same way. Rather than construction of elaborate operational models, the simpler content analysis of converging data as described above was used. Because of bulk of material and the difficulties in ascribing it to a source, it was not used to form the framework but to substantiate it.

---

[23]See discussion in Section 4.5.

Data came in three types.

- Narrative interview
- Interaction sheet information
- Observation and field notes.

To address each of these in turn I shall examine weighting of information, types of bias and error in these data types and treatment of data.

I have discussed at length the reasons for adopting narrative interview as my primary method of data collection. I have used what is spoken within the interviews as 'truths' though truths mediated through social and personal contexts. Therefore the primary weighting of data sources is given to these interviews. I have examined elsewhere the role of interviewer on the data and address the built-in retrospective problems with narrative. However I have not addressed the various weighting given to types of interview and the analysis of data or the tools brought to the data to aid with analysis and theory generation.

Interviews were carried out in three phases as outlined earlier. The preliminary interviews were carried out in a less focused manner, as the research questions had not been fully defined. As a result the narratives were not well structured, my questions were sometimes off topic and several profitable lines of inquiry were not followed up. In other words the data was not well formed. Therefore for the initial analysis of data and formation of theory the preliminary interviews were not used. At later stages in analysis the preliminary interviews were examined for confirming evidence but also for negative instances. It was expected that as the research focus was diffuse at this stage, negative instances of later theory or data that was later shielded through interviewer affect would emerge. As the preliminary interviews were carried out with a range of student teachers and convenience sample parents it was also felt that they could contribute to ideas about the generality of any theory.

There were only a few interviews with Asian-Pakistani parents and these I have treated as a discrete group rather than trying to integrate their data with the emergent theory. Though it was my intention in the first stages of the research to treat all parents as a largely homogenous group the flaws in this assumption quickly emerged. My basic assumption was that as parents of primary aged children they would focus their narrative on concerns for their children's education and related that to their own experiences. This assumption was actualised but a neglected aspect was that culturally the form of narrative could be different across cultures. Because of this my interviews were tailored to a Western-white interview group and it is possible that the framework of questions in fact has hidden differences in the narrative.

Therefore I have analysed this group separately and have related the findings of the main body of study to this data rather than integrating it. Though I would like to examine these issues further it is not possible within the scope of this study. I could not in good conscience leave this group of Pakistani parents' data out of the research, as it would be unethical not to represent them and their views as I have interpreted them. The caveats attending this section of this study are large and very important. The data is not 'flawed' but it was not gathered with appropriate knowledge and so it is untrustworthy as representative.

As the interviews were maximised to produce narrative the transcripts are generally long and unwieldy[24]. This prohibited the use of a very detailed analysis of the transcripts. The interviews were coded by generating a series of categories for the information given, then examining the transcripts for examples of these categories. However, emphasising the reflexive nature of the research process, the categories were refined and restructured throughout the research. For example, an initial sweep through the data would identify information concerning key events, views and stances, where a second sweep, after the typology has been refined would identify the different forms of stance and view espoused. This closer look at the transcript might itself engender a further refinement of the typology, precipitating another look at the transcripts.

Key events were the hinge point for the research. They provided starting points for analysing the transcripts and illumination for the research generally. As a common mode of communication they provide insight into the generation of attitude to science and science education (articulated in this study and view and stance to science) in an accessible form. The use of key events in this form, make them not only part of the analysis, the surrounding concepts of attitude but also a research tool for the examination of complex phenomena such at attitude to science and science education.

Interaction Sheets.

These sheets were icebreakers, fun activities and illustrators of points. They were aimed at assessing different things at different times and so were not systematically handled. Here I list the sheets and where they might be used and to what purpose.

TOSRA based Likert type attitude questionnaire (used as part of a small piece of research on comparable measures Johnston 1997. This was not used in any way within this research.)

Draw a scientist (used as an icebreaker to show how small children stereotype scientists and how parents can exacerbate this. This has been referred to in this research and referred to by parent respondents. Data was not gathered systematically but examples have been used illustratively within this research (see appendix 1)

Circle sheets (see appendix 5). These sheets had science-related statements or pictures on them. The workshop participants were asked to ring those pictures or statements they felt related to science. The data generated by these sheets has not been used within this study, as the sheets were not designed as an instrument for this research. It may have been illuminating to see what words, phrases and images were associated with science but the data was collected without the participants giving permission for it to be used for research.

[24] See appendix 6

Observation and Field Notes.

The retrospective nature of observation and field notes as written means that they can compliment the interview data and workshop data but must be treated with caution. As previously mentioned it was difficult to take notes during the workshop as it made parents feel uncomfortable but this was less of a problem during interview as my note taking was supplementary to a tape recorder. Inferential notes were treated with more caution than strictly observational notes. Notes and observations of interviews were used as subsidiary data when their inclusion added an extra facet to the data. Generally, they were not reported but were used to recall the interview and aid interpretation. Notes and observations of workshops however, were used to provide the main bulk of the illustrations contained within this study. The observations and notes from the workshops can be treated with more confidence as they were collected from 56 workshops and in some cases the whole workshop was noted by myself if there was an opportunity for discrete observation. Such occasions could arise when the workshop was well staffed and there was a secluded corner not directly overlooked by the main body of the workshop.

Reflexivity and Going Back.

- 1st cycle strands- Identification of key events from interview narrative.
  - Qualities of key events substantiated with additional material, observations.
- 2nd cycle strands - Views of Science from interview narrative and group discussion
  Sources of information about science from interview narrative
- 3rd cycle strands - stances to science from interview narrative.
  Development of process of attitude to science

The nature of this research is basically cyclical, and as such requires the revisiting and re-examination of research, both the raw data and the research findings. The transcripts of interviews, as the most important part of this work were revisited for theory generation purposes as well as analysis. The first transcripts were scrutinised primarily for key events and information on attitude (see above for outline of research cycles). This led to the generation of a conceptualisation of attitude away from the traditional view, and the ideas concerning types of key event. The transcripts were then was then revisited to look further at this, with new transcripts being added to the research as the study progressed. Stances and views were identified and a typology generated through successive 'trawls' through both new transcripts and ones that had been previously analysed.

Throughout the process of the research the science workshops provided a forum to explore ideas about science and science education through discussion and observation. Though often informal and unrecorded these added greatly to the generation of the rich description within this study. It was also an opportunity to go back and revisit the observations made in other workshops.

Different 'slices' were also taken through the research data. Some transcripts were analysed for gender-based information, others for culturally embedded information. All of this added to the picture of complexity provided by this study and adds breadth to the focus of the research, the typology of attitudes to science.

5.2 Findings.

This study has explored the factors that make up key events[25]. It has indicated that emotion attached to an event makes it memorable. An emotional response, such as fear, frustration, disappointment, pride, satisfaction and so on, to an experience in science, could also become a key event. This emotional component to an individual's science education had been long neglected and this research has begun to address this important issue. The analysis identifies processes by which individuals make sense of their experiences of science. It suggests ways of accounting, or modes of accountability that are appropriate to a range of stances taken by individuals in relation to science. The defining of parents as the research group should not limit the application of this research, as there is nothing 'parental' about the way parents think. Willis (1977) argues that parents do not form a sociological subgroup and therefore cannot be expected to have distinct set of attitudes. Indeed, Solomon (1994) suggests that parental attitude and approaches to science can be *"expected to run the full gamut"* (p569) by which it is meant would extend to very keen from utterly disparaging. However, as will be discussed later, it does give them a focus that is not replicated in many other groups.

The focus to the research was;

To describe and develop a typology for interpreting incidents pivotal in the development of the attitudes of parents of primary school children's to science.

This was carried out in the context of an intervention programme ('Let's Investigate Science! A workshop for the parents and guardians of primary aged children'). This workshop, discussed in detail elsewhere[26] was designed with the intention of improving attitudes to primary science education, as part of the public understanding of science movement sponsored by the Royal Society.

As key events form such an important part of this work they are discussed in the next section. The section also provides the rationale for why the traditional views of attitude have been discarded in the subsequent arguments. Once again, the following look at key events must be related back to the earlier discussion of critical incidents within the research concepts.

5.2.1 Key Events; What are They?

Strauss (1957) identified particular events that changed the trajectory of people's lives and reassessments of priority and transformations of identity that are provoked by dissonance caused by misalignments of this nature. This misalignment can cause *"chagrin, shock, surprise, anxiety, tension, bafflement and self-questioning"* are 'hall-marks' of key events and these emotional responses are equated with the situation that provoked them even if it has been in some way resolved or suppressed. For example, a feeling of nervousness due to an unpleasant incident in a laboratory could be carried over to other situations without the specific event being actually

---

[25] See section 3.2.5 for discussion of definitions of critical incidents and key events.
[26] See section 4.2.

recalled. As an alternative to this responses could be learned, such as a fear of mice picked up from a parent or society generally.

The cognitive component is coupled with this to make up a challenge to the individual's ideas and in some way make them redefine themselves. Therefore an event is critical if it involves both these components. It does not always have to have a massive impact. It can be the point of crystallisation of ideas for an individual. This is significantly different from Flanagan (1954)[27] but it retains the idea that an incident involves more that just feelings or thoughts alone.

A key event can be an in-depth analysis of an event that acquires significance through the process of analysis. Tripp (1993) uses this type of incident. This research would suggest that challenges to the individual's thinking, provided by the activities and subsequent discussion, are the substance that goes to make a key event in the development of attitude. Such a challenge could be in response to a deeply held belief such as 'I don't use science in my life'; the individual could become aware of the scientific skills and knowledge they are using on a day to day basis and so have to readjust their thinking in some way. I have called this process 'paradigm challenge' as it challenges the individual's ideas or personal philosophies that form their working paradigm for science.

The next section outlines the initial categorisation of these challenges and their affects on attitude. It includes an account covering the ways challenges are recognised and significance attached to them. The account will explore the changes key events may cause to self-concept. This study draws upon the research history of critical incidents. Walker (1978) uses critical incidents to examine pivotal moments in teachers' lives and careers. These moments have implications for identity and new aspects of the self are being brought into being. Walker mentions that the incidents gave an insight into a process (becoming an experienced and competent teacher) at work. They also crystallise the individual's thinking as they force a move in the process. Perhaps most significantly Walker feels that, *"The episodes worked to set many of the teachers' attitudes for the remainder of their careers."*

Accounts of key events can be found in most biographies. However it is more difficult to find them in science, as it seems so natural to many people not to analyse their science experiences. I might also suggest that analysis of life experiences is fairly rare in itself but I feel that unless the individual is prompted then it is most unusual to analyse what science means to you and why. This incident is recounted by Hans Krebs (1981), a famous biologist who discovered the citric acid cycle, and it shows how one key event helped him develop an interest in biology.

> *"To this day I can relive the experience, when on one of our family outings, I found a rare orchid, ...even now I could point to the spot where it was growing."*

Measor (1985) suggests there are critical phases in which change is likely to occur and from this initial work I would suggest that all childhood years are a time that can be viewed as a career in which progress is punctuated by these phases. Incidents are a new way of gaining insight into the process of change by encapsulating the mood of the moment, the strong motivating factors, the

---

[27]See literature review on critical incidents section 3.2.

ideas and attitudes held by the individual and giving us a small insight into the affects these times had on the individual. This is an original approach to the perennial problem of examining attitudes to science.

Within this study, key events were identified by their importance to the respondent in recounting their science narrative. Key events punctuate the narrative, drawing the listeners' attention to the rationale for actions. Key events are stories within stories, a micro-cycle of narrative that encapsulates an important point of movement with a story. As has been mentioned previously[28], the fact that the event was memorable to the individual immediately makes it worthy of scrutiny as a potential key event. However, it is the discrete nature of key events that aids the selection of them from narrative most. If repeated to a third party, they are the explanatory line in a story, a hook to hang following events on.

Previous research has illustrated how incidents are related in narrative by individuals engaged in recounting their biographies as examples or anecdotes to capture the spirit of the moment. These incidents illuminate and give rationale for aspects of current attitude to including views on the nature society. It also in part allows the individual to express ideas about topics in a meaningful context.

By analysing and categorising the content of these events it can be seen that there is a number of re-occurring themes. These themes express the general processes involved within the event. It is clear from reports given by the individual that these experiences 'colour' their attitude to science long after the event, and I would suggest, even cause selective processing of future events, as proposed by Fazio (1986). I see themes in the incidents as giving 'what events affect attitude' and this forms the basis of a typology for incidents affecting attitude to science. This includes a theory for one of the processes involved in development of attitude to science.

5.2.2 Forms of Key Events.

A number of forms of key events have been identified in the analysis of study material. These forms will be described and illustrated in this section. The study is not taken to be exhaustive. Other forms of event may be discovered or the area reconceptualised to erase the idea of key events entirely. This does, however, map out some of the ground and indicate the major features encountered during this research.

- Learning styles: subject matter
  teaching style
- Social pressure: peers
  parents
  teachers

[28] See section 3.2.5

5.2.3 Learning Styles.

The model of learning style used in this research is the 'preferred processing schema' model proposed by Johnston (1996). This model was selected as it uses the tripartite theory of the human mind, conative (behavioural), cognitive and affective that is mirrored in the tripartite theory of attitude initially utilised by this research. Johnston concentrates on 'frustration' as a key indicator of what learning style is being used by the individual. This is echoed strongly throughout the negative key events, as learning becomes frustrating in science. The emotion attached to this can broaden to encompass the whole topic. Positive events are associated with how individual learners prefer to work. This perhaps is not the easiest way of looking at learning styles as it is often easier to examine what you do **not** like.

A learning style key event is characterised by either a 'revelation' or a complete lack of comprehension of the subject matter. In science this involves attributing failure to not understanding concept or the teacher's explanation.

R *It was another world, another language.* (L-1-2F)[29]

On the positive side it can be a joy of learning experience where a special talent was found.

R *It was wonderful to see all the numbers working out. It didn't matter to me that sometimes it wasn't quite right. It was the pattern that mattered. Seeing things slot into place, more fun than that.* (JB-1-1F)

To first examine the 'clash of learning styles' scenario.

I *Can you remember anything from your first science lessons?*

R *Well, school mostly. It was never really my best subject. The writing of the experiment. What was it? Method, apparatus, results. No that's not it! I'm still like that now. I only ask for help if I need it. The children are like that too. I don't interfere if I'm not invited. They can just get on without directions.* (P-1-5F)

[29] A system of listing the interviews was developed so that interview data could be traced quickly to the original source. The first letter refers to the school, the first number to the interview number from that school, in this case the first interview from that school, and the number and letter combination identify the sex of the respondent and number of respondents interviewed at that school, in this case 2 respondents of this sex were interviewed.

Here, a technical processor has been asked to process sequentially. The dominant feeling is one of wasting time on senseless activity when more important things could be being done. Some pride was taken in this way of doing things but often a feeling of failure could be associated with a clash of learning style.

I *What can you remember about your science lessons at school?*

R *Primary it was just nature table, growing carrots tops on a windowsill. Secondary, staring out of the window. I really used to daydream. I used to doodle fantastic pictures in my books and get into awful trouble.*

I *Trouble?*

R *Once, because I wasn't listening I didn't know what to do so I just mixed everything up. What you could think to do is always so much more exciting than what you were told to do.*(laughs). (P-1-7F)

This person could be a confluent processor asked to sit and listen to instruction and getting terribly bored. People who could be precise or sequential processors often had little problem with science.

R *I liked to follow the instructions and get the right answer. I'm a slow and steady person and really careful. I get fed up of people who don't listen to instructions.* (JB-1-TM)

Here the speaker could be a sequential or precise processor but the thrust is obvious. Here is a person who enjoys close instruction and felt themselves ideally suited to a science-laboratory environment. The interviewee has already asserted that they enjoyed science and especially the chemistry experiments so the interviewer attempted to probe further.

So far only general impressions have been gained about what problems a clash of learning style can cause, but more specific incidents that have been gained by narrative interview give a dramatic insight into what things can go right or wrong depending on learning style.

R *It was pretty terrible actually. I was asked to draw and label the parts of a flower. It was only in primary school you understand so it wasn't too complicated, just petals, stem, leaves and what not. But at the time it felt really important and I spend ages trying to draw the flower and put straight lines on and everything. But I spent more time with the rubber than I did with the pencil* (laughs*). At the end of the lesson I had nothing but dirty smudges and a couple of words. I felt awful. I could say what everything was but I couldn't put it down.* (MM-1-2M)

This incident is particularly interesting because it is one recounted from primary school as opposed to secondary school. Most stories about science were recounted from secondary school or at work. It could be conjectured that primary school experiences with science were either

forgotten due to the science lessons not being called science or simply that there were fewer science lessons in primary school due to the lack of a national curriculum. It is also possible that memories of primary school are generally forgotten due to the individual being so young when they experienced it.

Some incidents that are negative can be interpreted as 'due to the teacher' rather than the subject.

R *I did ask the science teacher a load of questions, but he never had time to answer. He said 'Why can't you just do what's on the paper?*

I *You couldn't ask questions?*

R *No, or I never asked the right ones. The instructions never seemed clear enough to me, they weren't written right. I mean, how are you meant to do anything if you're not sure what you're doing? I never enjoyed school that much really but science wasn't the worst, just bad.*(laughs) (BR-1-1M)

This was interesting, as when I heard this incident recounted I was confused. I thought the respondent was telling me the teacher would not allow questions, but then I realised that it was the respondent that had a different style to both the teacher and myself. I was listening as a sequential processor to an incident involving a sequential teacher and a precise student.
I empathised with a teacher who had given instructions that were ample in his view but the precise student couldn't see a way to begin without more specific input. The phrase "how are you meant to do anything if you're not sure what you're doing?" was vital. I didn't understand this phrase because 'just do the best you can and sort it out later' is a dominant learning strategy in my schema and I would be able to act on limited instruction. I puzzled over this phrase until I understood that this individual needed additional information to start the task.

A positive experience is rarer to find in science, most being of the more general type but some revelation-type experiences have been recounted, involving both the teacher and the subject matter.

R *Well, I remember being really sceptical about the whole thing at first. You know, not really knowing what it was going to be like. I didn't get to grips with it, it was ticker tape timers. All those little dots and what they mean. But then we had this test and though the teacher had given us all the information, I hadn't taken it all in the class. I thought I didn't understand it so I was really worried about the test. I revised and revised and wrote everything out really carefully stage by stage until I was sure I knew what it was all about. When we did the test, well I got the best marks and that was the first time I'd got the best marks in anything. I was really chuffed and thought, well if that's all it takes, just sitting down and working it through carefully then it's easy.* (RM-2-3F)

And another incident that involved the teacher more explicitly

R *Well, I found my teacher very inspiring. I remember the infinite patience he had carefully explaining everything in as many different ways as he could. He would do a demonstration or something as often as he could, he really tried. If he couldn't get something to go right he'd make us act it out or do a demonstration using something else.*

I *Act it out?*

R (laughs) *Yes, he'd have us all as particles moving around and then he'd throw in a beach ball which was a grain of pollen. And that was Brownian motion. The particles moved the pollen which you could see.* (EF-1-1F)

The enthusiasm of the teacher was often cited as inspiration for further science study but this is often not enough. The following quote was taken from the Times Educational Supplement (24.1.97).

> *"On one memorable occasion he hurtled into the lecture theatre in an even more enthusiastic state than usual, carting a high performance amplification system and explaining how he was going to try to use it to demonstrate magnetism. We all sat in silence and absolute concentration while Tom magnetised a steel needle near the amplifier. Eventually, strange, fluttery, squeaking noises emanated from the speakers.*
> *"Listen! Listen! " he intoned, his face alight with excitement. "It's the little group of atoms - they're all lining up North to South!"*
> *I still remember the awe of that moment. It was the sort of thing that could turn you onto science for a lifetime. Maybe a few more lessons from Tom would have inspired even a hopeless non-scientist such as me to pick up a Bunsen burner and set out in pursuit of the fair test."*

5.2.4 Social Influences.

Social influences as key events can be identified by the involvement of another person not the subject matter itself. The people who have experienced this type of key event often use the level of involvement in science as an illustration of their personality.

R *It's just not **me**.* (G-1-1F)

Peer Pressure.

These people often have a definite image of science with regards to them and their peers. Often this image was supplied by the immediate social group or respected source.

> R *My group didn't like it and I suppose I went along with it. I don't really regret not doing it anyway. I don't feel that I missed out on anything.* (BI-1-3F)

Social incidents are often portrayed as a result of rejection of science rather than the causal factor.

> R *Well, I suppose it was never that interesting so when my friends were all off down the town, I went too.* (G-1-1M)

However peers can be identified quite strongly in decision making about science.

> R *Well, I didn't mind it too much. I suppose I really enjoyed doing something different, something with my hands. But my friends at the time thought it was rubbish and so I went along with them.* (MM-1-3F)

> R *I was quite good up until I went to secondary modern. It was very different there, it were like you were already got your job mapped out, it were like an apprenticeship. Still, I worked quite hard for first couple of weeks. Then I remember doing a bit of science work in a break, catching up like, and there were all these lads stood round, some of them my mates and they were taking the piss and calling me names.* (BI-1-3F)

Peers can also act in unexpected ways

> R *My boyfriend at the time, well I was only young and you know how it is, you think they're wonderful and really they're one year older than you and far more immature. Anyway he said that girls were rubbish at science and science was for boys anyway and was I a boy? and all that sort of thing. Anyway, that made me really cross so I took science instead of art, which I'd been planning. I didn't do so well in the end but there was no way I was going to give in after that little incident. Oh no. I've never regretted it.* (JB1-F1)

> R *No one. My daughter will do science and she'll enjoy it just like me and I'll make sure that no lad puts her off anything she wants to do. It didn't matter that I didn't do anything with it or didn't do so well. What matters is that I was the one who made my decision.* (AP-1-2F)

Here it is interesting to note that the parent has identified that her daughter will enjoy science just like her even though in this case her child had not entered school. No mention was made of the

son who was at primary school in connection with science. This might suggest the identification between parent experiences and child experiences is gender biased or an alternative interpretation of this would be the strength of the experience was such that the parent felt that it might reoccur in the same form.

Parent pressure.

Parents have a profound influence on their children and their children's attitude's to science. This research is based on examining the development of attitude to science to give insight into the development of attitude for the current generation of primary school children. However, this research has circularity in that the parents were children when they were developing their ideas about science in school and society and so their parents had a great input into this process. The following excerpts from interviews show how children felt their parents influenced them and reflect on what events triggered their views of science.

I *So how did your parents feel about you doing sciences, because, as you say, it must have been very unusual?*

R *Well, quite unusual I suppose. Not many girls were doing sciences but I'd changed from a girls school to a mixed school so before that I hadn't thought girls doing science was unusual because we all did it. When I said to my parents that I wanted to do science and may be be a scientist they were really supportive. I can remember it really well because it's one of those little phrases that my Dad used to say loads. He said "Lots of opportunity for scientists these days." He used to say that about almost any job. I felt it was support, not that it was much but that was loads from my Dad.* (ASH-1-1F)

Here the approval offered by the father was paramount and the women felt she was entering a gendered profession. Using parents' approval of science as a career can be contrasted with parents who approved of science study from a more learning based approach. Key events of this nature often have the feel of a parable, of passing on knowledge. The child doesn't immediately realise the importance of what the parent is advocating but realises it later.

R *I didn't realise what science was all about at first, especially physics. Oh I whined and complained on to my Dad. He said that it was discipline and a methodical way of working that was important. We all have to do things we don't want to but it's best to find a way of just getting on with it. I tell that to my children now, just sit down and do it and do it right. I think science is great for getting them to sit down and think and work hard.* (O-1-1M)

This pattern seems to be one that repeats through generations as shown in the excerpt above. Once again it is not the topic matter that was gaining approval but in this case the nature of study attached. Parents can also act to give a very negative view of science but this is difficult to notice. I would suggest that because attitudes are internalised and so views espoused by parents are internalised and seen purely as internal judgements.

R *Oh I hated it from the word go. Smells, dissection, test tubes it was just really unpleasant and all the teachers were men in white coats. I couldn't understand anything.*

I *What about your parents?*

R *Oh yes but they didn't care. They knew I was terrible at science. We're not a scientific family at all. My Mum said to me that she was always rubbish at science. I loved art and English and history. I do a lot to help out in* {my child's} *school now but I'm no good when they're doing science. I help them with reading and painting. Even the youngest are better than me.*

I *Do you think* {your child} *enjoys science*?

R *Well, she does at the moment, I think because it's not real science yet, just playing with sand and water and things. I mean she does do things like write up what she did and results and conclusion but I wouldn't be surprised if she goes right off it when she's older.*
(JB-1-2F)

Here I made efforts to see if there was any gender bias in the parents' comments about her daughter but there seemed to be the idea that aptitude for science was a genetic disposition. It may be the case that the learning style of this family is extremely confluent and the notes taken from this house could be interpreted as supporting this evaluation. On arrival I was shown into the kitchen which lead onto a work room/ conservatory. The observation notes written after the interview read;

> Easel in same room, children's pictures around room. All very arty. Child D.I.Y stained glass set on table plus pastels. Baby in high chair with biccy-pegs and paper. A bit untidy. Pleased to see me, offered cake, chatted about being student/ students days.

I have discussed the perceived role of the interviewer and here from the notes the parent being interviewed related to the interviewer as a student and was relaxed. They didn't feel constrained to talk about science but appeared to interpret the purpose of the conversation as a discussion over education in primary schools and the enforcement of the national curriculum.

Teacher pressure.

Teachers are the other big influence in take up of science. They can act to provide incidents pivotal in the development of attitude as mentioned earlier.

> R *My teacher was brilliant a real inspiration. He was really patient and had a really good way of explaining things. I remember the time that I really couldn't see the interference lines in the light between two pinpricks in a piece of card. And though it wasn't important really, he was really concerned about it. He stayed behind with me and helped me see it and I just thought it was great. I wanted to be just like that. He was really down to earth and I think he really believed that science was a subject that everyone could do. He didn't think talent came into it, not like art. He believed that everyone could do it if they took their time and found a way. Their own way to understand.* (P-1-3F)

Teachers can also cause difficulties.

> R *He terrified me. His name was {} and that's a scientists name if ever there was one. He had terrible bushy eyebrows and used to shout so loud I thought I'd wet myself. I don't remember what we were taught though I was quite good I think. It was just I remember fear more than anything. The next science teacher we had was just as bad in a different way. He used to be really sarcastic and personal. He had me in tears more than once. He didn't seem to be able to control the class but I hated him more than* {my first science teacher}. *He used to write your rank in your report twenty-three out of twenty seven or something like that and it meant that you were twenty-third best in the class. I hated that. I didn't want to know, because I was already doing my best. I remember that I got the science prize though. I was sat in assembly at the back and day dreaming. I heard him say that it was the time to give the science prize and I was so sure it wouldn't be me, I thought it would be a boy called {} another scientists name eh? Anyway I was so sure it would be him that I didn't hear my name announced. They had to say it again. It was a lovely book on biology and that I think annoyed me because I always hated biology. I hated cutting up lungs and the fish. I felt ill when they would talk about blood. I think that book helped me make up my mind that I would rather be a physicist or a chemist.* (BR-1-1F)

It must be recognised that though these events are cases of overt teacher pressure both positive and negative, generally teachers influence attitude more subtly as do parents. The 'incidents' recalled are often a summation of subtle messages accumulated through years of education and home life. To use Freudian terminology the feeling is abreated and there is transference of this emotion onto one event. Therefore the absolute 'truth' of the event is not necessarily of any importance to the

study of development of attitude. It is the nature of the expression of the event that gives insight into the development of thinking and feeling about science. There is no catharsis for these feelings, they are not repressed but expressed generally through 'voting with your feet'. The declining number of science graduates is testimony of the process.

Beyond the teacher themselves is the way that science is taught and presented within schools. An interesting feature of the literature within attitudes to science is that often school science is treated separately to science in society. I have addressed this issue earlier but come back to it here to look at the influence of teacher's presentation of science on attitude to science. A large survey undertaken by the Institute for Electrical Engineers (1994) found that of 1552 students aged 14-16 years found that 68% of students thought science was useful, and 58% relevant. However, this provides an over optimistic picture of attitudes to science, as it is often the 'technological' aspects of science that is found relevant. The telecommunications breakthroughs are higher profile and more quickly utilised than the breakthroughs discussed in school. School topics often focus on famous discoveries and yet these discoveries might not have had a discernible impact on the individual. It is difficult to see the impact of the splitting of the atom on everyday life as it is concealed within electricity bills. Penicillin is no longer a marvel of modern science. The science in school often has lost its feeling of wonder, as it is old science and distant science. There is no thrill of discovery and no excitement in replicating the experiments.

The lack of contemporary role models is also a difficulty, identified both by parents and their children.

I *Have you experienced any differences in science*? [since the 1960's and the sexual revolution.]

R *No. Not really. It still seems to be stuffy men teaching you about other stuffy men. It's still Newton, Einstein, Fleming, Bell and all the guys who got stuff named after them and Marie Curie, the token woman. There was nothing to relate to, and heaven knows what there is to relate to now. I suppose it's important to learn about the history of science but there has to be something 'now' to capture the imagination.* (OQ -3-F)

R *I found it difficult, there are not real role models. In literature I always wanted to be like D.H. Lawrence, on the cutting edge, having my books banned and then published. I wanted to be like Germaine Greer, writing outrageous thought provoking stuff. In science I couldn't be like anybody. There was no one to aspire to be like.*

(speaks to child who is sitting in room)

R *Who would you like to be like, {}?*
C *David Beckham.*
R *Who in science?*
C *Science? I suppose my teacher is good.*
R *Who else?*

C *There isn't anybody. No. {pause} Yes. Wolverine.* [Cartoon character, one of the X-men]
R *He's not exactly a scientist.*
C *No one then.* (G1-1F)

So the problem of role models is often a difficulty and though may not be a cause of negative attitude it does not aid the development of positive attitudes in science. It could be argued that desirable associations with science fall into two categories. Those key events that are critical in the development of positive attitudes to science such as teaching sufficiently adequate to keep the child stimulated and interested in the topic and those that are desirable but not essential for the development of positive attitudes to science such as role models. A child will fail to develop a positive view of science and science education if the teaching received when at school failed to engage interest or intellect. If a child can identify with an inspirational role model this increases the chances of the development of a positive attitude but if it is not available then it does not hamper the development of a positive attitude. There is a dimensionality in key events and other 'factors affecting success' that allows the analysis to tease out a greater quality to the development of attitude. It is not a process in a linear sense, neither is it compensatory. The lack of role models does not compensate for poor initial teaching in the way that a swimming pool does not replace a bathroom but can add value to the house. Further within this thesis the issues of this complexity will be discussed with regard to policy and practice because it can be seen that a simple intervention programme that tries adding 'extra' to attitude to science might be misdirected effort.

The final point to be made in this section is that choices made in school to study science or not can be a simple choice. Research (Hendley et al 1996, Crawley and Black 1992) identified students perceptions of the difficulty of science as a school subject might influence their decision. Sears (1997) suggests that the decision not to choose science may be as a simple preference for other subjects. To address this last point first, I would suggest that this is a completely correct finding. Students do like other subjects more. It doesn't matter if they like science or not, indeed they might really enjoy science. However it is the reasons why they like science least that need to be addressed if numbers of science graduates is to increase, and perhaps more importantly society in general takes more interest in science.

The perceived difficulty of science is another matter not so easily rearranged. Data from the ALIS team demonstrated that physics A level is effectively half a grade harder than other A levels. Greater weight is given to the notion that physical sciences are perceived as difficult by the DfEE (Cheng et al 1995). They found the most significant correlate with uptake of science at A level was GCSE performance in maths and science. In other words if you did not do well at science you do not do it. It is not a subject you do for enjoyment or as a subsidiary subject to pick up an extra A level. So perhaps this is a form of self-selection and so science has become harder to compensate for its student's intelligence. Alternatively this self-selection could emphasis the stereotypical image of science. If science qualifications are gained, from personal experience, it is often an additional proof of intelligence.

It is often too easy when examining the views of individuals to look at the individual's relationship with the object rather than the social interactions surrounding the object. Thus many studies have looked at the structure of science rather than the individual and their learning preferences.

Attitude is not formed in isolation and key teaching and learning events are as much as part of the development of the attitude as science itself.

5.2.5 Summary

In conclusion the concept of a key event as a pivotal moment or a culminated expression of feeling about science provides access into the inner development of attitude to science. It can also give an insight into the perception of science and science education and the decisions an individual makes about their position regarding these related issues. The interactions that occur during the development of attitude are complex and this makes the process opaque and impenetrable to scrutiny. This tangle of interactions can also be seen as the reason that conventional psychometric testing has not proved adequate to linking attitude to behaviour or explaining the genesis of attitude. It has, in some part, be able to affect attitude change, for example work on phobias and work by Festinger (1964) on cognitive dissonance.

Incidents can be due to the subject matter of science and the teaching style of the teacher can also cause difficulty. The perennial problems of Piagetian egocentricism on behalf of the child and the specialist can cause clashes of thinking that are difficult to overcome.

Social influences over the view of science can be brought to a head in incidents that can shape a view of science considerably. Peers can challenge an individual to identify themselves with science learning or against it and this is echoed by parents and teachers who provide the source of adult attitude to science. Parent identification with the child and child identification with role models provides a huge unexplored wealth of material for the ideas associated with development of attitude to science. Finally science as portrayed in school may be actually more difficult and less relevant than other subjects may.

This section has outlined the nature of key events and their effect on the development of attitude toward science and science education. The following section develops these ideas further, looking at the views of science espoused during the interviews and linking these to historical educational theory and the development of attitudes to science. It draws a fragmented picture of 'science' that has before this point been treated as a coherent entity.

5.3 Views of Science.

Traditional models of attitude are static and tripartite[30] (Azjen and Fishbein 1980, Bem 1970). They generally suggest that attitude is an equal mix of how an individual feels, thinks and behaves toward something. The extant attitude research generally suggests that there is only a weak link between action and attitude. Narrative data does not fit this conception of attitude. Firstly there is no means of measuring attitude or examining behaviour. It is self-report of behaviour but also it is reflective, the individual doing a 'post-hoc' analysis on their reasons for actions. Also actions are conceptualised as an outcome of how the individual felt and how they thought or further how they thought and felt about a subject but also what action they could use to deal with the situation. Thus my study data could not be related to the static, traditional view of attitude. I chose instead to categorise data by thing about the views of science held by and individual and their stance to science. Views were a cognitive component, what the individual thought about a subject, how they conceptualised it. Stances reflected a more operation part, an interaction aspect which links more closely with behaviour.

If we want to understand attitude we must examine closely how it is formed and how it is articulated, not try to force a psychological structure on what is a very nebulous concept. By attempting to find discrete components to attitude or examining its predictive capability based on measurement we miss the important role a simple exploration can play in helping us understand and shape attitude. In effect this study looks at key events as an affective event (with cognitive components) that shape attitude. But rather than thinking of attitude as a tripartite balance of emotion, cognition and behaviour, this study breaks it down into a cognitive component of 'view' and a behavioural component of 'stance' (the affect component being the key event that impacts on both stance and view).

When examining views of science it is important to remember that an individual's view of science depends on their understanding of what exactly comprises science. The following work displays the various views of what is science but also what the nature of science is. This study is not an assessment of how closely parent's views of science are to a dictionary definition or another desirable definition of science but an exploration of various perceptions of science. In using social constructionism as a theory of scientific epistemology it would be contradictory to claim there is any scientific knowledge or nature of science that is not negotiated. Views of science are life-views, perhaps more fundamental than attitude in that they carry many implicit assumptions. They are the immediate product of key events and throw additional illumination on the processes of attitude development.

5.3.1 View of Science as Neutral

Working scientists accept through experience that science represents the truth of nature. That is what their job is, to determine facts that lead to theories. That these theories may be questioned is an insignificant caveat on the huge body of knowledge. Theories get dropped when they are not useful but up to that moment they hold unreserved credence. The fickleness of scientists and their theories has be much discussed by Kuhn (1963) and more recently by Appleyard (1992). However, it is the faithfulness to one theory that the non-scientific communities see and

[30] See section 3.5 and figures 9 and 10 on page 151.

misconstrue. The coquettishness of science can cause the public to become disillusioned as these persons of learning who have hither-to been espousing one view suddenly change to vehement support of an alternative view point whilst still saying that they have the full support of the facts. It is confusing for those outside and irritating for those inside to be reminded of their changes in direction. The recent B.S.E. (Bovine Spongiform Encephalopathy) scare reflected this panic when scientists contradicted each other, themselves and the public feared things were covered up by politics. Indeed, scientists acting like a donkey between two bundles of hay caused some scientists to examine closely the tenets of their own profession.

I *So how do you think science fares in the media?*

R *Ho. [pause] They do themselves more harm than good, those who go on T.V. The B.S.E. scare was pretty terribly managed. Scientists should deal in the facts [pause] not speculate or tell people what to do. All this saying one thing and then another and arguing was really undignified and I think a lot of people lost confidence.* (JB-1-M)

The view that science is value free is one that is held by many who support science. Wolpert (1995) maintains that "ideas in science are simply true." He goes on to express the view that science is superior in understanding the world because the most complex theory can be explained in a few words. Thus he epitomises this view of science, that separates arts from science dichotomously in a similar way that the physical has been separated from the mental.

R *Science is a description of the physical world in the most minimal way possible.*

I *Just that?*

R *Well, I'm not going to define science for you because that would go on for ever, but I do think that science is a way of finding out the facts of the world. It's not got anything attached to it, it's just a machine to do something. It's what you decide to do with it. In itself it's not anything.* (MM-1-1M)

In some ways, from these statements, these scientists appear naive in that they think that other academic subjects follow the logical pathways that science is supposed to and evidence is weighed and considered in similar ways. Those who study humanities or the social sciences will know that controversies are not resolved always through the scrupulous examination of the facts. Scientists often believe that others strive for the same definitive answers and are bemused when it becomes apparent they are not.

R *What sorts of things are you hoping to find out, love?*

I *Well, I like to think that I have an open mind. I'm not looking for anything in particular, just patterns.*

R *I mean, are you testing a hypothesis or something?* (E-1-M)

This faith in the methods of science to get to the truth leads to a faith in other disciplines such as history or English as long as they feel science is not being attacked or misrepresented. In interview this has caused some problems, especially when discussing the nature of science.

R *What do **you** think about science then?*

I *Science education? Well at primary level..*

R *No, science like scientists do. Research and stuff.*

I *Umm, well I suppose I feel that they are misunderstood but they misunderstand other people too. I suppose I think that they are pushing their subject too much without thinking about how people see it. And that's what my research is looking at.*

R *So you don't agree with the public understanding of science movement?*

I *Em. [pause] Well, I'm not sure it's been considered carefully enough. I think it's important to know how people feel about science before trying to give them something they don't need.*

R *I think everyone needs to know about science don't you?*

I *Well, I would certainly agree with that.* (E-1-M)

Here there was hedging to keep the interview going without allowing the speaker to feel that I was hostile to science. Awareness of this stance to science makes speaking about the nature of science from a sociological standpoint very difficult. Agreement was reached through a possible double reading of the speakers' final statement. Agreement being reached allowed the normal course of the interview to be followed.

It is interesting to note the speaker identified the public understanding of science as a 'movement'. It could be argued that the use of this word could reveal a perceived similarity with religious or political movements. Such things would be very contradictory here to the speaker's view of science. The neutral view of science may be better explained as the view that science is neutral. Therefore it should be a-political, a-religious and almost devoid of social trappings. This thesis is based on an epistemology that grounds all human phenomena within its social context and so suggests that science is heavily political and bound to religions and cultures as all people are. To call the public understanding of science a movement is to tacitly acknowledge its factional nature and show that the views publicly espoused by these interviewees is perhaps not what they actually believe. This is not suggesting they are deliberately giving a misleading view of their ideas about science. It is rather to draw attention to the inability of individuals to give a fully coherent picture of their views. Psychological theory suggests a subconscious mind and it could be that a full awareness of cognitive schema is not available to individuals. Thus it would be misleading to interpret each of these views of science as static, complete and coherent. They are the most

dominant, most easily declared view of science available to the individual. The views of science are related to self-concept and so equally as flexible to social context. This section presents the views of science as complete but fully acknowledges the incomplete, fractional nature of ideas.

The public understanding of science desires the positive familiarity with science of society. However, this view of science as neutral is a form of familiarity, yet one that divorces the individual from participation, which is not a stated target of the project. Those who held this traditional view of science were often positive about science and science education as will be explored in Section 5.4 Stances to Science, yet the focused ideas in a neutral view of science are indicative of a very rigid education process. I would argue that the key events in developing this view of science are linked to a stimulating but narrow way. It was the joy of the scientific process that developed into a positive attitude to science but a view that science was apart from social influence. Perhaps this purity of science is the attractive feature. In the following view, Fragmented science, the espoused ideas contrast with neutral science in that the idea of science is incoherent and linked to many other topics. Science is not seen as a narrow but coherent; core process but a diverse set of ideas.

5.3.2 View of Science as Fragmented.

This research shows that those who are informed about science and scientific issues are often more discriminating about what exactly comprises science and what parts of science they agree or disagree with. This research has found it is the most informed people who often have the most definite views on aspects of science. This leads to a fragmented view of science where the definite opinions are coupled with a less focused idea of science. This is a political view of science where the attitude to science is as fragmented as the view. Science is viewed as part of a pattern or somehow connected to many things. The view is one where science is conceptualised as a process more than a body of knowledge. However, the interviewees were still aware of social and academic boundaries surrounding the topic matter.

R *What do you mean, science?*

I *Well, I'd like to know what you think science is. Part of my research is to look at different peoples views of science and what science is.*

R *Oh, so you want me to say what I think science is.*

I *If you don't mind.*

R *Erm [pause] well it's really difficult to give a definition. [pause] I suppose it's exploration, finding out about the world around. Some's really good. Other bits are a bit, well I think perhaps some stuff we'd be better off not meddling with.* (P -1-6F)

This speaker had obviously well formed ideas and opinions on subjects they felt confident in but would not discuss topics they felt they didn't know enough to form a coherent opinion. People who have views of science that are fragmented often follow this pattern of having firm opinion where they are knowledgeable and more hazy, less polarised views where they are less confident.

This is also reflected in the 'borders' of science where the interviewees were often unwilling to express a certain opinion.

I *Do you think science education is science then?*

R *Well, that's tricky. Perhaps that depends on what is taught. No, because that would be science [pause]. If you wanted to teach scientifically. [pause] That's my answer. I don't know enough. What do you think?* (P-1-3F)

I *What do you think science is then?*

R *Well I think it's a bit of everything. Maths is like science but you can't experiment with numbers. No for maths. Music, well I think yes because you have a method and techniques, [pause] ah, but you do in Art don't you? Creative. Umm [pause] well let's pass on Music and think about P.E. [pause] Yes, because it's biology I think so that's easy. Actually it's more difficult classifying than I thought. I think I'm happiest when I know about what's involved. I could tell you more if I was a musician.* (BR-1-1M)

A fragmented view of science seems to be an awareness of boundaries and connectedness. Though that may appear contradictory, it is a feeling for the edges of socially constructed spaces. It is a questioning attitude that in some ways is in tune with the 'questioning' approach to science advocated by a constructivist teaching approach. It could be suggested that these are significantly linked as this fragmented view of science was generally found in the younger parents (those under 35) and perhaps reflects their teaching experience. Certainly many confirmed that they had experienced a more integrated teaching of science and were very aware of their child's progress through the current education techniques. Cross-curricular activity was seen as very helpful and the parents were keen for their child to experience the connectedness of science with other school topics and outside of school. They experienced the workshop as a fragmented entity with many topics within the format. This was particularly interesting as the workshop contained only activities with a physics base. Yet these parents saw the diversity rather than the coherency. They saw the connectedness with other experiences rather than internal consistency.

In summary, parents who expressed a fragmented view of science generally were positive about science. They had enjoyed the process of science and the range of topics involved. They had experienced a 'versatility' within their science education that had made them confident in what they knew but also willing to recognise science as a multifaceted area that they could not hope to understand as an entity.

5.3.3 View of Science as Authoritarian.

The view that science is a method is a strong view held as unifying by those expressing a fragmented view of science. However those who have a more authoritarian view of science, whether in a positive or negative way, will hold that it is more than a method. It is something to do with the nature of the subject. They have a view that sees science as a definite area with a subject matter exclusive to itself.

R *You just can't say that science is this or that but you can say what it's not. It's the opposite to Art. There's one way to go about it, one way to get to the facts of the matter. Art is just the [pause] well arty things. Writing and painting and bits and bobs. It doesn't help with technological progress in the world.* (LM-1-1M)

This speaker actually has a positive view of science yet perhaps was as challenged by the workshop as many others with less enthusiastic approach to science. This view is very coherent and if it is considered as an expression of attitude it is a very positive expression of belief in the value of science and science education. It has been argued within this study that it is these types of beliefs about science that cause the difficulties that science disciplines are having in recruiting. Ironically, it is this view of the value of science that is providing the impetus for the public understanding of science initiative.

Examining the genesis of this attitude and view structure, the individual has formed a strong self-concept based on the distinguishing of groups and the function of them. This was very characteristic of those who believed in the intellectual or moral authority of science. It is also interesting to consider that some individuals within this group believed in the moral authority of science *because* it was a-moral. A scientific view of the world was seen as superior because it transcended societal rules and was 'above' them, rather than apart. On embarking on this research I had conceptualised the amorality of science as 'apart' from society and I was both surprised and intrigued by the removal of consideration of externalities giving a right to judge those externalities. It seemed to be that science could pass comment on moral and ethical issues because they were not part of its structure. It could be argued that this is analogous to religious establishments providing judgement on scientific endeavour. Indeed it happens but it is crowded by similar debate but almost in reverse. Should religion be solely concerned with spiritual matters? Or should it be similarly political because it is 'above' society?

Other speakers have developed a negative view of science through this authoritarian appearance and so polarise similarly. It is this attitude to science that the workshop was most challenged to tackle as the workshop was a product of the authoritarian view it was supposedly working to dispel.

R *I'm very upset mostly with what {my child} learns in science. I don't think they question the ethics of the issues enough. We spent a lot of time a home discussing science programmes and discussing what the alternatives might be. They are not as impartial as they think they are. I always wonder, who's paying for your research eh? I really think that you have to look at everything sceptically. Generosity and compassion. I think that if they can't explain it they aren't interested and if anyone tries to study it they get cross and say it's not science.* (DQ-3-F)

These two views appear dichotomous but they both express science as the authority and polarise arts away from it. This is less obvious in the second view but I would argue that the image of science excluding certain issues suggests a polarity or 'defined' view of science. This issue of

what constitutes science doesn't arise, as science is not a method it is a way of being that is opposite to art even in principle. The view expressed by this speaker has been argued by Rose (1997) using the works of Wolpert (1993) to express the 'mirror to nature' and 'ultimate truth' arguments. She refutes them using work from the social science school.

This view displays an attitude generated by the lack of connectedness shown by the fragmented view of science. If examined for evidence of the development of this attitude framework, most individuals who expressed this view have had very negative experiences of science through their science education. Characterised by the 'clash of learning styles' key event the individual has felt disconnected from the topic with no 'way in'. Therefore the authority with which scientific knowledge is imparted and the esteem that science is held is perceived as unjustified. The individuals who see science as an authority in a negative sense are rebelling against this authority. They do not see the connectedness as any boundary areas are either an area, with which they are familiar, or therefore not science or an area that they do not except authority from and identified with science.

The next view of science, science future, has a more utilitarian outlook. The individuals are not necessarily considering the structure of science or its attributes. They are considering the future and anticipating the impact, for good or bad, that science will have. They are also focusing on the job market and the need for science qualifications. It is a distinctive outlook, quite contrasting with those previously described.

5.3.4 View of Science as a Future.

Another view of science found amongst these parents was the view that science education was necessary as it was the face of the future. They held differing views about whether this was a good or bad thing but the over-riding view was that science was the becoming more and more important.

> R *They all need science, a good science education these days. There's not a job that doesn't use science and technology.*

This parent has identified two levels of science required by children growing up within modern times. The first level is a purely pragmatic acknowledgement of the permeation of science through every level of society. However, the recognition of the need for a good science education is related to the job market. So this speaker encapsulates the sentiment of this view, but adds a caveat.

> R *We haven't all got minds for science. I don't have much patience with it.* (ASH-1-1F)

Others feel very positive about a science-dominated future.

> R *There aren't enough scientists to do all the research and things that need doing and our children must know about it all. I think the future is going to become more and more dependent on science. I don't see how to avoid it and I don't necessarily think it's a bad thing.* (RM-2-2F)

This view has strong echoes of science-fiction images but also once again the economic awareness is apparent which is not so salient in other views.

> R *It's money as well isn't it?*
>
> R2 *There's more money in scientific discoveries than there is in anything else. Look at him who made Microsoft.* (BI-1/2-2F/1M)

The view that science education is necessary for economic achievement is very much in accord with the view of science projected by the Committee on the Public Understanding of Science. If science is promoted as a sound career prospect and an economically progressive one, then it could attract the interest that it requires. However, it could be argued that the 'time' of progression in science, when there was a lot of media attention and the capturing of the public imagination was during the space race. Here science seemed very important, scientific development was linked to national security and the economic superiority of the Western nations. Many parents remembered this era clearly and recalled a 'different' nature for the science experienced.

Those parents who had this economically driven view of science included the Pakistani parents and this is discussed further in Section 5.7. They were often parents who had experienced first hand a technological advance that had impacted hugely on their own careers. Two personal assistants working for large production companies identified the huge changes computerisation had brought to their jobs and the constant upgrading of skills they had had to maintain. The increasing profile of technology and the changes in skills required by people seeking work has caused these individuals to identify science as linked strongly to economic achievement by both the country and at an individual level.

The prominence of science education as a response to the job market and economic development is explored further within the next section. Once again the view is influenced by economic factors but the actual conceptualisation of science is more focused on technology than other views. The distinct between science and technology for many people is clear-cut.

I *What about technology?*

R *Well, I've always felt that was different to science. It's about problem solving and design, not discovery. It's working with computer and 'how to'. I don't think it's so.. well, important isn't the right word. Perhaps central is what I'm looking for.* (ASH -1-1F)

R *I use technology. I don't do anything else with it. I use it like I would use a tool. I don't think science should be linked to technology. Science isn't commercial in the same way.* (L-1-1F)

So this linking of science and technology is very distinct in this economically driven view of science. Though it may occur in other views the distinguishing factor here is that it is seen as an integral part of science and science development. Other views see technology as a separate discipline or working environment.

5.3.5 View of Science and Technology.

The linking of science and technology is relatively modern. Philosophy and science were closely allied in the past, with craft the preserve of lower classes. This historical split has been carried on throughout history, and so science has always been quite separate to technology, which is generally thought of a practical application of science. Technology has become more intimately entwined with science as often scientific discovery was precipitated by an advance in technology, but often it is an advance in scientific understanding that practically applied to advance technology.

More recently the visibility of technology has increased with the growth of the Internet and email. The reduction of traditional jobs such as mining and car production has also been attributed to increases in the automation of such tasks and also changes in the global economy. Even the toys available to children have reflected the increasing technologification of society. Toy fax machines and computers are quite mundane and the more 'traditional' toys such as fluffy animals and action figures have become far more technically advanced, incorporating talking, movement and even an ability to 'learn'.

So the parents who express this view of science and technology are perhaps merely reacting to a shift in emphasis in society.

R *It's important that children learn about computers and technology.*

I *In the curriculum?*

R *In science. The practical applications of what they do.* (S-1-1M)

Here, rather than seeing science practicals as exploring the practical applications of science, technology is seen as the practical side of science. Technology is seen as the extension of science, rather than a separate topic. This gives the impression that technology is not as important as science and yet this was not the case. It was an additional emphasis rather than the only emphasis and it was at the expense of science. This is interesting implication for the public understanding of science as the initiative has often used technological advances to advertise science.

R *I think the technology has been really advanced, what they do in school. I remember that we never did these things in science.* (L-1-2F)

The parent identifies science directly with technology in that technology education is science education. It is attributed to the development of science that the topic matter has changed. Once again I would link this to the impression that many parents held that science was at the cutting edge of developments in society as it was during the 1950's and 60's. Now it is the technological developments that capture the public imagination and are perceived as progressing society into the future. Science has more recently been shown as performing biological research, such as growing human ears on mice and genetically modifying plants, which though acknowledged as important, has not impacted as directly into everyday life as the highly visible technological advances of banks, shopping and audio-technology.

This research also suggests that science in the classroom has grown further apart from science in the commercial research markets. This is necessarily the case as scientific development builds upon itself and gets further and further advanced whereas the scientific phenomena explored in science education - what has come to be regarded as the basics, are never changing. Perhaps the reduction in the relevance of science is inevitable and technology is supplanting it quite rightly as the 'step into understanding' that science used to provide. It is certainly true that the parents interviewed who were involved in gaining educational qualifications themselves were often doing Information Technology courses to update their skills. Any inadequacy with dealing with modern technology was remedied through technology education rather than science education. It could be argued, in conclusion of this section, that science is losing its academic primacy as it is seen as less relevant to everyday life and contradictory though it may seem, no longer on the cutting edge of scientific development. I would argue that this view of the ultimate nature of basics of science teaching is a cause of profound difficulty. It could be suggested that it is time to re-examine what is taught and valued as fundamental.

It is this perception of 'what science is' that has influenced these parents. Their ideas of science were based on qualities of science that have now been superseded by technology. It is difficult to say that any event or educational experience created this view as it seems associated with certain images of science rather than an attitude set. It may be that this group of parents did not necessarily share their attitude to science and so this could be an 'empty' subset. However, within the limited scope of research it seems to be an identifiable group and thus worthy of comment.

5.3.6 Historical-philosophical view of science.

The final view espoused as a distinct by a group of parents is the historical-philosophical view of science. This group is small but distinct in having a unique view of science and science education. Demographically concentrated around post forty females, this group espoused views of science that were very specialised in their focus. Sociologically based these views were questioning the position of science in Western society and the development of science.

I *So what is science then, to you?*

R *Umm, one of those things that I would like to have under the microscope.*(laughs) *I work with a lot of, multi-ethnic groups and it really makes you think..well where did it come from? It's not the way other cultures do it. It's a really Western thing. I think we've become too dependent on science for answers to questions that really perhaps don't have answers or have many answers or shouldn't be answered. I'm not anti-science. It's just it's one way of seeing things.* (N-1-1F)

The individual here is seeing science as an entity, a social entity like any other and worthy of study as such. Science itself is the phenomenon to be studied rather than the topics that comprise science. It is a very reflexive view and the parents who discussed this view often had thought about their science experience with a sociological view. In this way they were most aware of the process of education they had experienced and the events that had influenced them and I would argue that they had experienced 'critical incidents' in the sense used by Tripp (1993). By this, it is meant that they experienced a meaningful framing of their science education through analysis and reflection.

R *I think we ignore cultures that have something else rather than science. We look at what they've got scientifically rather than examining ourselves. I really believe that other cultures have other ways of conceptualising the world. It makes me cross that we use scientific development as a way of assessing the development of a nation culturally.* (P-1-4F)

This parent did not begin to question science as an academic and commercial pursuit until they worked for an international support centre. They then developed an interest in how other cultures perceive British science education. So in a way it could be argued that the events that have formed this person's view of science were not formed during education at all. They gave rise to a

set of concepts and ideas that were considerably challenged by later experience. It is this 'change through challenge' that was the goal of the 'Let's Investigate' workshop. It aimed to challenge ideas through offering differing experiences of science, perhaps very different to those previously experienced. The view here could be seen as threatening to traditional Western science but has a lot to offer education in science as a model for making scientific ideas internationally relevant and challenging to school children.

This view that science is a cultural and social phenomenon was also shown by interviewees who were interested in the historical aspects of science.

R *I read a lot of books about discoveries.*

I *Yes?*

R *Well, not everything was found out by us lot, here.*

I *Sorry?*

R *I mean, all the Chinese inventions. Their society is very different. Historically.*

I *This gives you a different view of science?*

R *Well I look at it in light of the atmosphere at the time. Economic influences, religious influences. I think that everything is discovered at a time suited to it.* (P-1-5F)

This is a very complex idea and certainly at home within the wider body of philosophy. I would rephrase the idea as the scientific conceptual development of mankind is linked to their economic and religious development. Some might argue that in fact the economy and religious development of society was determined by the development of scientific thought and this is certainly not a debate that would easily be resolved within the space available here. What is worthy of comment, however, is that this complex philosophical view had risen, for this individual, from their interest in technological development caused by the introduction of some science 'history' into science lessons.

R *My teacher brought in some different radio and the class was talking about different ways of communicating and how they had changed to world and I was really interested. I suppose it started there.* (P-1-5F)

If the homogeneity of this group is ignored then it could be argued that this view of science was generated through key events and a process of development as all attitudes. The individuals here are expressing ideas based on a particular view of science not often emphasised, within the class room or within a commercial setting. The cultural boundaries of science are certainly visible on scrutiny and the differences between Chinese development in science, Japanese development in science, Arabian development in maths and Scandinavian advances in environmental technology highlight the different cultural histories and attitudes to what could be considered science.

However the Western idea of science, which is surely what is being discussed here does not allow for the cultural perspective as it is meant to be objective and thus beyond societal influence. As I have previously argued and will, no doubt, reiterate this is errant nonsense as science itself is a socially constructed topic and the topics it focuses on are socially and culturally determined and though to a certain degree so are its findings.

The historical-philosophical view of science is a look beyond the boundaries of science into alternative sciences. To draw attention back to the demographic profile of the parents interviewed who expressed this view it could be tentatively suggested that they have perhaps become more socially aware of boundaries and alternative worlds through their experiences socially and personally. To be more specific, divorces, racial integration and changing work place have changed the roles and opportunities available to women. Their lives have made them re-examine assumptions about roles and knowledge and ability. So it could be argued that these women have experienced a challenge to their ideas of science through the same social changes that have challenged science to address the apathy toward it. Currently the science industry is attempting to change society into appreciating it more and understanding it more rather than attempting to change itself, its structure and presentation to create the interest and respect it feels is required. It may be because those who are involved in science do not see its indeterminate nature and so feel that science cannot change. It is the truth seeking discipline and to alter its nature would change science until it was unrecognisable.

5.3.7 Conclusion.

In conclusion, these views of science are neither discreet nor ultimate descriptions of how individuals may conceptualise science. They are dominant features of groups, as I perceive them. Access to these views is available to all individuals, it is just a preferred perception of science that fits with their personal narrative. Their view has developed through key events or as in the case of technology and science, an enduring perception of science that has not been shaken. It is part of their working narrative for dealing with science related issues. It is this working narrative or schema that will be addressed next where stances to science are examined.

What can be seen from the views of science shown here is that many individuals are aware of a connectedness of science outside the body of the topic. This will be discussed later in talking about the boundaries of subjects and gatekeepers of science[31] but here there will be a brief discussion of the implications this has for the formation of views of science. The public understanding of science has not aligned itself with any topic outside its main allies, such as technology. It seems, from this research that people's views of science give it a far broader outlook than might be anticipated using P.U.S. as a starting framework. It must be considered that people attitudes and views of science are not necessarily referring to the same science 'object'. An expanded sense of connectedness could aid understanding of science as it allows various attitudes to form about different aspects of science rather than being insistent over the body of science and thus alienating people. For example, an individual may be interested in the history of science. Rather than attributing this interest to history, it could be claimed by science. But to do this science must give up the idea that it is a non-political process and acknowledge its social nature.

---

[31] Section 5.6.3

Another example would be an interest in mechanics. Rather than disassociating itself from the crude applications of scientific principles, science could claim this area as part of its body corporate; it certainly has not balked at reclaiming technology and computing, as these subjects have ascended in profile.

On the nature of key events and science education, it seems that views of science are often 'pinned' to events or opinions or impressions formed through education. However, life offers its own challenges to assumptions and the progression of views beyond those formed at school; and important lessons can be learnt here for attitude changes and the development of more questioning and positive attitudes to science. This thesis is concentrating mainly on the factors influencing the process of attitude formation and structure, rather than how to effect change, though that is a discussion point. Therefore in-depth discussion of how attitudes have been changed through key events is beyond the scope of this study. However, the actual mechanism of attitude change has not been addressed beyond the work of Festinger and Bem in the 1960's and this research may provide an insight into an alternative approach to this study. For example, if attitude change is conceptualised as significant change in life narrative and conceptualisation of the attitude object then a better predictive link with behaviour may be discovered rather than the superficial changes engendered by cognitive manipulation through psychological experiments.

Another important implication of this research's examination of views of science is the importance of history to science: both recent history within human memory but 'ancient' history and the genesis of science and scientific ideas. The access to history of a subject seems to be important to feelings of empowerment about science[32]. The knowledge of science history can give the individual a sense that they can comment on science and science education without an indepth knowledge of the topic. In other words they can express differing views on science as the exposure of its history also exposes the falsity of its claim to be above comment through its objectivity. It becomes apparent on studying science history that science is more than the seeking of truth about the nature of the physical world. In-depth knowledge of a scientific subject does not preclude discussion of its nature and purpose. Certainly no one feels that a teaching qualification is required to comment on education or a nursing degree to express an opinion on the National Health Service. It is the political nature of these entities, in that they are of concern to everyone that encourages this discourse. The idea that science is not political and not involved in society, and therefore not open to criticism or debate from the general public has stifled interest in the topic and engendered misunderstanding. The isolationism and elitism apparently fostered in science has removed it from the public domain. It has become without history. It seems an unavoidable tension that to put science back within the public domain also involves allowing the history of science to make it a political creature.

Now the various views of science have been identified and examined, it becomes important to consider how individuals make this view operational. So the study moves on to consider stance to science, this working dynamically with views of science to give an 'attitude' to science related to all three aspects, key events, views and stances.

---

[32] The word 'empowerment' is used with caution here. It has been much abused in the nineties as a catchword for management or self-improvement courses. Empowerment has often been used to mean 'education' and even 'indoctrination into a certain mind set'. Here it is used to convey the idea that the individual can speak as they see fit, either for or against or from a difference conceptualisation completely. In other words, not empowered to speak positively and intelligently about science but in any way they see fit.

5.4 Stances to Science.

5.4.1 Introduction.

Stances to science comprise the dynamic component of views. They encapsulate the characteristic behaviours of people interacting with science and come toward linking attitude to behaviour. This chapter attempts to show the different stances to science used by individuals and how these interact with and are linked to their experiences and attitudes. It also shows further how personal narrative and self-concept can add another dimension to a view of science, making it dynamic and functional.

Stances to science are not only linked to views of science. As stances to science are ways of seeking information, processing information and drawing operational conclusions, they are also linked to the learning style of the individual. For example, those categorised by Johnston (1996) as precise processors will seek detailed information, at a high level of complexity. Technical processors will seek a pragmatic approach to what information they seek and the responses they give. Johnston points out that learning styles are not discrete categories, much in the same way as views of science and stances to science have been conceptualised here as options available and 'preferences' rather than absolute 'types'. So for the purpose of analysis within this study, learning styles have been thought of as 'cognitive processing preferences'. The argument used for including them as explanation of key events in science can be expanded by the use of learning styles here.

The preference for one or two types of information and the predisposition to match information within certain schemata is an expansion of the simple learning style clash. It illustrates how information can challenge ideas or be ignored because they do not match previous ideas, or perhaps are simply missed in the information search. A comparison between this and the latitude of acceptance as explored by Bem (1970) would be somewhat erroneous. Latitude of acceptance suggests that if an individual receives information that falls within their boundaries of belief they will accept that information. If it falls toward one end of the scale then they will perhaps shift their latitude of acceptance to incorporate this idea more fully. If the information is not acceptable then it is disregarded. I would argue this is an almost Bayesian conceptualisation of belief and flawed in the same ways[33].

Latitude of acceptance assumes that the individual has a continuous scale of belief and will not believe contradictory information. Neither will people use other schema for making judgements

---

[33]Bayes theorem suggests that if a person has a certain belief that an event will happen that is not completely certain, they will also have a belief that the event will not happen. These two beliefs, when expressed as probabilities must add up to 1, because an event must either happen or not happen. As an illustration, an individual will normally have a belief that a coin will fall on 'heads' at a 50% level and that it will fall on tails at a 50% level, reflecting the two states available to a coin. So the probability that it will land on tails or heads is 100% because there are no alternatives. [We assume for the purpose of illustration that the 'edge' probability and the 'roll away and fall down a floor board crack' are neglible]. However, the idea that all events are open to such logical numerial interpretation is flawed. An event such as the belief that science is an autocratic institution is so complex that the number of states it encompasses is almost infinite. It would be extremely difficult to assign numerical probabilities to beliefs about the various states.

about information. Neither will people miss information due to these schemas acting as cognitive short cuts or heuristics and bypassing this information. I would argue all these processes cause a form of positive feedback where people tend not to find information that is outside their latitude of acceptance. They are also not capable of the fine definition that identifies something as 'just within' a latitude of acceptance. As this chapter illustrates, information that truly challenges attitude also challenges belief and cannot be ignored. Stances to science show that the conceptualisations of attitude generally used in psychology have been crude and tuned to experimental use.

Learning styles influence information processing and views of science provide schema for the interpretation of data. Stances to science show us the information searching and provide the causality of the patterns we see there. The narrative process also provides insight into how the individual deals with information as it provides linguistic devices and cultural frameworks for us to use that are universal communication devices within our culture. This thesis is not engaged in linguistic analysis but because it seeks to reflect the connectedness and shared spaces espoused as a moral and epistemological framework it seems appropriate to utilise tools that allow insight from all academic disciplines. In other words, it is useful to borrow from other areas and does not run against the philosophy of this research.

The narrative devices used to examine stances to science are generally literary types. These types are found in English literature and to some degree shared over other Western cultures. There are stories of triumph over adversity and these are romances; there are tales of struggle and needless loss and these are tragedies. Stories of triumph in foolishness, comedy and stories that parody respected societal bodies and thus pass comment of the human condition.

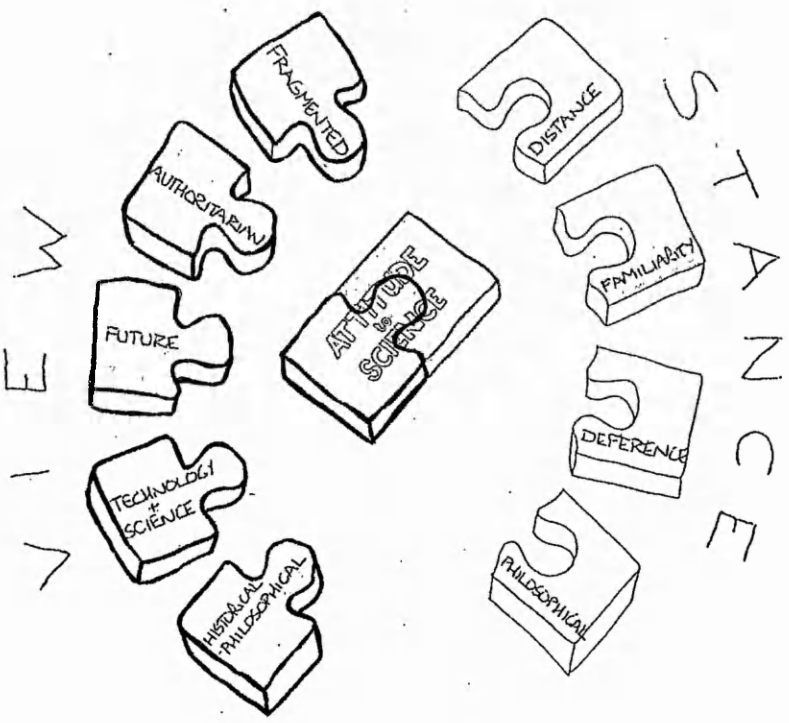


Figure 2

Diagram showing combinations of stances and views possible

5.4.2 Distance.

Those who put distance between themselves and science use external forms of judgement to support their stance. They do not depend on scientists themselves or science teachers to provide information about science. They seek external sources of information, parties they see as having no vested interest. What is particularly interesting about this stance is that it does not believe in the impartiality of science. Those who take this stance seemed to be those who were either feeling that science was authoritarian in a negative sense or taking a historical-philosophical view of science, though of those who were grouped in the latter group tended to combine a number of stances to science. The difficulty with this view is that external sources of information are very few. One response to this problem is 'cross referencing' sources but also 'alternative' information.

> R [scientists] *are just going to put forward their view aren't they or the view of whoever's paying them. It's too political. I see what's on telly and read the papers and that gives you a start. Ask the people who work there.* (RM-3-F)

Note what is required here is not some statement from the persons involved but an external source of information on which to judge other information. This effort to gain information is not associated with a positive view of science education. It is linked to the view that science is a school subject little to do with science in the real world and that science itself has little to do with day to day living. It has little concern with the value or nature of science but has doubts about information with regard to individual projects. It requires an external view with which information can be judged.

> R *It's hard because science is so complex these days. When I was at school the whole world was involved in science with the space race and such like. It seemed so much more accessible, less faceless. Now you can't rely on them, you have to listen to other people.* (L-2-F)

Sometimes personal experience is used as a judge of science.

> R *I worked for a while in part of a management team for {pharmaceutical company} and that was a real eye-opener. You'd never believe what you hear after that.* (JB3-1-M)

In this way science and sources of information about science can be judged without reliance on the scientific community. In fact it is an inversion of the 'normal' judgement process. Rather than the scientists providing information, science is judged by the people with 'insider' knowledge such as 'scientist friends'. It seems to be linked with narrative tragedy, perhaps betrayal or distrust. The stories used by the individuals showing this stance to science concentrated on their 'enlightenment' or 'disillusionment' with science in contrast to their former innocence. It does not necessarily have to be a first party information search.

> R *My sister works for {large petro-chemical company} and she says nothing is done with out one eye on the budget.* (BI2-1-F)

Those who use external sources seem to keep themselves at a distance from science and the scientific community. They express a desire not to be involved, not to know about the details of the subject. This emerges as indifference rather than a determination.

I *Do you get involved in 'Science, Engineering and Technology' week?*
R *Only if there's something on at the school that {my child} is involved with. It's not something I'd usually be interested in.*
I *Do you think there are things about science you'd like to know?*
R *No*
I *Or science education?*
R *Well, not really, no. There's nothing I can think of.*
R (laughs)
R *Well, not that I'm not interested in {my child's} education. I just think that if he's happy then I'm happy.* (G2-1-F)

So the accessibility of science is not questioned. It is seen as a matter of personal choice and inclination. If science is work, then the distinction between social and work involvement is drawn. It is a particular group that involve themselves in scientific hobbies but this is regarded as a personal interest.

The view that science is a school subject is a characteristic of many of those taking this stance. They see science as a subject to be studied not utilised outside of school. The understanding of what rationale is used for the study of science within school is variable. Some parents understanding is that science taught within school to cope with living in a technological age; others that science is used as a way of giving access to tools to shape life. Others see it as a method of insuring certain skills that are required for day to day living, such as logical thinking.

R *Well, it's good to know these things that help around the home. For example I'm sure I could do the job that this electricians doing in here* (this room) *at the moment. It must be a simple case of circuits and I feel frustrated that I have to get someone in to do it.* (L1-1-F)

The 'science to cope' attitude system is a reactive one. Science understanding is required to cope with things that will happen to an individual. The parent expresses a desire to have more control of their life through better access to science but the view is one of passive reaction. In contrast those who have a shaping view of science are more dynamic in their view of the purpose of education.

R *If she gets a good education in science that will leave a lot of doors open for her. And I want her to have control over what she does. She's already familiar with all the bits of technology in her home but I want a science education to give her more than that. I would like to think she understood the principles more and how things worked. I want her not to be afraid to ask questions and basically I want her to be confident.* (W-1-F)

This is a stark contrast to the view of science as an obligatory subject. Parents with this view often don't think the content of science is the important facet. This view is that science produces mental discipline but is a bit useless content-wise. Science can also be perceived as a thing that scientists do. A distinction is drawn between science education and science in a working environment.

In conclusion those who are expressing a distance from science either education or 'outside' are using the stance to science to fill in an information deficit. They are filtering out the 'biased' information from science and weighting external sources more heavily. Relating these to key events these individuals have often felt that the science education they received in school was irrelevant to the science outside and make a distinction between these two regarding their children's current education. The negative authoritarian view of science which influences this stance generates a mistrust of information from scientific sources but does not necessarily preclude a view that science is useful whether it is to cope, shape or provide mental discipline for life. I would suggest that this stance has generated from the experiences of science that have meant they have distanced themselves from science. Such experiences seem to be widely based around a feeling of non-utility of their science education.

From this initial look at a stance to science it can be seen that is not perhaps as keenly associated with one view of science as one might expect. In fact it may be that there is a deeper level commonality underlying these groupings that would provide a more parsimonious impression of function. However, within this research nothing has been generated to suggest that this may be the case. So it is concluded that though elegance is desirable it is not always obtainable and in a post-modern interpretation of research necessary. Stances to science here can be seen as ways of gaining information and dealing with science. They are more immediate than views of science, which can sometimes be expressed philosophically. Stances to science are the 'business end' of attitudes and views.

Within this very first section mention has been made of the idea of stances to science as an attitude heuristic. If we accept the premise that an individual's view of science is fundamentally pragmatic (but not necessarily optimal) and not based on a 'rational' approach (such as latitude acceptance and Bayesian probability) then it is easy to conceptualise attitude as a 'rule of thumb' or scheme that allows social judgements to be made fluidly. It allows the integration of a wealth of material into a picture of self that is working well for that individual. This idea bears a resemblance to learning theory, but only superficially. Learning theory does not support a coherent personality theory that is similar to a social constructionist self-concept. However learning theory is based very much on simple rules of aversion, reward and identity crises (Mischel 1973).

The idea of a stance to science as a heuristic also allows it to be conceptualised as a bias. This has negative connotations that this study wishes to avoid. Attitudes are not biases to be eliminated or controlled for, they are legitimate, functional schema without which social interaction would become immensely more difficult. In the next section the stance can be thought of as a heuristic

that uses personal experience as a criterion of judgement to the exclusion of other information sources, though this information can be as up to date any other information source, depending on the relationship with the topic matter. In the next section the opposite stance to science is examined, that of familiarity. The proximity of these sections allows a strong contrast to be drawn between these stances which helps draw distinctions in what could otherwise be a confusing selection.

5.4.3 Familiarity.

Those who have familiarity with science are expressing a certain rapport with the subject. This happens when the individual has prior knowledge of or involvement with science. In its extreme form this is actually being a scientist but those who are involved in scientific matters may make an involved judgement about science also. Familiarity involves general knowledge of scientific progress but also the terminology and methods involved in science. It is associated with a view of science that is in keeping with current practice and appreciative of the aims of scientists and science educators. Thus, for instance, a discussion of ethical issues or journal reading may be seen as being central rather than marginal to more formal considerations. It is a working view of science that may have a positive authoritarian view.

> R *They have to assess the pros and cons and listen to all sides. They can't just make a decision anymore, they have to think about safety. And schools reflect that. The schools try to explore these issues, to get people to think about science, not just scientifically. They have to consider different methods and techniques. Recovery of by-products, disposal of toxic waste they're all important.* (L1-3-F)

This parent knows what science education is all about, or at least exhibits knowledge of current thinking. Such knowledge is necessarily associated with this view of science. The very language of this parent betrays a participation in scientific discourse. Scientists may use little snippets of scientific knowledge to illustrate their conversation. Essentially a familiar stance to science is a stance of romance. It may be a cerebral romance but is still narrated in the familiar form of initial attraction, some adversity overcome and a happy conclusion. In looking at the interview narratives with an interpretative framework based on literature styles, the 'romantic' narratives seem to have a 'rites of passage' view of the adversity or perhaps a transition through a boundary. It was often expressed as the moment when they first felt like a 'real scientist' or that they had been accepted into the scientific community. It could be suggested that this holds similarity to an 'ecstatic' religious experience, however in accordance with the philosophy of this study, such events are defined by their interpretation and not by the features of the experience itself. This pattern of experience is also found in those who express a familiar stance to science but do not necessarily work within a context that could be considered scientific. Their adversity and triumph seemed to be expressed more as a challenge of understanding science rather than a challenge from 'within' science. To illustrate this point, a challenge from within science might be a promotion, getting an academic paper published or finding a rewarding job within science. A challenge provided by science is more like a key event. It may be comprised of a sudden understanding of a principle, a hard earned success at an experiment or a recognition of endeavour by a scientific body. The distinction is the nature of the challenge and the timing of the challenge. An early success can lead to a career in science or just a continued familiarity and liking for the subject. If

the career in science progresses the initial triumph is usually superseded by another event 'internal' to science. So first comes a key event to inspire science study or pleasure in science and then comes a 'boundary' crossing admitting the individual into the scientific community and confirming them in their role.

Familiarity with science does not necessarily mean a positive stance to science. What is key to this stance is whether there is agreement or disagreement with a line of scientific endeavour its language can be understood at a general level. Thus, a form of science or science education can be challenged on its own grounds. Scientific endeavour is not distant and distrusted but investigations into potential futures that require serious attention.

> R *While I was training in the lab I was very aware of the skills and methods I was being taught rather than just the information. I was taught to examine discrepancies and interesting sidelines as areas of potential study. Never discard something that's gone wrong until you know what's gone wrong. Study differences and eliminate untruths.* (SM2-2-M)

There is a view here that is in distinction, if not opposition to that taken by other parents, particularly those who are critical of scientists. For the criticisms of science made here are always insiders' criticisms; they are aware of the problems of scientific research and interpret it in the light of its own intentions. Others may interpret the delay of release of a useful medicine as a kind of control mechanisms, those who are making involved judgements, with a familiar stance to science see the possibility of various reasons for this action or inaction.

> R [some people] *think that I'm always testing on animals and things but it's really difficult to do that these days. You need a lot of permission to do that sort of thing. It doesn't get done unless it's necessary.* (T1-1-F)

Here the speaker makes sense of a misleading impression and stops the negative judgement. This ability to make sense or justify what occurs, based on a knowledge of science itself, allows fine distinctions to be drawn such as that between what can be achieved by modern science and what cannot.

> R *It could be muscular you know, if I can't find any exposed nervous tissue. It's difficult to always be certain. Some things you wonder if they would be better off going to a throat specialist. Sometimes it's impossible to find out what's wrong.* (WB1-1-M)

Thus, judgements of this form depend upon interpretative procedures stemming from a fairly close knowledge of science. This knowledge predisposes the speaker to make a particular sense of other science disciplines. Whereas it is not necessary to enquire whether this is an accurate or good reading of the situation, it is clearly significant that it would be intelligible and acceptable to the scientists involved.

For a parent who is also a scientist they have a particular interest in their child's science education. They are in a unique position to judge what their child is learning by formal standards. For example the action of forces.

> R *I suppose I don't pass comment on his schooling unless it's something I know about like electricity. When he was doing circuits I felt that they were using the wrong ideas about how voltage works but then I am not a teacher so perhaps they know how to get the idea across better.* (T1-1-F)

It is interesting to note that whilst the parent gains insight into the child's progress he doesn't necessarily act to complain. For this parent there is also a view of teaching science that doesn't always follow from science as he experiences it through work.

Parents who are familiar with science through work otherwise are confident of the accessibility of information if required.

> R *I feel there is a genuine, well a desire really, between the scientific people that they want people to understand what they're doing.* (WB2-1-F)

They say there is a good relationship between science and society and that scientists are generally motivated to inform. In some ways these parents have established their relationship to science in a way that makes scientific work another 'normal' job. Scientific work is familiar and demands for explanations or illumination unexceptional. Contact with scientific expertise does not have to be created or sought but occurs as an aside to other actions. This view is often a supportive one toward the scientific community including science education. Support is offered but not control or interference.

> R *I think it's important to understand that they're just humans doing a job for money. Of course they are going to make mistakes, be good and bad just like everyone else. It's too easy to forget that they're just normal.* (JB1-1-F)

However this view is ideally reciprocal and science is expected to act in a professional and ethical manner.

> R *It's a huge disappointment when you feel the scientists are just doing silly stuff, like searching for the Loch Ness monster or doing experiments on why coffee drips leave brown rings.* (JB1-1-F)

The consequences of this relationship should be evident if information is asked for. Parents who have interacted with scientists as a client, through the health service for example have expected and to a large degree found, care and attention paid to them as a 'service user'. Although this support is an important characteristic, it is not the central element. It is a familiarity with

scientific affairs that forms the key factor in this stance. Those who adopt it want to be familiar with science and not shut off.

Social relationships with people considered as scientists are also characteristic of this stance. The distinction between scientist and non-scientist is merely a role distinction and they are socially homogenous. They can meet at social functions or are friends.

> I *Do you know many scientists?*
> R *Yes, but then I would expect to living in an area like this, so close to the* {large hospital} *and the University and the* {pharmaceutical company} *site. Loads of my friends work in labs and the other parents around here, loads of them work at the* {hospital} *or the University.* (AR1-2-F)

So the familiar stance is not one taken up after parenthood but precedes it and makes a particular view of science education possible. It could be suggested that this stance has a broadly social basis. There are those who build upon this basis, but these are people with a particular interest in scientific matters, often involved in work of that nature themselves. This stance is not adopted in later life however, but a reflection of social origins and experience.

This participation in science provides an indirect enhancement of subsequent encounters with science education. It enables parents to learn about teaching methods and underlying rationale behind science education. Often parents will work with their children and so remove from the experience overtones of authority that adhere to being told about things by a school teacher. Parents sometimes find that they have acquired a specialised knowledge that allows them to understand their children's work, a knowledge that marks them out from other parents. This knowledge is in some ways a language, rather than a gathering of facts. It is difficult for parents who don't speak the language to break into the mindset of possibilities.

A shared language and understanding have more than communicational significance. It is more than just a technical matter. A willingness to talk freely and listen carefully requires confidence. Whereas familiarity may involve learning the language of science, knowledge of that language itself is not sufficient to constitute familiarity. For although it allows for efficient communication it may also at times render communication unnecessary due to the establishment of trust.

> R *I wonder if there is any real need to know about it all really. I think an awful lot of trust comes into it, and I believe that most are real professionals. No I'm quite happy, because I get told that things are alright. I suppose I take it a bit for granted that if something goes wrong then we'll all hear about it won't we, these days.* (WB1-1-M)

Other factors associated with familiarity also contribute to trust in one form or another. As most of the people who adopt this position have had extended dealings with science, they tend to take science education for granted. They readily assume that children will develop an interest in science and this will happen naturally. They are, therefore, less concerned than some parents about the standard of work in basic subjects, and may show more appreciation of other activities such as music. Judging possible futures by their own past they may already believe that the child

is likely to end up with an adequate understanding of science for whatever they want to do and therefore be less anxious about the stages along the way. However it cannot be expected that all parents who may be considered as working in a scientific environment relate their experiences to schoolwork or to science of another nature. This leads to a dichotomous view of science taking different stances to different aspects.

R *Do you mean what they do in school or what scientists do if you know what I mean?*
I *I'm not sure. How much do you think they are related?*
R *Well, not a lot really. Science education is education, not training for a job. I mean if* {my child} *decides to take up a career in science I'll be able to help but science education I can't really help with this stuff because it's not what I do. It's designed for a different purpose.* (KIA1-2-F)

This speaker identifies that science education is very different to science as they have experienced it and could be familiar with her work but distance to science education. This pattern can be repeated with all people who do not have an integrated view of science.

In conclusion those with a familiarity with science are often those who have had their stance to science influenced by their key events experienced within science. Their familiarity allows different access patterns to information and often different interpretations of what they see. However, they will often distinguish between aspects of science and seem to be more conscious of defining definite boundaries of science as a topic. They are more aware of the differences between science and science education. Within this category I have included those with a 'familiar' stance to science education rather than perhaps science. Though there were differences they could be considered minimal in consideration of the differences across stances. However some brief discussion of these contrasts is worthy of inclusion in this brief concluding section, as they provide an area of possible investigation for this research or perhaps, as I have suggested before, a different underlying framework that could provide a more elegant conceptualisation of attitudes to science.

Those who are familiar with science *education* either through work or through immediacy of experience (some of those interviewed were in the process of acquiring educational qualifications in a science subject) stance to science was different from those who worked within science either as a hobby or as a career choice. Though they sought information in the same ways, for example they had no problems approaching or challenging sources of science information the 'educational' view of science was unsurprisingly more pedagogically oriented. They focused more on their understanding of the processes, nature and knowledge involved in science rather than presenting an absolutist view of science. It is a fine distinction and yet one that does reveal a slight difference in stance to science. It seems that the transmitting of science knowledge is the focus of those who are involved in science education.

I would tentatively suggest that this research has shown that those who are involved in science education are concerned primarily with the learning process and interpretative process rather than the knowledge of science itself. This orientation places a different categorisation on information in that it is not valued for itself but its usefulness in facilitating education. For example: the

removal of DNA (diribo-neucleic-acid) from an onion is possible though diligent boiling and judicious application of washing-up liquid. The DNA is finally extracted as a white cottony lump that tells you nothing about the nature of DNA, how it was discovered or what it means for society. However, as a pedagogic device, as an exciting experiment that helps ground material in real life experience it can be considered invaluable. So information is valued differently, though it is sought in the same manner.

Thinking along these lines has suggested that perhaps stances to science could be thought of in terms of information processing. The type of difference I am suggesting between those processing from within science rather than those involved as an external participant could be cautiously linked to the forms of thought and language suggested by Habermas (1984). He suggests that two forms of thought, the first is action oriented, seeking pragmatic solutions and functional focused interests; the second is a discourse, focused on an inter-subject search for knowledge that is guided solely by the aim of reaching a rational consensus. Those within science are action oriented those in education perhaps more discourse oriented, seeking to understand science as a human process from the perspective of the various participants.

From familiarity the study moves to deference, once again trying to contrast stances to highlight similarities and differences. Deference is a good contrast to familiarity, for it is rare to defer to something you are comfortable or familiar with. Deference implies distance and it is this distinction in view that is particularly important in the next section. It is also a particularly interesting stance considering the movement toward the public understanding of science which appears to wish for both deference and familiarity in the public.

5.4.4 Deference.

It could be said of those who adopt an authoritative form of judgement that they defer to scientists as the access to universal truths. Thus the relationship between science and parents associated with this view of science seems to involve a deferential stance by the parents. In this relationship the scientist is viewed as the impartial expert who pronounces on matters of concern. The part of the lay person is to listen carefully and act accordingly or provide information to the expert to aid their work. This stance is perhaps the most closely linked to the corresponding view of, the more crystallised ideas of science expressed by those who have an authoritarian view of science.

> *R* *They have spent years studying these things. Even if you don't feel it's the best way or whatever. They always know what they're about.* (SA1-1-F)

This stance does not deny the possibility of error by scientists but suggests that their goals are altruistic. This view can even stretch to privately employed scientists. To think once again about information processing, these parents are not seeking information actively. They are passive recipients of scientific knowledge and when queried they did not necessarily see the levels of credibility of information seen by other parents.

They appeared to suggest that all information delivered through authoritative sources was not questionable.

I *Is it important to know about the scientists themselves?*
R *Well, it's nice to see them on telly, but I don't know whether that's important. I think it's nice if you feel you can know them a little but I don't think*
I *It's important?*
R *Yes.*
I *So what do you feel is important then?*
R *It's between the people who talk to the public and the scientists. They've got to make sure that's right, that we're getting the right information. That's the main thing.*

This parent relies on public liaison to find out what the scientists think. She asserts that the scientists' words are the essential information. The questions offered by the interviewer are aimed at finding out how they see themselves in relation to science and the answers offered are to point to the information systems to generate trust.

I *Do you think scientists are good at communicating what they're doing?*
R *I can't say. It's up to other people really. I feel like I get all the information I need and I trust the in between people to keep us up to date.* (P-1-3F)

This parent was particularly concerned with the information sources during the B.S.E. scare of 1997 and felt that rather than unclear advice being offered by scientists, it was unclear communication of politics and the media that resulted in mixed messages being passed onto the public. The essential relationship is between the scientists and the "in between people". If that relationship is good then one can trust what information is being given. It is irrelevant to ask how one goes about finding things out as an activity in itself for there is no secondary or alternative evidence that can replace the scientists authoritative comment. The only way in which one can judge this comment is to examine the 'in-between' reaction. If it is one of confusion then judgement cannot be made.

R *This one's* [my doctor] *is very good with information. My other one would say, "well, there are alternatives and it is your choice", I'd be really confused. This one says 'this is the latest thinking and this is what we're going for'. I like to think I'm getting the best, the latest.* (MM-1-1F)

Here the doctor is an in-between person who is expected to provide information about the latest thinking so that others can know what is happening. Parents who take this stance in their relationship to scientists defer to the in between person as well as a 'judgement maker'. They themselves are peripheral to judgement making and do not attempt to access information unless there is a break down in communication. Scientists are ranked along with other professional people such as teachers and engineers. They will not presume to question or seek out professional

opinion unless it is expected and though they may find the scientific community friendly they will not presume upon that friendship unless they have a specific question in mind.

Some of the parents interviewed like to have some part in their child's science education and look for opportunities to help at home. To this end they seek to develop an understanding of science. Those who take a deferential stance are less willing to display this knowledge by working at home.

> *I* *Do you do science activities with your children, at home?*
> *R* *Well, I might encourage to look at things and tell them a little bit, but I always worry about confusing them. I wouldn't want to give them wrong ideas.* (G-1-M)

Most of the parents interviewed said that the huge advances in science had created a difference atmosphere both in school and in society in general.

> *R* *When I was at school everyone was into the space race, it was brilliant. We all used to watch on television and there were cards to collect and toys and it was everywhere. The astronauts were celebrities. It was a real spirit for the age.*

Science education now is seen to be less transparent.

> *R* *I knew about science then but now it seems a lot more technical. I mean, the basic principles must be the same but the technology seems to have taken over. It's all CD-ROMs and computers.* (RM-2-F2)

In this case there is a harking back to older forms of teaching that might suggest that these parents prefer amore traditional science education without reservations. This is not so. They are usually fairly appreciative of modern science and the inclusion of technology into the curriculum.

> *R* *I don't really see how they can teach science to the youngest ones, the infants but if they can I think that it's good that they will have a better understanding of things when they get to do science at secondary school. With all the new information technology that's coming in they're going to need to know how to get along with it.* (L-1-2F)

The perceived division between secondary science and primary science education is most clearly visible in this stance to science.

> *R* *It's nice, they do all sorts at this age. I wonder why sometimes, or what they do is actually real science. I said to her "did you do chemistry and things?" and she said she did baking which was chemistry. I think that's all they learnt.*

There is something wistful about this piece as if the speaker would really like to believe that cookery is really chemistry. But somehow she cannot quite accept that this is so without the

traditional signs and markers (test tubes, work sheets perhaps). However, the general point being made is that modern pattern of science education is very different to traditional patterns. Those who take this stance don't feel they really understand the pattern of development in science education but neither do they feel they should.

The interviewee here pointed attention way from herself toward her partner as being a suitable authority on science and technology knowledge. This pattern of deferring to others occurs, not frequently but with a persistent regularity. It could be interpreted as a personality trait of those who share this point of view but it could also be a deflecting strategy aimed at moving away from the topic under discussion.

5.4.5 Philosophical.

A philosophical view of science is linked to the historical view of science but also is the stance to science taken by other interviewees. Despite differing views of science the actual stance can be less polarised and lasais faire almost in reaction to this. For example, someone with a strong authoritarian view of science may also characterise their stance through their reaction to this, which would be a philosophical. In other words they have a view of science but their reaction to this view is philosophical in that seem to see view of science and level of involvement with science as a life style choice or a intellectual position.

Those who have this stance to science are tending to see their view of science as a view to be argued with. Not that their view is incorrect, just science in this form can be challenged; not whether science is authoritarian, for example, but whether it *should be* authoritarian. Those who take this stance to science express it as a historical development to be discussed and a source of argument over social justice issues, ethics, technological development and so on.

This is a stance of satirical narrative. It is can be aware of subtlety and contradiction or simply a blunt statement of opinion.

> R *It's just a way of looking at things. It's not special.* (P-1-3F)

The next respondent had a more oblique approach to science.

> R *I think it must be the subject of most contradiction. It must be the most popular cartoon topic and the most easy to caricature just because everything is so serious. The contradiction, cartoons and then the reality - it's too much alike almost.* (ASH-1-1M)

So this stance is less socially naive than other stances, and as such it does not tolerate the social naivety of science. The adherents to this stance tend not to hold ideas about the authority of science but seek alternatives. It is not a stance that focuses on the functional qualities of science, though they acknowledge it as a career choice, rather than a vocation. People who share this stance are often more concerned with the 'rounding' of education through the inclusion of science rather than concerned with the factual content.

So during the search for information about science education, the philosophical stance will seek information on the pedagogy of science education, how it is being taught rather than what is being taught.

> R *She (my child) must enjoy it, what she is doing in science. It don't matter to her or me what it is because you can find out other stuff later.* (EF-1-1F)

Information searches for scientific knowledge seem to be broad and wide-ranging within this stance. The choice of information is from a variety of sources, including the scientific community. This contrasts with the stance of distance where alternative sources of information are desired, or familiarity where the scientific community is used as the primary source of information. They may have a wide variety of views of science but it is largely their stance that dictates how they then deal with this view. In this stance a negative view of science does not necessarily preclude a philosophical stance. This stance encompasses this view. For example, if someone has a negative neutral view of science[34] and is uncomfortable with its tenets it does not seem to stop them being open to opposing argument and debate about the nature of science or the primacy of its methods.

The demographic distribution of this stance is far less focused than the corresponding view. This may be because this is a very flexible stance, which explores a lot of the in-between space in academic disciplines. I would suggest the fluidity and adherence to principle rather than view could be frustrating to those who have a more rigid stance to science. This stance is one of negotiation. This is similar to Habermassian ideas about rational consensus. People who share this stance also seem to believe that there are no true empirical statements independent of our technical interest and so do not see science as a non-political subject; even if they support its neutrality and objectivity they still see this a political decision.

In summary at this point it is important to emphasise the child's place within examination of parents' attitudes to science. With the focus of the child's performance at school being attributed to either the parents or the school as some commentators have already observed, the child is neglected (Edwards and David 1997). This work, once again, is primarily about the parent rather than the child. However, as a basically theoretical piece that though encourages reflection on policy and practice does not lend itself readily to a bold statement of pedagogy. Generally this work recommends a constructivist approach to primary science education, as the process mirrors the research findings regarding attitude formation. If attitudes can be challenged by 'unpicking' key events and challenging the conclusion from them then the presently advocated constructivist science in primary schools that challenges ideas by providing a range of experiences is a possible foil against negative stances being adopted.

This work has also shown how other influences outside the 'content and method' of science teaching can also assist the development of positive or negative stances to science. So I feel that this is a weak endorsement. The true strength of the work is not to influence practice but to aid understanding when dealing with attitudes to science and assist in the continuing debate of its nature and how it should be presented to adults and to children. It is perhaps an unusual argument

---

[34]That science presents itself as a neutral subject but in fact is highly political and this misrepresentation is not acceptable.

but certainly a valid one, that this work suggests that current primary science education is not wrong. Present theorising around this area relies on outdated concepts of attitude and science. It also supports a call for 'parental involvement' to be re-examined to avoid a 'parentocracy' that doesn't recognise the problems of academic, practitioner and politician that synthesise (or not) in children's education.

Both views and stances to science have been discussed as findings. These are generated as a result of interview data. Other information which has added richness to the analysis here also bears some examination. Therefore in the next section a vignette of a workshop is given to provide insight into the research process and data, with a particular focus on home school liaison and the modes of communication. It is followed by a vignette of one particular interviewee, to illustrate how some of the issues to do with women and science were generated and explored.

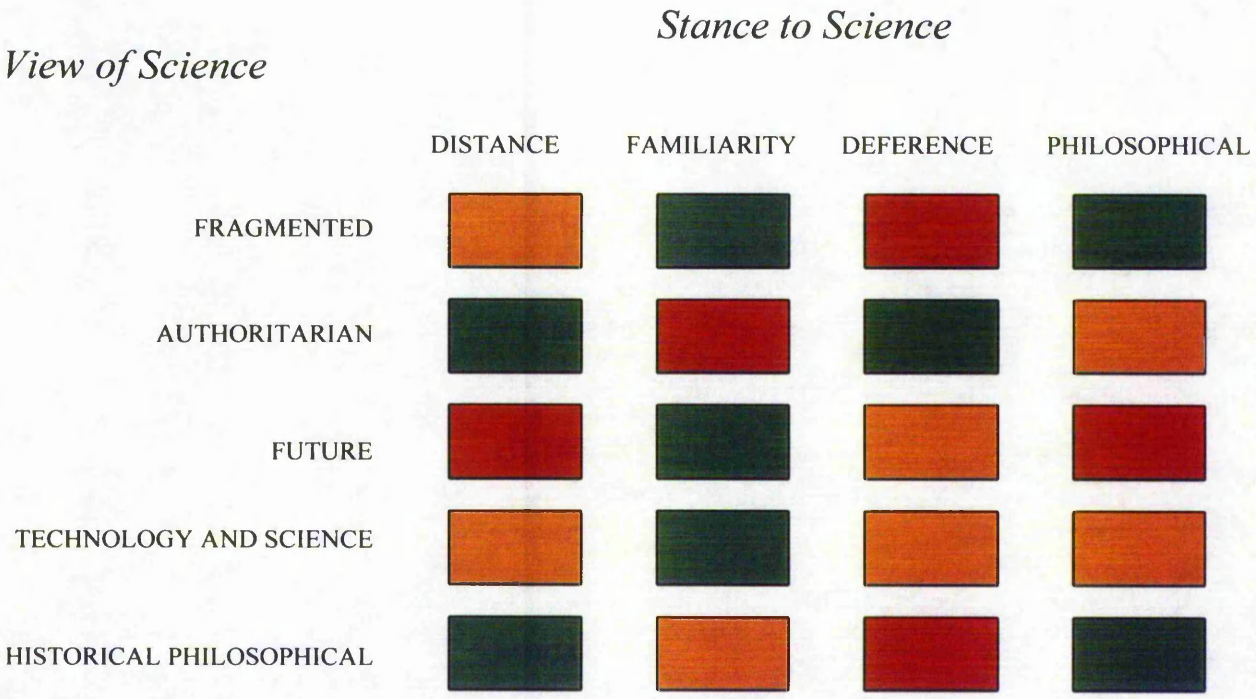
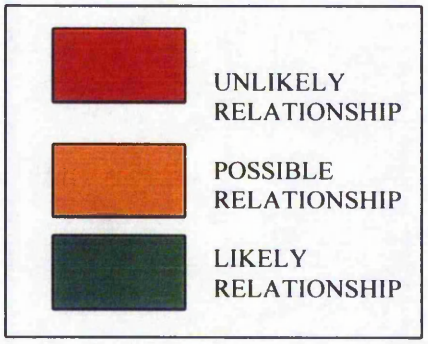


Figure 3: The relationships between stances to science and views of science



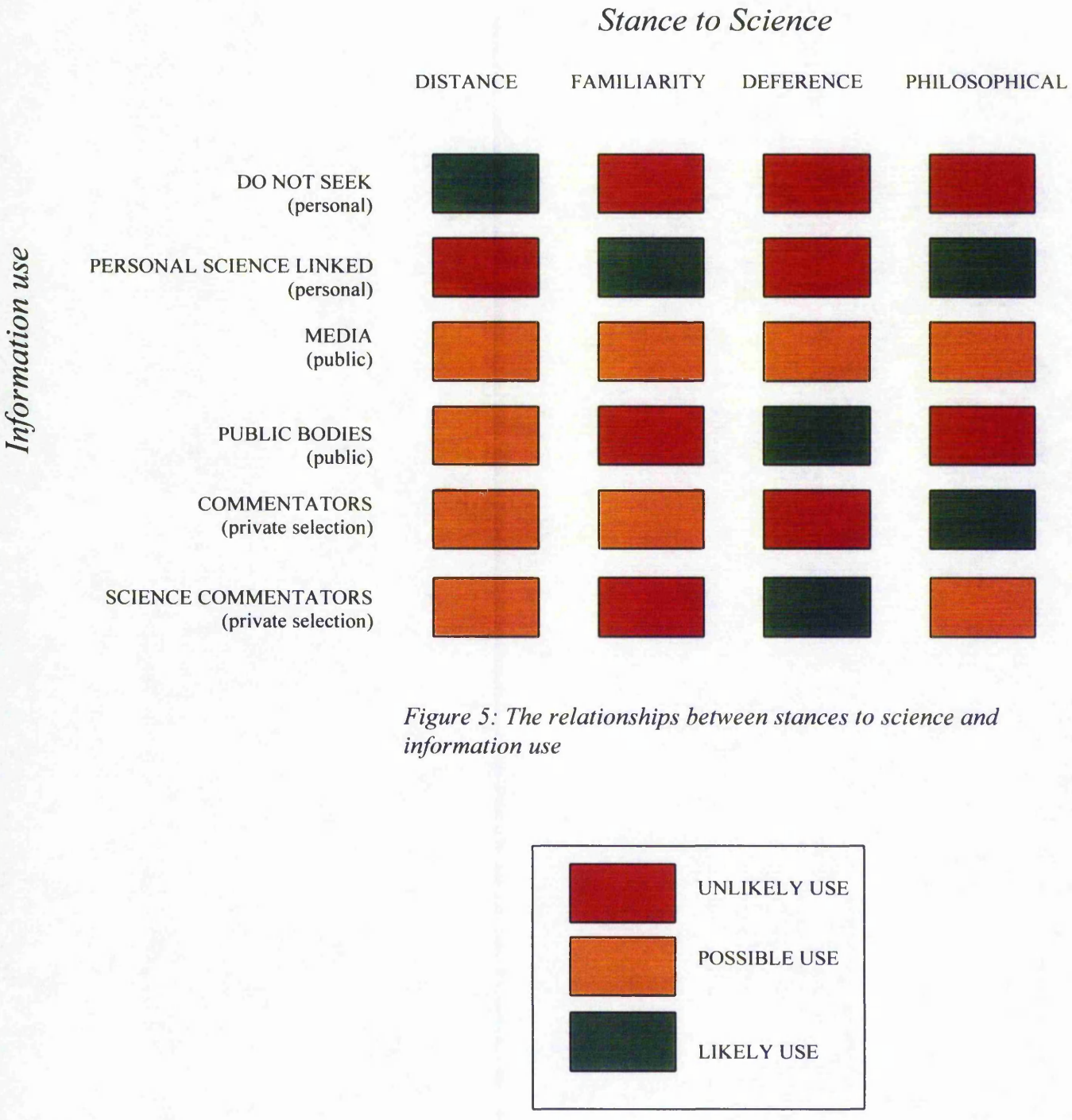


Figure 5: The relationships between stances to science and information use

5.5 Science Workshop Vignettes.

Science workshops and the impact they have on data collected are affected by many factors. Though the relative importance of factors can never be fully ascertained it is imperative that the variety of influences on the workshops and the effect this might have on firstly the data and secondly subsequent development of parental attitude is explored.

It would be naive in the extreme to suggest that the workshops play a vital role in the development of home school liaison but the way the workshop event is managed can give insight in to the workings of home school liaison within an establishment.

The following outline of one particular workshop examines the factors affecting the workshop, how the workshop provides insight into home school liaison and how all of these are reflected in the data given by the parents interviewed.

Mary Anning Junior School
Fressingfield
Small Market Town estimated pop. 15,000

Time 7-9

Weather was Cold, Wet and Windy

Mary Anning Junior is a medium sized (260) junior in the market town of Fressingfield. Its catchment is mainly within the town and close surrounding district. It is within easy commuting distance of a city. During the summer term in the previous year the school had had a science workshop that was held outside as the weather was so good. It was sparsely attended (approximately 8 parents). However, the parents that did attend were enthusiastic and wrote letters that were printed in the school magazine to express this (See Archive). On this basis of this response another workshop was organised. It was part of an on going programme to involve parents in curriculum areas and followed after English and Maths workshops. This workshop was "Parents only". This was so the parents could interact freely with the activities and they adopted a learning role rather than a teaching role.

Advertising for the workshop involved using the standard flyer (See Appendix 4) and then a school letter with a reply slip. This letter was referred to by the teacher as "a letter with a proper reply slip". It was advertised as a follow up to the summer workshop.

Throughout the workshops it became apparent that the importance of initial contact with the parents through invitations was paramount. With initial invitations the school sends out a message about its expectations both of the parents and of the workshop. In an average workshop the school sends out a standard invitation followed by either a reminder with the children and or another letter with an 'official' reply slip. The implication of the latter being that schools reply slip is one that commands a certain amount of respect. A reminder sent with the children is sent with more optimism than expectation that it will produce results as the wry smiles from the teachers who have reported this method of advertising attest. It is interesting to note

that communication between school and home is often kept to official channels such as reply slips, letters sent with children or a school magazine. The reply slips here were fulfilling the role of 'gate keeper' between home and school. The invitations were issued via the children but the reply must be official, through the slips. A phone call or letter would not be regarded as highly as the return of the slip though the fundamental function is the same. The implication here is that school home liaison must be carried out through school sanctioned channels.

The invitations for the workshop changed to try to meet the demands of schools for an invitation that did not deter parents from attending the session. Therefore the invitations were altered over a succession of weeks and at one stage an invitation was devised that didn't mention 'science' or 'workshop'. No change in the attendance or the comments from teachers regarding the invitations was noticed despite these innovations so the invitations reverted back to 'normal'. See appendix 4 for samples of invitations.

Some schools have adjusted the invitation to suit their particular 'message' that they wish to give to the parents. The Primrose School was one such case and here the workshop will be contrasted with the workshop held at Mary Anning. The Primrose School placed scientific pictures drawn by the children around the invitation and phoned parents to let them know the school was paying for our workshop. I felt it was made clear that the parents were expected to support their school and visibly appreciate all that was being done for them. This was emphasized by the headteacher outlining some of the literacy problems the parents had and how they had 'come on' since the school had been encouraging them.

The workshop was introduced with a heavy emphasis on the erroneous fact we had come from Nottingham University. There was good interaction with the activities at this workshop but perhaps little interaction between parent groups. I would query whether this was because of different social strata and/or because of differing roles for the parents within the school. Some parents were there because they were expected to improve themselves and support the school as the school had supported them and others were there to be informed and as enlightened parents. Perhaps even provide a role model for school liaison for those parents that had difficulties with education, both process and content.

Despite the driving rain and wind the school was very dark and locked up when we arrived and it was difficult to find a window to signal to any one that we needed to be let in,. Access to the school was kept firmly in the hands of the headteacher and entrance to the school was on their terms only. I felt that theme then linked through the workshop and though the workshop could be considered successful in that the parents expressed appreciation, the messages given by the school were not concordant with workshop philosophy. The school had gatekeepers in other ways. The idea of gratitude and duty seemed to be the main themes. This is not to say the parents didn't enjoy the activities. It was the circumstances under which they attended.

To contrast the greeting at Primrose primary with that from Mary Anning Junior, we were greeted at Mary Anning by three teachers and helped with our boxes. (Help with boxes normally only occurs when it is time to leave!) We were shown into a brightly-lit hall and offered coffee and biscuits.

The school hall was set out with tables and chairs as requested and the headteacher and two other teachers greeted us. We were expected and offered help and drinks. They estimated that around 55 parents would attend and this was not a bad response for a parents evening. The one teacher suggested that this response was greater than the evening event for parents to learn about headlice but not so popular

as the English curriculum evening. The parents from the local primary of a similar size, Kettlewell, had also been invited, though the teachers expressed doubt over the response from Kettlewell. They suggested that they did not know how many would attend.

In all 35 parents attended with only one late arrival from Kettlewell. Kettlewell parents had brought 10 children with them and this caused some tension, manifesting itself in teacher anxiety and parents from Mary Anning telling the Kettlewell parents that they couldn't bring their children. The Kettlewell parents sat at the front of the set of chairs which signalled they had arrived later. The parents from Mary Anning felt resentful and the teachers were worried that the workshop could not go ahead as planned due to our rule about no children. We reassured the teachers and set the children minor tasks such as warming plasticine and helping hand out pencils. The headteacher of Kettlewell who had turned up slightly late and had to leave early, during his introduction suggested that 'Kettlewell parents can't read properly' and this humiliation furthered the resentment felt by the Kettlewell parents.

The Kettlewell parents maintained they had not been informed of the parents only rule or that it hadn't been made clear. The truth of this matter was never discovered. To further or perhaps erroneously enlighten this response it is interesting to note that Kettlewell's headteacher was at the time engaged in an ongoing battle with the governors over whether the headteacher should resign considering recent inopportune conduct. This had caused much division among the staff and so could have affected the parents. I believe it could certainly have caused a communication breakdown between staff and parents.

The situation was succinctly expressed by the respondent from Mary Anning school.

"There's been a bit of whatnot going on with the Head at Kettlewell. I'm not surprised the parents had been fed the wrong message. I think there are two parties fighting it out and parents get caught up in it."
RM2-1-F

The workshop itself progressed fairly well with parents engaging well in the activities. I used the time to take some photographs and note the general progress of the participants. One feature of the workshop was that the parents rotated around the activities trying each in turn, engaging with some more than others and using the question cards rather more than I had normally experienced. I felt this showed that the parents were 'doing what they felt to be the 'right' thing in such circumstances. I think that the parents were very aware of the other school's parents and were carefully making sure no groups clashed, everyone got a fair turn and were behaving generally in the manner of socially aware strangers. The parents with the children however, concentrated on one activity and made sure the children were engaged. This behaviour, though very typical, is the reason for 'parents only' workshops. The parents see the evening as another educational opportunity aimed at children and use their time to instruct or work with their offspring. As this is not the aim of the workshop it has now evolved into a parents only evening which allows full parental interaction with the activities.

In the summary session at Mary Anning, a quick hand total of how many people had come before was taken. It was only one or two, but perhaps others felt shy of raising their hands. This total was taken to inform the workshop facilitators about returning parents so that the activities during the plenary could be tailored to suit. The end session was a discussion of science and the activities and was unremarkable other than the parents were particularly unresponsive. The children from Kettlewell tried to answer all the

questions that were really designed to spark interest and discussion from parents, but once again this is the normal reaction of children at such events.

5.51 Data Collection: Home School Liasion

Three parents were interviewed from this work shop. One from Kettlewell and two from Mary Anning. The theme I have used this interview data to illustrate is communication in home school liaison.

The Mary Anning school respondents were asked about how they found out about events at the school with the opening question focused on how they found out about the 'Let's investigate' science.

R1 *A letter came home with [my child] with an invitation on the back. The letter just said it was like the workshop they had had previously and that had been enjoyed previously. I couldn't go to the other one so I went to this one.*

I *Does the school have many events outside of school hours?*

R1 *Well it has the usual curriculum evenings and a parents' evening where you can make an appointment to go to speak to their class teacher. Then there's the usual Christmas play and the odd jumble sale or fete.*

I *Do you go to these?*

R1 *Often to the official things, I go. But the concerts, I must admit I go if [my child] is in it or involved. The fetes and things I think you need to go to support the school. There's quite a bit of, well, encouragement to go.*

Mary Anning School seems to have a comprehensive programme of home school liaison but the parents themselves did not seem to be active in its initiation. This is a common 'style' of home school contact (Tomlinson 1998) where the official channels are from school to home, often via the child. Home can only feed back into school during appropriate junctures such as a parents evening or fete. Even the concerts and curriculum evenings require the parents to be passive recipients of what the school feels they should experience.

R2 *Most of the letters we have from school come through [my child]. He's not always that reliable, sometimes it can stay at the bottom of his bag until it's almost too late. I feel guilty if I'm late in replying.*

I *Do you feel you have to attend?*

R2 *Well, it's not compulsory, and it is difficult sometimes to get away but I do feel bad if I can't go and then in the school magazine they write thanks to all those who supported the school. I can't always get away.*

Supporting the school seems to be the main focus of home school communication. The magazine is for the school -supporting parents to say how well the school is doing and for the school to praise the school-supporting parents. There seems to be a feedback loop of positive reinforcement for supporting parents

and exclusion for those who cannot attend. The parents who cannot attend cannot contribute to the school magazine and can suffer adversely when they try to contact school.

R2 *Well, it's difficult to keep up with where he's at school so sometimes I try to make an appointment to see his teacher but she seems to say that it's all covered in the curriculum evenings so if I'm not interested enough to come then, why should I be told separately. It's strangely like being back at school yourself.*

Once again the communication paths are from school to the child to the parent. If this breaks down then there's the direct school parent contact but this is in the school's power completely. The parent here feels it is difficult to find out any more information if they have 'missed' the official opportunities.

However, when communication breaks down completely the parents can find other channels and means to work around the school system. The respondent from Kettlewell illustrated this.

R *I was really cross about that [they had not been told that children were not invited to the science curriculum evening]. The letter we got wasn't too clear so I called my friend up the road and she knows one of the secretaries at Mary Anning and she said it was just another curriculum evening so I thought I'd take my two along. It was meant to be an activity evening so I assumed that what I'd heard was right.*

What can be seen here also is that the communication is from the school to the parent, regarding, not the child as might be expected but the school itself. The manner of parental involvement is controlled by the school and the perception that parental involvement in education is a good thing, is made without reference to the child. The 1992 Education Act and the Parent's Charter are silent with regards to the wants and rights of children and this has been recognised widely (Edwards and David 1997). Also the communication channels are either authorised (officially sanctioned) or subversive. The information that is passed from parent to parent without reference to the school is a reaction to the control of information by the school. If the parents feel that they are not receiving the information they require, informal networks for communication begin to run through existing networks for parents. They are already used for information not available to parents from schools such as how other children have found the school, which classes are best to get your child into and which teacher is most approachable. The use for communication that would traditionally come from school, for example, notice of curriculum evenings, can also be past through these networks if necessary. It is an example of the extreme utility of the grapevine. Though it was not specifically mentioned by any parents Ofsted has provided another information set that parents desire. Children are used as sources of information about Ofsted before an official report is made. Though parents may feel ambivalent about the role of Ofsted they are still anxious to see the report.

In conclusion, this section has briefly looked at communication systems generating from home school liaison. It has suggested that parents have alternative sources of information rather than those generated by the school itself. These different communication networks are important for both consideration in home-school liaison but also of importance for this research. In examining attitudes to science it is important to understand how parents access and use information about science education and science. Within this study, the interview data and analysis has begun to give a tentative model for the interpretation of information by parents and how this can influence their ideas and actions. It gives us insight into how attitudes can be expressed through both engagement with the object and when the individual is not engaging with the object at all, something that has be neglected by traditional attitude research.

This section outlined a 'story' concerning a workshop at one particular school. In the next section the study examines women and science using the story of one particular interviewee as a 'jumping off point from which to discuss issues of gender and science.

5.6 Women and Science.

5.6.1 Introduction

The problems of women and science have risen to prominence in the last decade. There are three main bodies concerned with progress in this area: Science educators who are generally committed to equal opportunities and look to enhance the curriculum, feminists whose both intellectual and practical concerns with the involvement of women in science stretch beyond the usual limits of interest and the industry that use science educated work forces, the pool of untapped 'man power' providing them concern for staffing levels.

Of these three groups it has been the feminists who have been most ideologically concerned with the issues surrounding women and science. They have been less concerned with the practicalities of getting women interested in science and more concerned examining the structure of science and how it acts and has acted historically with regard to women. Feminists are interested in the gendered nature of science and how this manifests itself. Other groups have been concerned with how to package up science so that it appeals to women without necessarily changing the product.

Though the 'Let's investigate' workshop was primarily concerned with promoting science to parents it was not attempting to promote specifically for women though this was a major part of its task. It attempted to portray science as relevant to day to day living and potentially interesting to both sexes. Though the intention was that science generally should be similar to that portrayed by the workshop the general conclusion was that it was generally assumed by the parents attending that primary science education was as shown by the workshop, not science generally (Johnston in conversation, January 1996).

So for the purposes of this research I have abandoned curriculum considerations when examining the narrative of women and science. The re-packaging of science as girl -friendly occurred after the women interviewed left school and their experiences of science were not influenced by this movement though their views may be. I have tried to make sense of their experiences in a wider context, in a context of gendered society and gendered science. I hope that by considering issues such as this the research will show the multi-faceted nature of the narrative and the topic of science and science education.

It is important at this point to examine my own interest in this subject particularly and understand my own feelings about science. I think I am safe in saying that I fell into the shy, be-spectacled, brainy -girl category at thirteen and my competence at physics and chemistry soon gave me an avenue to express an individuality from my family who were not so 'scientifically' inclined. After G.C.S.E's it was the choice of maths, physics and chemistry for 'A' level was easy and was assisted by my ardent dislike of my English teacher and my fondness for my Chemistry and Physics teachers. I aimed for a place at University studying Geophysics and planetary physics that I succeeded in gaining. Perhaps it was at this point I wondered if in fact I should have chosen a

subject I enjoyed rather than one I found challenging and interesting because though I was inspired and curious about science I had never enjoyed it at the same level as English.

I feel it was at university that I had my naiveté concerning science destroyed. Days of lab work, problems that I couldn't see how to attempt, being afraid to ask for help, not understanding the help when you got it, faking the results of experiments or copying someone else's results, being ridiculed for not having a classical education and not being recognised by my personal tutor after a year finally drove me to consider changing courses. It was not that the work was too hard, I could get by. It was that I had not inspiration to do anything than just get by. I was disillusioned and failing. So I went to see my tutor who didn't understand what I was trying to say. Was I struggling with physics? Yes, but how could I be when I got a good A level grade? Was it not the maths perhaps that I was having a problem with? In fact it was the whole subject not the content, but I think that it was beyond my tutor to think that someone could not want to do the course any more. I was one of four people to leave the course that year, and only eight people had started it. Only one girl remained on the course and she achieved a third class degree.

My encounters and thoughts during my time studying psychology are outlined elsewhere but it is important to look at my own views of science and how this has influenced my study. It has given me insight into both the pleasure that can be gained from scientific endeavour but also the sacrifices of femininity that have to be made. It is easier to get on if you are already awkward in your current role. It has also made me think that perhaps it is not necessarily the knowledge contained in science that is the problem but how it is structured, how the actual doing of science is put together. So I am very interested in theories that suggest if there were a 'female science' then it would discover the same things but contextualise them very differently.

What follows is a discussion of some initial emerging categories and subcategories that have that have come from an initial full data bit inventory about women and science, illustrated by some narrative from women interviewed as part of this research. I do not offer a synthesis of current theory through this study but assess how well the models and ideas offered in theory fit the stories that have been shared with me. At the end I offer a summary tracing the main themes and linking them with the stances to science outlined. It is no longer sufficient to speculate over the lack of women in science without discussing the implications of the nature of science for individuals.

Over the course of this research thirty women have been interviewed in-depth, but the experiences and comments of almost 600 women from the Midlands with varying experiences of science and education have enriched the data. However, here I have chosen to use the experiences of one woman, as the complexities, connectedness and sheer amount of data emerging from all the women interviewed is huge and varied.

I am referring to the woman in question as Sue. Even in selecting a name to anonymise this study has been difficult. Female names can 'date' a woman as some of the perennial male names will not, and also they can be an indication of class. If there are any associations with the name Sue in either age or class I would ask that they be ignored.

5.6.2 Women and Science: A Vignette

Sue is not employed; she is what has been referred to historically as a housewife, bringing up her six-year-old son in a market town in the commuter belt of a city in the UK. At the time of this interview she was intending to start retraining and looking for a part time job.

"A change of pace, to start bringing in a bit of money, to make me feel part of the working world..."

Most women I have spoken to, recall early years education with fond memories. If they remember science at all it was a subject focused on communication of ideas, using description and very open, drawing linkages and unstructured. Sue was not an exception and her professional journey from primary school through to her search for this new job has also been mirrored by a more personal journey trying to reconcile the personal side of her life with the professional.

" I had a teacher who was mad keen on going out into the park and hugging trees and I thought that was wonderful. We used the woods, we looked at trees, we looked, we felt things, we smelt things, we collected things, we looked through microscopes, we did an awful lot of work"

Sue was extremely happy and motivated throughout her primary school days though she didn't really think that what they did was 'real' science. The change to secondary school was a big change for Sue.

"I went to a comprehensive, and I suppose I hadn't really noticed the boys. Then all of a sudden it was really noticeable, the divide between boys and girls and it was really important to be in the right group. I don't think I was in the right group. I seemed to be on the outskirts. "

Here Sue is not only referring to the groupings of boys and girls but also of the social groups within the society of girls.

For many women the transition between primary and secondary science also marks the beginning of Father's interest in their education and so from an early stage become aware of the male-female tension in science. Before this age education is seen as a fundamentally female task but from secondary school onwards the male takes part in education. Thus the message is that the male is in charge of the more complex aspects of the intellectual development of the child. Sue felt this had both happened with her and she expected it to happen with her child. But this did not prevent Sue's mother from acting as a strong role model.

" and when he leaves primary school I suppose I'll let his Dad take over a bit more. He'll be doing proper stuff then, real subjects. I'm better with the creative stuff. or with the computing of course. I think when I left primary school my Dad took more of an interest. Of perhaps it was that my Mum stepped back a bit, perhaps she didn't feel confident or something. She still helped though, but not so academically."

Sue progressed well in secondary school but found her drawn to the more scientific subjects. At this time she felt a growing alienation with other girls. Smial (1987) has suggested that it is because girls are asked

to choose science as an option at a time when they are establishing their identities as women. Sue echoes this when she talks about her friends at school.

"*I got on with the boys in my classes fine, but no, I wouldn't say they were friends, we didn't sit together at lunches or anything. I think the contact was very difficult. I felt like I wasn't quite attractive enough or whatever to interest them but they sort of got on with me because I was in their groups* [Academic groups]. *I think the less ' in' boys were more interested in me because I was friendly and would talk to them and they wanted to speak to girls and had an excuse to speak to me. But of course I didn't like them enough to see them. In fact I was a bit embarrassed because they were the more awkward boys and I didn't want to be associated with them. I had a couple of close friends who were girls, but they weren't 'in ' the right groups either. It's far more complicated at school than you can imagine from the outside."*

Here information given is relevant to the self-constructs. Sue has both a female self, who is interested in the same 'high social status' boys as the other girls but considers herself not attractive enough to warrant their attention. However, she sees that she is in a social level above the 'geeky' boys and does not want to associate with them outside of classes. Her friends are also of this social status. The impression is of a confident, socially aware young woman who is conscious that her academic choices have influenced her social life. The rewards of choosing unusual subjects that also have a reputation for being difficult are double edged. Sue progressed well choosing to study science at O' Level and then going to a local technical college to study computing.

" *I must admit I enjoyed shocking people at college for a while, you know when they would say ' what subject are you studying?' and I would say 'computing science' and that I took Maths, physics and chemistry at O' level. But I soon found as well as thinking I was really clever they also though the subject was boring and I was a bit of a science girl. I suppose I had chosen a tomboyish image, or rather I think I felt it was an option that was open to me to fit my chosen subject. I felt special but I don't know whether it was because I chose science or because I had to choose science to feel special. I enjoyed the other subjects as well I could have chosen those."*

Here a less confident Sue realised that her choices may have been a function of her social self and so she had perhaps excluded herself from the social group she would rather have been in. Her terms of 'Science girl' and 'tom boy' show her moving away from a feminine image. Her social vulnerabilities pay a great part in Sue's story as rather than being an answer, a way to make her feel special, science became a way of separating her from female company and giving her a new role. Having left college with a further qualification, Sue found a job in a large computing firm.

" *Oh yes it was all men. I was very much in the company of men. I suppose we didn't see each other out of work and so they never knew a lot about me. It wasn't an office where you were chatting, it was very much doing the programming and then home. I think the men might have gone out for football or a drink and I think they may have included me if I wanted but I didn't want, really."*

Again, this is another example of the interface between the 'professional Sue' and ' social Sue'. She felt that not only was she not included in the office group but she wasn't sure that she wanted to be. In her social life she had made inroads into change however.

" When I went out I wouldn't tell people what I did as a job until I knew them quite well. It's a usual opening line, isn't it? What do you do as a job? And I got really good at giving vague answers, you know. I would say ' I work for such and such' rather than say I'm a computer programmer. That way I can tell myself that it's their fault if they get it wrong but really I know that I'm misleading them. But loads of people lie about their work to make it sound more exciting.

Though Sue found the assumptions convenient on the one hand she found it very frustrating on the other.

"It's awful to think things were like this once, but they all thought I was a confirmed career woman. I think that they all thought I would never get married or anything. Even my girl friends were always saying how much they admired my determination to get on and such like. Well, I found it really frustrating to be introduced as Sue the career woman. I saw myself as someone who would like to have children and everything, just like everyone else. It was difficult to shake that image. Every time I went out with a man I got teased. Even my Father was a bit that way. My mum never said anything though."

So Sue's self-construct involved more than the scientific professional self which many people focused on. She also had a view of herself as 'any woman' wanting to have children and be involved in a serious relationship. She felt her mother was supporting but her father was more resigned to the situation and acknowledged it as what Sue wanted even though what she wanted was ambiguous even to herself. Late in Sue's career her meeting with Peter brought the personal and professional tension to a head.

Sue met Peter at a conference that she was attending as part of her professional role. Peter assumed she was a personal assistant and Sue let him believe that to be the case. Peter worked for a large electrical component company. They began to see each other and Peter asked Sue to marry him three months after they had met. In effect Sue was being 'outed' as a scientist by her boyfriend but also in the process outing her as a woman to her work colleagues. She felt her acceptance into her work community was due to her suspension of female concerns. It was a crisis point.

" I suppose I turned to my mum for advice, I think we all do really."

Sue decided to tell Peter about her job immediately.

" I must admit I used the carrot and the stick. I told him that I hadn't not told him and he shouldn't have made assumptions, but also that I was telling him as I knew he wouldn't think I was weird like so many other men because he can cope and was secure in his masculinity. That sounds really clichéd now but I was trying to butter him up a bit. He was paid less than me."

This was an important juncture as Peter accepted Sue's explanations and the courtship progressed to matrimony and then to a late pregnancy. However, Sue's strategy of 'not telling' until she is sure set the pattern here.

" The guys at work were really shocked when I said I was pregnant and I must admit so was I. But the pregnancy was wonderful. I realised that I could have friends to talk to about it. I knew a couple of girls but they had had theirs a while ago. At first I didn't really have anyone to share the experience with."

Sue found herself going to ante-natal classes and after the birth to nursery and mother groups with other mothers and once again not telling them where she worked. Sue moved shortly after having her son and decided that as she needed the close support of women, as she had moved away from her own mother. When she moved she gave up work to bring up her child. She became very animated when recounting her decision to keep her career a secret.

"I don't tell a lot of people; I moved you see, I moved, I changed my life by becoming a mother. I became a bit of a different person. Nobody knew my background because I moved from a completely different area to where I live now, so all the people who are where I live now don't know my background. There are a few who I've let on , so I get some reactions. Aghast when I say I did that at all. Because people assume you're not, especially as you're a woman. They assume women are mums. Because you've got your husband and that's it: you never did anything else, but there are quite a few friends I've told it. They're quite surprised when I told them initially, that you have got that sort of background."

Sue felt that she didn't want to be perceived as very brainy or very capable or a know it all, so she didn't mention work at all to women she knew casually. Only to women who had become close friends. Now as she thinks about retraining she is considering another change in role.

" I help out in school with computers and other work, that I can help with but I think soon he'll feel embarrassed by having his mother around so I'll retrain. Do a course to bring me up to date. Computer technology moves so fast and I'm not sure I'll ever regain the skills I had but I think I should be able to grasp the basics. Enough to find a small job. I don't want to go for another career again."

When queried as to whether she would lose her new friends through taking a scientific job the answer showed that Sue's self esteem rested in her social group not her professional standing.
" Well, I'd rather get a job where I can make friends and extend my social circle rather than go back in for the money.. I'm proud of my achievements and they're what count to me now. I think back to the limited social circle I had when I was working or at college and I've progressed a lot. I wouldn't mind a job that uses my abilities but not hard science again. Not because of the work but because it spoils things."

Sue left this as an ambiguous statement shrugging off further questioning. I feel it is a statement of the influence of science on women's roles and how social position is precarious and support conditional on fitting in.

Sue's story illuminates several issues to do with science that are contemporary concerns. The first is 'girl friendly science'. It has been argued (Travis 1992) that the preference of women for group work, which is not largely available in science, is a weakness produced by unequal power distributions. Sue doesn't feel the unequal power or a particular need for group work but she does feel the need for group support in areas that she feels vulnerable. This lends tentative support to this theory but I feel this theory also denigrates group work as a lower type of work, which perhaps is not correct. Sue has a very confident and capable out look as far as her work is concerned and is very aware of the compromises this brings to her social life. McArthur and Wellner (1997) suggest that the collaborative 'nurturing' role is forced upon women but Sue's story shows that it is possible to give up that role but it also means giving up a connectedness that perhaps is available only through empathy of your own sex. For a clichéd example, no man could truly empathise with the experiences of childbirth. Perhaps they should be arguing that it is not possible to be both nurturing and separate, which is a very contemporary dilemma. Roychoudry and Nichols (1997) suggest that these

things are not incommensurable in the classroom but the differential participation in science stem from an epistemological disjuncture. Thus it may not be until later life this comes to crisis point, as in Sue's example.

In conclusion it seems that the interface between the professional and social causes a lot of tension when the professional -personal construct contains an idea of a scientific self. The main body of research examines the formation of attitude through key events and developing views but within this consideration of women and science I hope I have shown how the self as a person may experience this process and the wider connections between this process and other social situations.

5.6.3 Boundaries of Science: A Society within Society

In the discussion of women and science there has been only oblique mention of the creation and monitoring of boundaries within science and society. Who is it that patrols the boundaries within school and within science and acts as gatekeepers for people wishing to enter and exit? What are the criteria for 'scientist-hood' and why are women failing to meet them?

The boundaries of science are not clear-cut when observed from the outside. There is pseudo-science, soft science, alternative science and even Christian scientists. These addition sciences confuse and blur the boundaries of science and yet when entered it becomes clear these sciences are not Science at all. These sciences are aspiring. They are the subjects of Science and are treated with disdain. True Science is the search for Knowledge. The Facts; and as I have suggested before these Facts are not up for argument. If the point is arguable then it is not Science.

This relates directly and psychologically to the position of women. Women are traditionally negotiators. Feminist theories suggest this has generated, from the physical oppression of males, women seeking resolution through compromise, rather than suffer verbal, physical or psychological violence. Women have relied on co-operation more and invested more time in family and social concerns. Whether this is psychological or imposed by the power structure is astutely debated elsewhere in feminist literature[35]. The main concern of this study is that to enter the domain of Science women need to adopt ways of thinking and working that appears 'logical'. This involves working only with facts and accepting that compromise is not a substitute for the truth. Social constructionism and relativism has no place in science that is ideally a descriptive discipline. Science seeks to accurately describe the world and so there must be no different perceptions. There may only be emergent theories.

So boundaries are patrolled from both sides and teachers are neatly trapped and must make decisions regarding how they negotiate through the gateways of science. Women with talent for divorcing themselves from their thinking, those perhaps who are already interested in science as a 'male' subject, those who are finding it difficult to form a feminine identity[36] can be nurtured by

---

[35] See Roychoudhury and Nichols (1997) and McArthur and Wellner (1997).

[36] This makes a distinction between feminine and female. There is no suggestion that a 'female identity' is not formed or difficult to form.

teachers and sent to as potentials on to the next filter, academic life in university. Here the boundaries between those who do and those who teach are blurred and the 'rites of passage' into the scientific community are attempted. Women have to deal with male lecturers and male colleagues and a form of science entirely focused. There will be little or no female support, it's make or break.

Teachers are then left with a majority of girls to further their scientific understanding and increase their interest in science but are very unlikely to make it. Teachers will give advice that focuses on the individual's talent and their likes and dislikes. It is a brave teacher that encourages a pupil who has no apparent aptitude for science to continue in case they find something worthy in its study or perhaps even bring a fresh perspective to science.

So teachers are the first gatekeepers but they are also much castigated by the boundary patrollers in science. Complaints include the fewer science candidates being offered, they do not have such a high degree of knowledge as previously and they are not gender balanced. This is necessarily the fault of the teacher. It has been suggested in the media that as they are not scientists and they do not teach properly. It does not take much to see the heavy handedness that teachers of science have to suffer. The injustice is apparent. In no other discipline is the responsibility of recruitment and positive press farmed out to people not trained in public relations.

The second gatekeepers are university academics and researchers involved with the tutoring of science undergraduates. They are the interface between career scientists and the tyro. They provide the active role models for young scientists and so weed out those who cannot emulate them. This is inherently more difficult for females as they lack the necessary 'maleness' to do this convincingly. They must often rely on models found outside the academic sphere and these must both be recognisable as scientists but also conform to the university staff's criteria for such. Often as throughout early schooling, female students have no role models and make their own paths through science. Universities are also involved in the reward and punishment of those schools who provide suitable potential students. Rewards are through joint activity, raising the profile of the school. This is extremely important in this age of Ofsted. Punishment is difficult to see other than indifference but the wider implication may be the 'running down' of the university support for the teaching of science in general.

The final barrier for women is that of the scientific community itself. I have earlier discussed how the borders of science can act also as the area for women, a sort of intellectual no-go zone. Women must be twice as careful of their reputations as scientists as men lest it be taken away from them for not sticking to non controversial subjects.

5.6.4 Reflection on Attitudes to Science.

At this point it is appropriate to review the salience of this work regarding the place of 'attitude' as a useful concept in this form of behavioural research, as we have progressed from the very broad, views and stances to science, to the narrow in two vignettes. As attitude is a central concept of this research how does it relate to the vignettes or indeed to the wider aspects of this study? Allport (1935) identified a 'common thread' within attitude models that was the readiness to

respond: And it is at the far end of this scale where this research places attitude; a motivating influence that initiates behaviour. For a possible illustration of these ideas see figure 5, following.

As has been discussed previously attitudes that possess centrality are harder to change having been absorbed into the personality of the individual. Has this research suggested that attitudes to science possess this quality? In no way conclusively. This work has shown that something similar to life-script, a phrase used within Transactional Analysis (Stewart and Joines 1987), is developed in regard to science. The life-script within this research is developed as 'Stance to Science'. This taxonomy of attitude to science still acknowledges its multiplex nature. Ballachey et al (1962) suggests attitude to science involves 'differentiation between the physical and social science, between applied and pure science, between science and scientist, between the theories of science and the data of science'.

This work has examined the actuality of this, finding the distinctions are not drawn along the lines provided by the scientific community but along lines that pragmatically split the subjects into areas meaningful to the individual. That attitude to science is multiplex suggests that it is more easily moved in a congruent direction. However, as has been supported by this research it is more difficult to move in an incongruent direction, both because of the number of factors that must be addressed (stance, view, key-events, perception, the complex nature of science itself) but also due to its interconnectedness with personal value system. I would also argue that attitude as shown by these interviews in 'value expressive'. Attitude to science is an expression of personality.

It is conceivable that this over-states the case as the subject groups are defined. However, at the very minimum this argument could be applied to other 'consumers' of science[37]. Ironically, having argued for the seminal nature of science in day to day existence, I appear to be arguing against it. This contradiction is not necessarily uncomfortable, for it is possible within a post-modern research paradigm to allow a contradiction as long as it is a workable solution. This pragmatist approach is deeply and ideologically unsatisfactory and as such I would suggest a more parsimonious solution would allow 'conscious' consumers of science to be the defined group here.

In the next section the study moves on from discussions of gender and home school liaison and considers cultural factors within this study. It is given a separate section and perhaps a low profile, not because of any lack of importance attached, but a tentative awareness of the flaws with this particular research. However, it provides a final illumination to the previous sections, which had not, perhaps highlighted cultural considerations fully.

[37] See section on Consumer and Clients for Science.

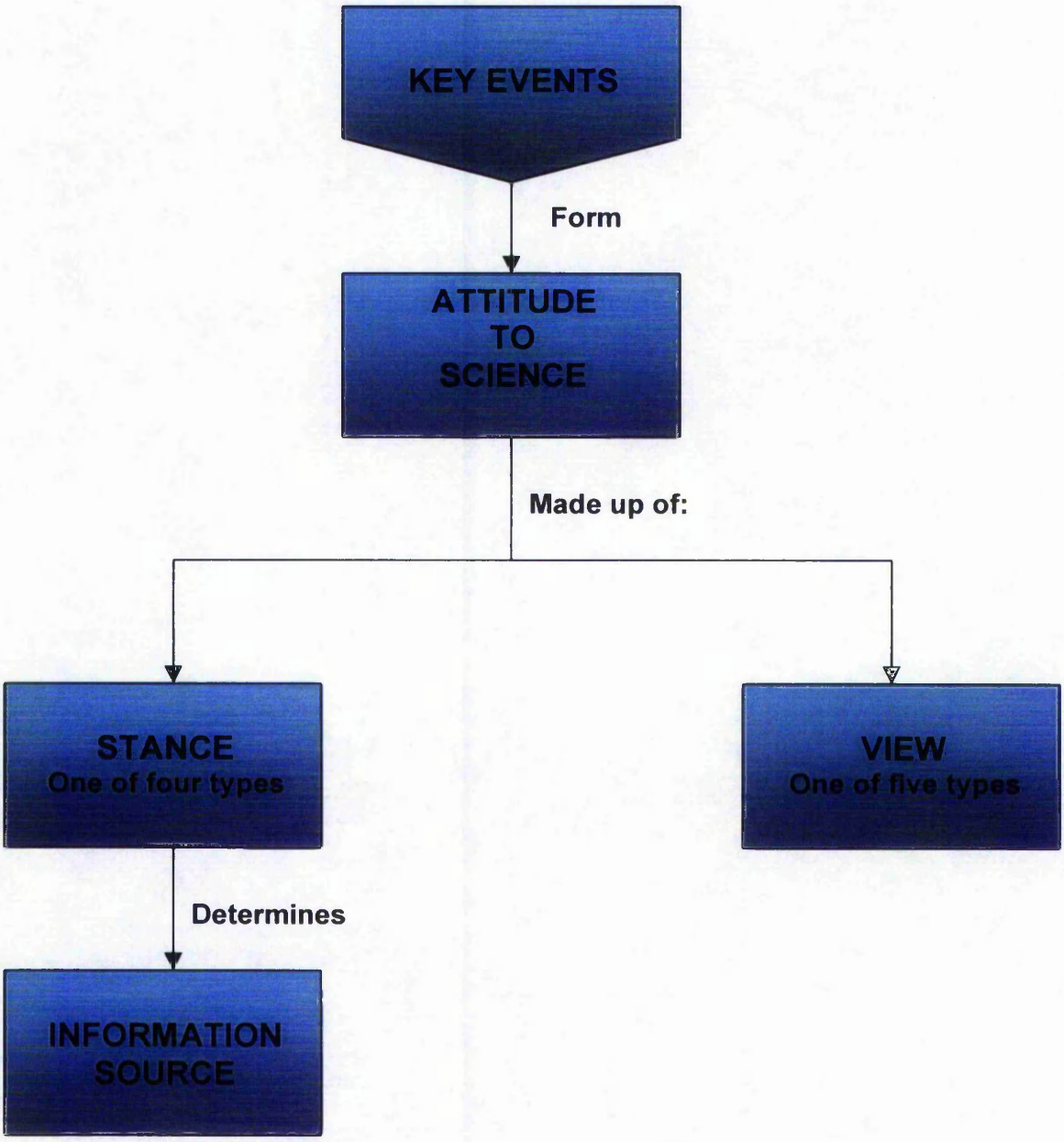


Figure 5. Attitude as a process showing use of information source

5.7 Cultural Considerations: Asian Parents.

5.7.1 Introduction

The relationship between culture and science education has not been well explored. The literature in this area is not well integrated and level of philosophical engagement with the issues has varied greatly.

The main body of research into cultural issues in education has centred on African American or West Indian children. The research in the sixties and seventies concentrated on a deficit model of multi-cultural education and aimed to improve the educational success of people of African, Caribbean and Pakistani descent. The Headstart programme in the U.S.A. is perhaps the best known initiative of this type. It was a mixed failure and perhaps exposed the naivety of multicultural work at this time rather than any true reflection of the worth of projects of this type. The Westinghouse evaluation of the Headstart programme greatly impacted on multicultural schooling.

In Britain the problems of multi-cultural education were very different and yet similar. Different, as the countries of origin of immigrants were different - from British Imperial countries; but similar in the issues of education provision and social provision. There is much written about multicultural education in the U.S.A. (Grant 1992 provides a range of research in this area.) and Britain (Smith and Tomlinson 1989).

Work examining science education in relation to culture has been extremely limited (Newton 1988, Bentley and Watts 1989, Woolnough 1991 Reiss 1993). The majority of work concentrates on superficially adapting current practice (Peacock 1991) to include a multi-ethnic element. For example, work focussing on material and might have a task of making chapatis rather than sponge cake. The work at secondary level has been more narrow still (Dennick 1992). The fundamental premise of multicultural science education is that it is too narrow in its focus (Science for a Multicultural Society Group 1985). The history of science is largely the history of Western science, and those with a limited knowledge of European history since the classics can feel alienated from the culture and context of science. Science education outside of Western countries is often imported (UNESCO 1984) from these countries and as such lacking in relevance and suitable context. They may also presume a greater level of background knowledge than is actually available. Ogbu (1981) has argued it is those who have abandoned their culture that do well in science.

This research was not designed to explore the cultural issues surrounding science education. However the inclusion of parents from a Pakistani background and culture within the interview sample meant this has become a consideration of some importance. This research can go some way to consideration of cultural issues in science education.

5.7.2 The Geographical Area of the Interview Sample

Previously within this study the area that the respondents have lived in has been anonymised. However, with these interviews the area provides important and illuminating data about the respondents and their narrative. Leicester is a light industrial city with a large Pakistani community. Many Pakistanis arrived from Pakistan or East Africa in the 1950's or 1960's and as such it is one of the most well established Asian communities in Britain. The early immigrants tended to be Urdu speaking from East African and the Punjab area. The later immigrants were Gujarati speakers from East Africa. Though the Asian community has Sikhs, Muslim and Hindu groups the interviews were carried out with Hindi speaking families only. The religion of the parents was not ascertained prior to the interview. The families tended to immigrate because of the labour shortages in Leicester in the hosiery trade. This industry has been in severe decline and the level of unemployment has grown recently. However the Pakistani community in Leicester is extremely strong and a celebrated part of Leicester's cultural resources. Provision within Leicester Schools for Pakistani children seem very good but this research concentrated on the aspect of science education so the issues of provision have not been fully explored.

5.7.3 Interviewing

The interviews were carried out in the same cycles as the interviews with White English families. There were only two interviews in the preliminary cycle that were carried out with parents from Pakistani and African descent. Consequently, my interview schedule, though very loose because of the narrative data I hoped to collect, did not include any notes about cultural data or issues. The parents interviewed were very aware of my ignorance concerning Pakistani matters and were perhaps more felicitous of my data than I was. More importantly my personal awareness was lacking so sometimes I missed opportunities to follow up what may have been important issues. Therefore the integration of this data was performed with more caution and greater caveats. The names used in the interviews are changed.

5.7.4 Previous Science Education

Only one set of parents that were interviewed had been educated outside of England. Their experiences of science education were very limited and had tended to be very formal and to a degree old fashioned. The practical elements of science seemed to be missing and yet the level of practical knowledge in science was very good judged by Western standards.

Mr. Kumar *Well, we had no formal English education, we were both born and raised in Kenya. We did go to school though. It was from books, we did little practical. There was not much at a primary level. I started really learning at seven.*

Mrs. Kumar *Yes, that is largely right. It is mainly play until you are old enough to sit and listen.*

Mr. Kumar *We learnt a lot about the history of science. The scientific discoveries. It was very exciting though we lacked the resources to replicate the experiments. Our books were very old.*

I *So there wasn't much practical work?*

Mr. Kumar *Well, only what we [devised] ourselves. A lot of science we learnt was informal. Practical in that sense yes.*

I *What about you Mrs Kumar?*

Mrs Kumar *Well, I would like to think that there was not much opportunity for girls to play at science as boys but I suppose I was not so interested. I was interested in women's clothes and cooking and womenly things. That is not to say I did not enjoy the maths and science that I did.*

The parents who had been born in England tended to focus on the home school differences

Mr. Jain *My parents were very keen for me to learn a lot about science and do well in school. They liked me to have textbooks and work through problems. They didn't see the experiments as work. More as play. I think the presentation of work at primary school is a lot like play but I think that is good. I think my children enjoy science a lot more than I did. As you say, learning should be fun.*

Mrs. Jain *My parents were also keen for me to learn from text books and not to do any silly stuff.*

I *Did you have any problems, with the science?*

Mrs. Jain *I had no problems at all. I enjoyed it. I realise that my parents weren't British but I've always been brought up to feel English. My parents were very understanding. I think they were wise enough to realise that you can't bring your home country with you. And so I just learnt English science. My parents helped me relate it to our home.*

All the parents interviewed mention textbook science as opposed to practical science and that there was a perception by those whose birth country was not the UK that text book learning held more weight than practical science. It is interesting to note that the parents did not question the representation of the history of science which is predominately white European. I would suggest in-line with UNESCO (1984) findings that most science education, even those outside of the

Western world, tend to portray the established history of science rather than present a complex pluralist view. A black woman whose country of origin was Kenya, interviewed during the preliminary interviews tells how this affected her view of science when she moved to Britain.

> R *We had learnt about science through learning about all the great discoveries. We learnt about Fleming, Marie Curie and Faraday. We did no practical at all and just looked at the things in books so I found it quite frightening when I first went to a lab. in this country. I hadn't encountered anything like it before and so I found it a bit intimidating. I don't think the white coats and goggle helped and the safety notices were very scary.* (P-13-F)

The interesting points arising out of the interview data concerning gender are mainly that science seems not to be perceived as a traditionally male pursuit by Pakistani parents. In fact questions trying to probe this issue were sometimes misunderstood.

> I *What type of problems did you encounter when you were studying science?*
>
> Mrs. Rasul *Well, they would say something like 'what would happen if you mixed..*
>
> I *Er, No. I mean were you teased or anything during science?*
>
> Mrs Rasul *Did I suffer racial attacks do you mean?*
>
> I *Er, No. I mean because you are female and science is sometimes thought of as a male subject.*
>
> Mrs Rasul *Ah no. It is not always encouraged for a woman to work but is certainly expected that she should think! But perhaps men like to think that they are cleverer than women. But that 's not cultural I think. (laughs).*

It is suggested (Community Relations Commission 1986) that in Pakistani cultures it is more accepted for woman to learn maths and science and that if Pakistani women tend to stay home in Hindu families it is more due to language difficulties than cultural or educational barriers.
In fact neither gender nor race was mentioned as causes of lack of employment prospects. The main barriers were perceived to be economic but also achieving the necessary grades, but once again this was not seen as a racially, or gender, specific problem.

> Mrs Jain *It is very important to study science. In fact all study is important if you want to get on. Getting a good job is really difficult there is a lot of competition especially in Leicester. All the usual factory jobs have gone.*

Mr. Kumar *The level required to get into university these days, I mean a good university to study say, medicine is phenomenal.*

To integrate this with the model of attitude development requires observation of similarities rather than differences, but it is the differences in the data that are perhaps most important. This data expands the model of attitude development by suggesting that if memories or key events are not perceived to be relevant to the current situation. In this example, a person raised in East Africa's primary education is not comparable to primary education in Britain, they are not totally discarded but used as a reference point. Rather than anchoring the perception of science these memories are used to catalogue the benefits and drawbacks of this contrasting education. The parents who had been given little formal education felt that text book learning was the hall mark of good education, whilst those who had been given this learning felt that practical application was the key.

Pushing this theory a little further I would suggest this 'contrast' attitude development is continued even when the parental experience is directly relevant, for example when the parents were raised in England. Though this type of attitude assessment is available to white English parents I would suggest they use their experiences as a more integrated attitude. Pakistani families may have picked up this attitude style from their parents who developed it in response to having contrasting rather than comparable experiences. Therefore even one generation down the parents tend to contrast their education with their children's rather than compare it. The difference is best expressed in the parent's own words. Here both sets of parents are talking about school reports.

Mrs. Jain *My school reports were one or two sentences on a sheet for primary school. The reports now are much more detailed and informative and I think that is good.*

R *I remember handing my reports over and always feeling sick. I think can only think it must be like that but worse now that they write so much. I feel sorry for them.* (AH-1-F)

Mrs Jain remembers the lack of information on her reports and contrasts that with information given now, whereas the respondent in the second quote compares her experience of handing the report over to parents to her child. She perceives a direct relationship whereas Mrs. Jain makes no comparison. She remarks on the differences rather than the similarity.

To compare experiences with their children, parents must see continuity between their own experiences and their children's experience, though I have suggested that this is not sufficient in itself. The parents must also have experienced this form of expression of attitude, perhaps through their own parents. To contrast experiences with their child, the parent's experiences must be very different from their child's. It seems that if the schooling very different the contrast of experiences makes discussion more meaningful.

So it appears expression of attitude, in the sense that the term is used in this study, has an experiential basis. I would not suggest that this is a persistent difference however. It seems unusual that people with dissimilar experiences would seek to explore those differences rather

than find common ground. In fact, where there is no relation between events this could be a non-functional exchange, where one party seeks separateness rather than continuity, when there is very little continuity and a lot of separateness. It seems more sensible to adopt a style of expressing attitude that shows the differences through connecting events. To look at the educational process as broadly similar and then find differences within those similarities seems more useful. By 'useful' it is assumed that sharing experiences has a functional dimension and if the contrasting of experiences is less useful in this way then I would be surprised if it is used as a made way of expressing experience. I would suggest that though on analysis these differences of expression appear real and significant, they are actually artefacts of the research process. The different responses of the Pakistani origin parents could be due to the reaction to the research questions that were focused on previous experience. In context this could be interpreted as an interest in the contrast between their experiences and the experiences of their child, leading to an undue emphasis on this aspect of attitude. During interviews with British origin parents my assumptions were that they had experienced an educational process largely similar to their child's and so continuity was expected.

In conclusion of this section the main points cannot be made as strongly as previously in this research. It has been made apparent that some methodological error, an unpreparedness has made this aspect of the research require more scrutiny and further research to explore any apparent findings. However, this section illustrated how Pakistani origin parents have found the science education experienced by themselves very different from that experienced in Britain, despite the similar origins. These parents are perhaps less disillusioned with science and certainly perceive science as a subject with economic importance. Perhaps the most interesting cultural difference is that they do not perceive science as a male dominated subject. Though culturally women may not be encouraged to work, certainly if they have a career then they are not excluded from any subjects through gender bias.

Chapter 6
CONCLUSION

In this concluding section I will outline the advantages and problems with the modern conceptualisations of attitude. This will include discussion of stories and the use of stories and narrative in personal development and as a means of understanding attitude. This section will also discuss the messages about science that the parents interviewed with in this research hold and the interconnectedness of this with current educational practices and the promotion of science. This has implications for policy and practice in the primary classroom and perhaps beyond into policy for the promotion of science, if the present government still chose to fund it in this unique way.

6.1 Stories.

Stories are appealing for several reasons. They provide an effective vehicle for conveying a culture's norms, be that culture shared or discrete. Stories happen naturally as a way of telling one's perceptions of past events, problems, or people. They can be held at all levels and within all groups of society and enjoy widespread acceptance as a means of communication. They are easy to follow, generally entertaining, and are more likely to be remembered than other forms of written or oral communication (Martin and Powers 1983). In addition, significantly for this research, provide a shortcut for new members to learn about the organisation of the culture (Barnett 1988, Martin 1982). In other words, stories provide an idea of development of attitude and this attitude is transmitted to others through stories about the nature of the story object.

Within this research a tentative outline for analysing stories of science using classical literature types has been suggested. Because of the cultural nature of these frameworks the personal stories of science do not always fall neatly into these literature types. The research suggests this may be due to the 'cultural' nature of science. The Western ideal of impartial science almost 'contaminates' the stories from narrative to commentary. There appears to be a leak of impartiality. Interviewees become aware of the subjectivity of their narrative, the personal nature of their experiences and this can make their narrative quite different to the narrative that fits the literature styles of comedy, tragedy, satire and romance. So while the use of these literature types give useful insight, they are not a complete tool for analysis. The perception of the nature of science affects the stories that are told and this interaction needs analysing. The methods provided by grounded theory have allowed additional frameworks to be used when appropriate but have not provided a rigid structure for analysis.

Stories have also provided access to attitudes in a way that is entirely novel. The genesis of attitude is shown through these stories but also they provide another avenue of research to increase the predictive power of attitude research. The lack of predictive value of attitude measurement has stymied development of attitude research and its conceptual development. Stories allow links to form that may not be discovered through attitude measures and the development that is revealed through narrative is essential for understanding the concept fully. However, this form of research carries all the problems associated with retrospectives such as changing memories to fit a current structure.

Particularly salient for this research is that stories are a traditional medium for transmitting information to children. Underlying this research is the assumption that parents have a profound influence on the ideas and attitudes of their children. Modern notions of 'parental involvement' and 'life long learning' support this. Supporting this also are the more traditional visions of parents as primary educators and co-educators of their children. This research has not examined this presumption in any real sense, the primary remit to be to explore the development of attitude to science through narrative in *parents*. It has not examined the potential effects that autobiographical stories told to parents have on children or the interpretation of such narrative by the child. However if the underlying assumption on which this study was conceptualised is challenged the study itself still stands. If the purpose for which this research is used changes this does not question the research and findings itself.

6.2 Science.

The conclusions from this research encompass a synthesis of the views of parents on the nature of science. This has been applied in a wider context leading to a picture of science that illuminates the attitudes of parents. The views of science are the 'attitude objects' of the parents and explain a great part of the rationale of this study and the problems encountered within it. Science, it would appear, is in turmoil. Outworn images of scientists are being discarded and replaced with styles for the 1990's and beyond. Ideas fashioned in the minds of media have come to represent the picture of modern science. We have 'new scientist' the caring and communicative face of science, a sign not only of change but of crisis.

Science has been engaged in self-improvement since the 1960's and 1970's when the triumph of the moonwalk was overshadowed by the threat of nuclear war. Suddenly the scientific age didn't perhaps seem quite so desirable. Feminist critique also attempted to shatter the scientists' perceptions of themselves. It tore away the ideas of benevolence and exposed power and brutality underneath. The shocking exposure of their complicity left academic and technical scientists floundering. The necessary project was to re examine their roles, both in relation to women and the subject matter and package themselves more astutely. Practice doesn't have to be changed, just public meetings attended, school groups organised and consciousness raised. This change of orientation has introduced a new discourse into the social and academic world. A discourse based on the public understanding of science.

This new movement seeks to challenge taken for granted notions of science. Science had concentrated on scientific endeavour hoping that the goodness of its works was transparent to the members of the 'grateful' public. However, as falling numbers of students took the scientific plunge it became apparent a new recruitment drive was in order. It was not enough for people to be paying taxes to keep the scientists in particle accelerators. They must also appreciate the work of the scientist and understand why it is done. A new theory of science was developed which ran along the lines of 'the public just don't understand us'. The implication being that if the public understood better they would support the scientists more. This might have been a trifle naive.

While a sweeping theory of the changing ideology of science is beyond the scope of this study I have investigated three major areas which should be of vital concern to such a theory and are vital to the consideration of this study. The first concerns science as an ideology, how do the vast array of seemingly diverse and contradictory images that we are offered, relate to each other, what

underpins them? The second concerns the relationship between this science ideology and the practice of scientists. We also need to examine who benefits from the move for public understanding of science, as analysis of science as an ideology implies that not all parties derive equal advantage. In defining this latter group we need to look at the ways in which science is bound into notions of progress and the consequences of this symbiosis in more general economic terms.

6.3 Science as an Ideology.

We are faced daily with a plethora of scientific images: The geeky computer genius, the mad professor, the megalomaniac who will control the world with his death ray, the caring public information broadcaster and so on. A kaleidoscope of images, seemingly disparate and diverse. The choice however, seems to be an illusion. Despite various guises there is only one theme of science around which these are organised. Underlying the apparent differences are three constants about the scientific role.

First among equals is the relationship between science and gender. The power and strength of science some how residing in its masculine image. It eschews all things 'feminine'. Intuition, emotions, social connectedness have no place in the laboratory. Mother Nature, the feminine earth is conquered and forced to give up her secrets to the masculine science. All woolly thinking, emotional rhetoric is cut through by the dispassion of the scientific voice. This lack of emotionality is strongly linked with ideas about masculinity and 'doing what has to be done'. But not only are scientists lacking in emotions through professional considerations, they are also lacking them socially.

The second key construct is the idea that science is involved in a hegemonic power structure. Science is dominant over subverted forms of itself and expresses a contempt for them greater than apparently diametrically opposed subjects. These it allows to grow knowing that they are weaker both economically and intellectually. Much in the same way that contemporary masculinity involves contempt for homosexuality as subverted masculinity (Connell 1987) so science involves contempt for social science.

The third quality of science is the association it has with the claim to objective truth, with superior qualities of intellect. This is a legitimisation, and one necessary to uphold those other qualities as superior, it also ties them into the wider economic, political and social system. Authority, bound up with ideas of power through the male, enlightenment and religious morality, is the legitimate use of this power.

What we have then in the coming together of these three core attributes of science is a malleable central definition of what is scientific, upon which a variety of models can be made. The latest model, the publicly accessible science has been hailed by many as a break from the traditional mould. Whatever, the superficial qualities however, there are points of continuity which underlies the apparent change these relate precisely to those core attributes to which I have referred.

Science has shaped up its image in response to the demands of the consumer. First it is 'public information' the authoritarian figure dispensing information to the public so they can act in a well advised manner. Then it is friendly science; let Patrick Moore and Johnny Ball take you in an

avuncular manner through the wonders of science. Then its 'Future science' with the wonders of the latest scientific and technological thinking laid out for your marvel. And most recently it has been 'pop science'. The writings of Richard Dawkins, Stephen Hawking and so on have been elevated to coffee table book status and fractals have made it onto T-shirts if not quite into the syllabus. Through the change though, there are points of continuity. The scientist portrayed as dedicated, phenomenally intelligent and socially inept.

So then, despite variation over time there is continuity in what we are offered up as defining science, changing images merely serve to illuminate the better points of the same character. But there is a problem that within and between these core concepts, contradictions are manifest. These contradictions are brought home in the way science is practised, learned and communicated. The images however appear to resolve or mediate these contradictions - as the world changes so must the images, but so in essence they must remain the same. The new public science attempts to make a virtue out of a necessity. Real changes have taken place in society, changes that means scientists have to make greater efforts despite themselves. Images are offered as new ways to consume science.

6.4 Structure of Science.

There is a complex relationship between science ideology and the actual practice of science. We therefore need a theoretical model which can comprehend the nature of this relationship. There is a sexual division of labour and also a technological one. It would be negligent however not to point out that the men who hold the power, the jobs and the access to resources in science also come from a particular social class. This structure however is not just held by men in their own self interest. Women can and do participate in the reproduction of these structures through their practice.

Individuals are also directly influenced by the images of science that they are offered in comics, books, film and so on. It is imagery that is presented to help the individual make a positive (for science) sense of the contradictions of their experience and forges a sustainable scientific image. It must be recognised that scientific ideology resides in those 'social rules' that are called into play in the scientific practice. This practice is ideologically conditioned, not conscious or fully purposive. It is open to reinterpretation and can feed into a modified version of existing ideology, which I would argue is the case with the new public science.

Men control economic and political power through the capitalism of society. The identification of men with work is 'an important part of an enlightenment inheritance' (Seidler 1988:279). He suggests men have identified themselves with the rules of the organisation for which they work in a effort to resolve their growing powerlessness under monopoly capitalism. These rules are based upon the standard of rationality that Weber identified as important in causing the shift from personal to impersonal forms of authority.

Men then, through their greater identification with work and the impersonal standards of rationality this demands, come to base their assessments of work in instrumental terms. These standards come to dominate not only public life, but private existence also. An important consequence of this is a rejection of emotional needs and relationships. Seidlers' analysis shows a

subtle face of men and science at work. Namely in the association of science and men with the qualities perceived as necessary for success; logic and rationality.

The changing nature of work, accountability and economic pressures has forced the scientific community to examine its relationship with society. They have had two choices, if they wish to continue with scientific endeavour, as we know it. Either cover-up the changes or brazen it out, pretending nothing has changed. The former strategy has crystallised into the 'Secret scientist' images, working on a project for the government or alone away from the rest of society, working on a strange project with terrible repercussions. The second image is the 'public scientist'. He is cool, possibly a woman, accessible and ethical. All the secrecy and dubious projects are out of sight.

So how does this relate to the three core attributes earlier? The first of these, the dominance of science over social science has traditionally been most clearly associated with the claim to knowledge of science. Scientists exercise power in a number of ways: from subtle influence over decision making to the use of financial power. However, the market has come to science and unless it is saleable and popular then its funding is in doubt. What will the public think?

The gendered nature of science is still apparent, and is experiencing a similar shake up. Assertive women who are not portrayed as feminists or matrons are infiltrating into a predominately male domain. Inspiring feminist writers such as Evelyn Fox Keller and Naomi Weisstein speak of subtle and not so subtle exclusion mechanisms that work from within science. These pioneering voices attract attention to the lack of promotion in science and though increases in female presence are evidence, for example in medicine, losses are also apparent. Harding (1986) argues that only in the last 25 years the sex-gender system is visible as an organic social variable. The peculiar contradiction of 'female and yet not a woman; a scientist' can be explored as it is acknowledged in the public forums of journals and other media.

So science is really a new science, a science of contradiction in the media and in reality. The preceding typologies are related to views of science and the key events experienced by the individuals but also are a synthesis in relation to science ideology. The work has sprung from the new public science and so have the stances formulated here.

6.5 The Research.

Though this research has developed a typology for views of science it is important to understand the part this view has in the relationship between science and the parent. A view of science is not functionless, it is a constitutive part of attitudes to science and responses to information and experiences to do with science. It is not possible within the scope of this research to examine the relationship that science has with parents as the focus has concentrated on the parental viewpoint. It seeks to describe the orientation of parents to science and what pattern of attitudes and behaviour this involves. It also gives indication of the processes of judgement that may be used by parents when dealing with science.

The information and perspectives offered in the interviews describe the speakers understanding of the relationship between themselves and science. This may not capture the full dynamic nature of the relationship or it may not be clear if this stance has changed due to the retrospective nature of

the interview. However, this study is not claiming that every parent will have one stance to science and this is static. I would suggest that these stances represent established patterns available to parents and, much like Johnston's learning theory, they can access them all but have preference for one. What follows is an analysis of a series of stances taken by the respondents regarding science and associated with views of science already described[38]. The concluding theory offers a possible view of the development of attitude to science and a tentative proposal of how this may integrate into the findings of previous research into attitude.

6.6 Public Understanding of Science.

It has to be remembered that the public understanding of science movement implies by its existence several assumptions about the nature of science and society. Primarily it suggests that science is not widely understood and that it should be; and beyond this that it is worth spending public money on improving the level of understanding of Science, but not Art or Geography or another worthy discipline.

The idea that this study should be funded gives the impression that society will be better if more people were involved in science is an interesting subtext to this initiative and one that it is difficult to challenge as it is not explicit. Though I would not venture to deconstruct in the classical sense the phrase 'public understanding of science' the question of 'who is this 'public", 'what is 'understanding" and 'what is science' are worthy of examination. If left ambiguous it could be thought, by those whose interpretation of the intentions of the parties involved was less than charitable, that it was the 'Societal Elite's self appointed committee to make the uneducated masses feel happier about science without actually knowing any more about what is going on.' This may be a more political interpretation where public education is starved of funds by the elite and kept in a state of ignorance. However I would suggest that though extreme it is a viable view and one that has not been addressed by the parties involved in the public understanding of science movement. Their good intentions are perhaps not as transparent as they would assume and whether this is naive or arrogant is fairly irrelevant.

If the body of science wishes to perform a public relations exercise without really increasing understanding of science then it would be wise to concentrate funding on advertising, awareness raising and all the other trappings of a successful publicity campaign. If true understanding is required then this is not necessarily going to occur without challenges to science and the position it currently holds. These are the perils of true enlightenment. What cannot happen, it would seem, is a combination of both. This research has shown conclusively that adults concerned with science, even on the periphery of their child's education are either impressed with the authority of science and do not seek to change the structure of science education and public policy concerning science or seek a more socially responsible science and are expecting science education to lead the way in these matters.

Within the public understanding movement itself, if there is such an integrated body, there is some dissent over how this funding should be spent. Some groups feel that 'mucking around in church halls with yoghurt pots' (Conference speaker 1998) not the way to *promote* science to the public.

---

[38] Where a particular stance is associated with a view of science the quotes used following are from the same parents in both cases.

The money should be concentrated in large projects aimed at attracting large company interest and there should be a more concentrated public relations effort. Others feel that the local projects run on a tight budget and a lot of good will are the important acts as they are getting to the people it is hoped need the encouragement to become involved in science; the people perhaps whom I have been talking to with in this research. During the period of this research a clear focus for the public understanding of science has not emerged. The blurring between science and technology is continuing and the demographics of science still male dominated, even when involved with the public understanding of science. It is perhaps too much to expect change but if this is correct then it is too much to expect an increase in public enthusiasm.

Clarity of focus is required. If the public understanding of science is trying to encourage more children to be empowered in science then the money should be given to small scale projects and to employ active, enthusiastic science teachers. It should also be ploughed into updating the crippling out-moded science curriculum at secondary level. This seems very sweeping but the points will be expanded below. From this research it can be seen that science is too diverse for a general increase in public understanding as peoples' attitudes are embedded in their previous experience, not in 'science' as an entity. Cultural influences, gender influences, art science differences are all based on historical perspectives. This would suggest that those parents who have taken a historical- philosophical stance to science are the most open and aware of potential in science to change its nature. Therefore perhaps the effort of the public understanding of science should not be to dazzle people with the progress of science, which somehow seems to confuse with technology but give the public ideas of where science came from, its historical, cultural basis.

6.7 Science in the Curriculum.

The word empowerment is worthy of a dissertation solely on its use and abuse. To some empowerment is a catchphrase to be used when providing information. We are empowering you with this information. I would agree with Griffiths (1998) in suggesting that empowerment means the relaxation of control. The mere provision of information is insufficient for empowerment. The individual must be able to act in a way that they see fit which is not the same as having the information and being 'empowered' to act in the way the establishment would consider a right use of your empowerment.

As I have suggested before, by empowering individuals in science you are empowering them to challenge science. To challenge its place in society, the value of its discoveries and techniques. To examine the culture of science and its contribution to society. Empowerment involves scrutiny and criticism and this should be encouraged and enjoyed. If science is convinced of its own value then the questioning should not worry the establishment.

The first step in allowing the questioning of science is to increase the accessibility to ideas. There is no reason why ideas in science cannot be shared at any level. When introducing concepts at an early level it is often queried how children are' meant to understand about electricity'. In fact they are not expected to be able to say what electricity is in terms of electrons available in the outer shells of atoms. The first steps to understanding are observation, exploration and questioning. It is this that parents who participated in this study recall for primary science. It is also the lack of this in secondary science that is a memorable factor. Seeing science in primary level activities clarifies for parents the idea that science is not a subject that they studied only at secondary level.

It validates their primary science experiences. The reintroduction of these ideas to parents causes them to question whether it is 'real' science but it is because the activities are the first steps in scientific method and understanding. When these ideas are understood then questioning such as 'why are we looking at things this way?' 'What are we learning that is useful?' can be asked and discussed. The lack of knowledge of the body of scientific knowledge excludes the individual who does not feel they have the right to question. Could it be in time honoured academic fashion that those who know about science present it in the most impenetrable way possible to make themselves look good and prevent questions being asked? Parents within this research with an authoritarian view of science certainly seem to feel excluded from science, with no right to question or opportunity to question science in education or in public policy.

So implications for the curriculum are to move secondary science closer to primary science. If you ignore the gender differences between the teachers and address only the topic matter it can be seen that the fundamental lessons in science have not been altered since the 1950's. The curriculum has become more and more skills and knowledge based and has been criticised generally, for without allowing time for the discussion of ideas beyond the body of science which is the exercise of empowerment. Policy should be encouraging the open discussion of the development of ideas rather than the adoption of the accepted value structure of mainstream society. Criticism of education in general has often focused on new and 'trendy' teaching methods that have emphasised the learning process rather than the subject content. However, depending on whether science education is seen as a method of discovering the world, forming a career or coping with parents would not necessarily see this as inappropriate. What is of particular importance is the emphasis on attainment targets and assessment that has been introduced into the curriculum recently. These have shaped curriculum experiences by focussing the goal of learning experiences toward good exam performance. Therefore the classroom activities are often more structured, producing an assessable outcome.

This research has shown strongly that the understanding of science is more complex than increasing the body of knowledge or increasing the admiration for science held by this anonymous public. Parents, who are the guiding forces on their children's attitudes and ideas are not convinced by media led changes in established institutions unless the impact is felt directly. They require access to science that does not deny their negative experiences but explores them and allows them to be explained as a consequence of societal structure. It is better for an individual to feel that they do not think the knowledge provided by science is as valuable to society as the resources it consumes than believe that individually science has nothing to give or take from their lives. Having a questioning approach, which is advocated in all teaching must be expanded beyond the polite questions on the body of knowledge and include questioning the tenets of science.

6.8 Home School Liaison.

Beyond more discussion of the foundations of science in this society this research has shown the need for home school liaison to be integrated into the curriculum. It should not be a bolt on; there should be no need for home school agreements. It should be a key task for all schools and teachers. The development and learning of the child should not be bordered by home or school boundaries. This work suggests the synergy between parents and teachers to acknowledge the varying needs of the individuals involved. Parents in this research have identified that their lines of communication are not necessarily running through the school. This means that there are other substantial sources of information about school that might be considered more reliable. This study has highlighted that importance of communication between school and parents in the 'messages' parents receive about their perceived role and information they have access to. Though parents acknowledged the efforts schools have been giving to parental involvement, levels of communication were still varying widely.

This being the case it highlights that home school liaison is often a controlling mechanism by the school and sometimes 'school compliant' parents, in that they will be readily involved in school decision making through school governance. It is not defined within the school curriculum at every level and the introduction of compulsory 'home-school' contracts makes the process of education one that is more separated into home and school than ever. Instead of a willing partnership full of altruism and high ideals the home school partnership has been reconceptualised as a business relationship with the parent as the consumer and the child as the product. The child is no longer an individual who is brought in partnership to the peak of its ability. The child is now a product that must reach a minimum standard otherwise the consumer will complain and the company or manager responsible for that product will be punished.

The fears of parents within this research, especially with the inclusion of science as a 'core subject' was that the introduction of attainment targets has introduced 'satisficing' (the psychological phenomenon of finding the minimal satisfactory solution (Kahneman and Tversky 1973)) into the arena of education. If 80% of children must be at a certain level when they are for example eight years old, the children who are already at that level need not be educated at all. The middle children can be brought up to scratch quite easily so concentrate on these, and abandon the 'no-hopers' who will comprise the 20% who are never going to get there.

By integrating school and home education and returning to a true partnership you are also reintegrating the school with society. Instead of sending your children to be educated, teachers become experts in education rather than imparting knowledge. The discourse in new managerialism that has dominated education since the 1980's has made efficiency the dominant ethic in education. There has been discussion of emergent, residual and dominant ethics in the professions and though the public service ethic is residual in education it is reduced as discourse of attainment, efficiency and customer satisfaction take over.

As socially sanctioned sites of power, though that power is diminished greatly by the last and present governments it is a moral responsibility of schools to locate themselves politically and take action in the world whether it is small and local or wider. The research has suggested that a new ethic of challenge and politicisation should be the emergent culture. The concern of the

individuals in this study was that they did not feel that they could challenge either the school or the science experiences they had. They presented narratives of risk, collaboration, civic awareness and adventure when they spoke about science but could not relate this to the whole of science. Only fragments and individuals were open to this questioning and challenge.

This study suggests that the scientific community is another socially sanctioned site of power and yet has neglected its duty to take action to fulfil a vision of a critical world. There is pride in the objectivity of science and that it is a-political and this is of course socially naive. However it has the effect of silencing children as they are integrated into the structure of knowledge in science. There are no personal narratives, no discourse of politics and justice as these things are 'beyond' the remit of science (see Section 5.6.2). Science is a hegemonic structure in that participants often work in fear of stepping outsides the boundaries of the profession. Once outside the culture of science the kudos is lost and authority is reduced and you are subject to the troubles of social scientists. I have elsewhere suggested who maintains and defines the boundaries in science (Section 5.6.3) but the finalising and deadening of the self that happens on 'entry' to science is evidence for this boundary maintenance.

6.9 Implications for the Structure of Attitude and Further Research.

This research has reconceptualised attitude as 'anchoring narratives'. It has suggested that people make sense of their experiences in terms of a patchwork self and take a 'stance' to science that reflects their ideas and experiences concerning the nature of science. This stance is not always singular or inflexible but reflects the individual's picture of different selves and different sciences. The individual may view school science differently to other science and differentiate again between school science at primary and secondary level. There is no comprehensive idea of science but shared understandings in a social context. The idea of attitude as a single measurable trend in behaviour becomes unfeasible if the multitude of selves and the multifaceted nature of science become acknowledged. There is not one 'attitude to science' but a shifting pattern, a kaleidoscope of attitude, shifting with the different selves brought into being in social contexts. Measurement becomes meaningless when the object that is being measured changes, but the lack of predictive value of measurement is explained.

Attitude research has not, before this study, begun to examine the origins of attitude. Its germination and development have not been examined and by listening to the small stories, the personal narrative it is possible to develop a deeper understanding of the formation of attitude and how it is linked with ideas of a multiple self. Reductionist approaches to the human psyche do not ever capture the full complexity of processes and so fail to be useful either for prediction or furthering the understanding of the self. Social justice demands the personalisation of psychological research. If the effort is to understand and *improve society*, to move it toward a just society then it is imperative that individuals are viewed as complex individuals who cannot be expected to react in the classical stimulus -response pattern which is still so popular in psychology.

This research has shown how rich stories and life narratives are for understanding and interpreting the development and nature of attitude. The impact of individual events and circumstances has been the focus of this study but the integration of this into the self has yet to be explored. This research is of a tentative and germinal nature and all the dynamics explored within it require

further intense exploration. The analysis of the data through theory generation and testing is not as intense as hermeneutic analysis and the peculiar rigour of this type of analysis could bring further or different insight into the storying of life experiences. I feel the value of individual stories is a very powerful research tool when striving for social justice through research. As a cultural resource behavioural scientists or educationalists do not access them enough. Abstract concepts of fairness are included in them in a way that is informative and yet unquantifiable. Stories are for sharing and expanding rather than reducing or silencing.

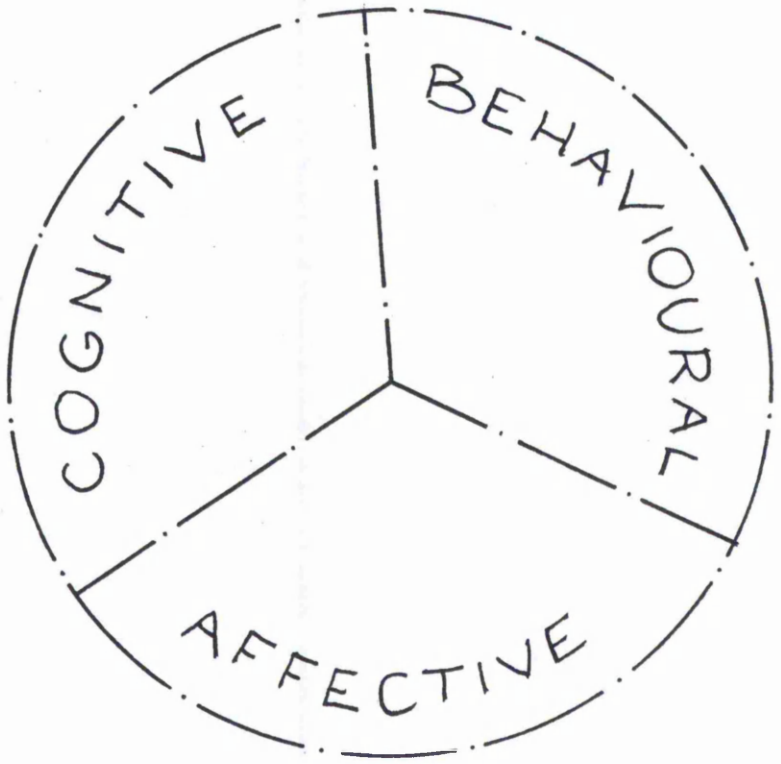


Figure 6
The Tradtional Tripartite view of attitude (from Fishbein& Azjen 1980)

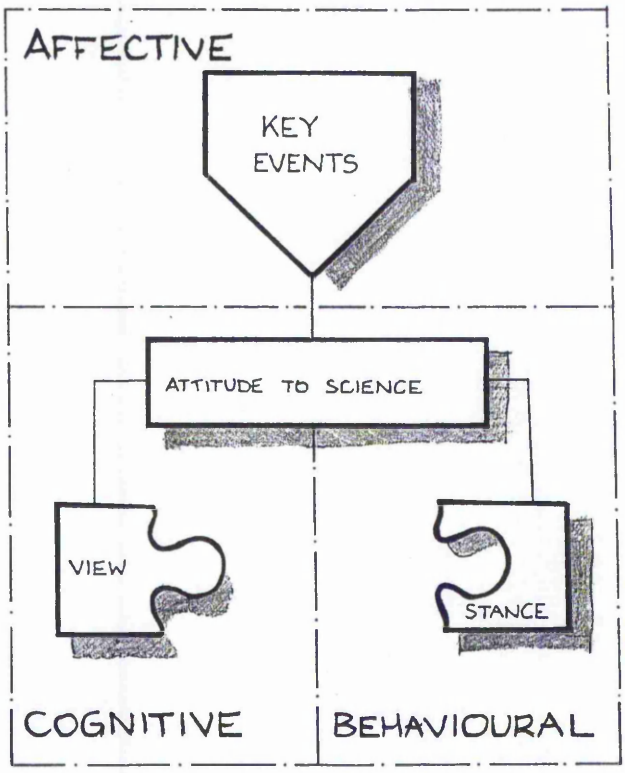


Figure 7
Attitude as a process

6.10 Discussion of Gender.

The gender-focused nature of this research has also raised some important issues. Primarily that science is still losing young women through depersonalisation but further, that role models are in desperately short supply. Projects encouraging women into science and engineering are staffed by middle aged men and Carol Vorderman has become removed from the scientific community and the female society through her media profile. It was suggested to me by one parent that "next year (1999) I would not be surprised if Carol Vorderman appeared on Page three and Melinda Messenger hosted the Christmas lectures". This shows the dilemma of intelligent women who must also be sexy and sexy women who strive to show their intelligence. It is not assumed that they can be equal, it must be proved.

The world of science is still not equipped to deal with women. The challenge to the 'nature is female, science is male' and the associated subtext of dominance and the 'organic, inferior' female mind is an effective filter for women. The exception, rather than the rule is a woman who makes her way and maintains her 'self' intact. I would suggest the fracturing and silencing by science makes it difficult to keep publicly a self that is recognisable by the inner self. The tension can drive women out of science, move them out of mainstream science into 'soft' science or attempt to 'prove' their other identities through contrasting actions.

This research has not attempted to examine the differences between narratives of women and men. It has not deconstructed (unless very minimally) the text of the different narratives and this may provide additional insight into the constructs used by men and women regarding science. It may also be crucial to the understanding of the role of media portrayal and manipulation of science both on gender roles and ideas about the gendered nature of science.

The media portrayal of science is very gendered and this is both unfortunately accurate and grossly stereotypical. This makes it hindering for any young person and especially at primary school age where identities and roles are being explored and formed. The boundaries of girls and boys gendered identities are founded in society and policed not maliciously by the teachers themselves. Discussion of the policing of gender boundaries is given in Chapter five.

It is important to explore the gendered nature of images of science from primary school onwards so that the understanding of interactions between the subject history and the subject matter is advanced. The current neglect in the curriculum of the history of science and the sociology of science has atrophied the general understanding of science and the lack of government and school agency in remedying this, is symptomatic of the lack of focus surrounding science. The call for 'back to basics' is contrary to the public understanding of science. I would go further to suggest that the back to basics policy is one that encourages the narrowing of the curriculum. It does not support development of understanding but by reducing the depth and breadth of the exploration of information while increasing the information transmitted in lessons serves to deepen stereotypical ideas about science and any development beyond those measured in attainment targets is effectively reduced.

Once again the use of 'carnival' in the classroom could broaden the educational experience of primary children. The upsetting of traditional roles and the examination of stereotypes this causes can be both memorable and attitude shaping.

6.11 Summary

The notion of key events has proved of particular importance for this study. Generated by an indepth review of definitions and previous usage of critical incidents, key events have been used as a research tool for examining the process of development of attitude to science but also their nature and qualities have been illuminated further by analysis during the research. Key events are a point of crystallisation of ideas, a memorable moment that can help to subsequently explain actions or motivations. Thus they are ideally placed to tell us about attitude. But further, these qualities lead them to be used within narrative discourse to indicate changes in the storyline, give rationales and conjure scenes for the listener. So by examining narrative, we can look for explanation of behaviour, we can examine attitude and maintain a constructionist research position.

The use and scrutiny of key events prompted an analysis of attitude to science that did not fit with conventional models attitude. Views of science and stance to science were found as separate, dynamic components of attitude. A typology for each of these components was generated, the views of science reflecting the individuals cognitions and emotions concerning the topic. Depending on how the individual perceived science in relation to education, society, technology, work, history and so on they espoused a set of ideas of science that could be encapsulated in a view of science. This would be related very strongly to the experiences of science they had had during their lives, (the key events) and how these had been interpreted. The key events shaped the view of the individual, allowing them to use the event as a point of understanding about science and the way they related to it. Thus the key events also dictate to some extent how the individual dealt with science in an operational sense. Within this study this is referred to as 'stance'.

A typology is also generated for stance to science and related dynamically to view. Stance to science shows not only how the individual relates what they think and feel into action but also where they seek information. Within the model generated in the research, the information seeking aspect is articulated through view, but as an action, is strongly linked to stance. Within this study, stance and view and key events replace the traditional tripartite view of attitude with a more process based model where there is a more clear interaction between how individuals think, feel and act. The way they process and deal with information and circumstances related to science now determine how we think of their attitude. The key events show the process of formation, illuminates view and stance and provides information about the individuals experiences.

References

Aamodt M, Keller R, Crawford K (1981) A critical Job analysis of the university housing resident assistants position **Psychological Reports** 49 (3) 983-986

American Psychiatric Association (1994). **Diagnostic and Stastical Manual of Mental Disorders IV.** Washington DC: American Psychiatric Association.

Appleyard, B.(1992) **Understanding the Present. Science and the Soul of Modern Man.** London: Picador

Azjen, I., and Fishbein, M. (1980) **Understanding Attitudes and Predicting Social Behaviour.** Englewoods and Cliff, N.J.: Prentice Hall.

Ball, S. and Vincent, C. (1996) 'I heard it on the Grapevine.': 'Hot' knowledge and parental choice. **A paper presented at the British Education Research Association Conference.** Lancaster University. September.

Ballachey, E.L., Krech, D. and Crutchfield, R. (1962) **Individual in Society**: A textbook of social psychology.

Ballentine and Henderson (1987) Teaching the sociology of Education. **Teaching Education** 1 (1) 33-35.

Barone, T. (1989) **A narrative text as an occasion for conspiracy. Qualitative Inquiry into education. The continuing debate.** New York: Teachers College Press.

Bastiani, J. (1993) **Your home-school links.** London: New Education Press

Bastiani, J. (1995) **Taking a few risks.** London: RSA.

Bauman, Z (1994) **Hermeneutics and Social Science.** London: Hutchinson.

Becker, B. J. (1989) Gender and Science Achievement: a re analysis of studies from two meta-analyses. **Journal of Research in Science Teaching,** 26, 141-169.

Bem, D.J. (1970) **Beliefs, attitudes and human affairs.** Belmont Brookes: Cole Publishing Co.

Benjamin, M. (Ed) (1991) **Science and Sensibility: Gender and Scientific Enquiry 1780-1945** Oxford: Blackwell Publishers

Bentley, D. Watts, M.(1988) Down the tubes- Views and Opinions of science Education television in the Classroom. **School Science Review**. 69 (248) 451-59

Breakwell, G.M., and Beardsell, S. (1992) Gender, Parental and peer influences upon Science attitudes and activities. **Public Understanding of Science,** 1(2), 183-197.

Brooks, G., Gorman, T., Harman, J., Hutchinson, D, Wilkins, A (1996) **Family Literacy Works**: The NFER Evaluation of the Basic Skills Agency's Demonstration Programmes. London: Nfer/Basic Skills Agency

Bruner,J. (1984) **In search of mind: essays in autobiography.** New York: Harper and Row.

Bruner, C. (1985) **Actual Minds, Possible Worlds.** Cambridge: Harvard University Press

Bruner, C (1990) **Acts of Meaning.** Cambridge Massachusetts: Harvard University Press

Bryman, A (1988) **Quantity and Quality in Social Research.** London: Unwin.

Burn, O. (1979) The concept of self and apology strategies in two cultures **Journal of Asian Pacific Communication,** 10, (1), 1-24

Carter (1993) in J.A. Hatch and R. Wisniewski (Eds.)(1995) **Life History and Narrative.** London: Falmer Press.

Cattell, R.B. (1975) **Personality and Mood by Questionnaire.**

Cattell, R.B. (1979) **Structure of Personality in its Environment.**

Charmaz, S. (1990) Discovering Chronic Illness using Grounded Theory. **Social Science and Medicine.** 30 (11) 1161-1172.

Clarke, K. (1987) The place of story in the study of teaching and teacher education. **Education Researcher.** 22, 5-12.

Clishner, K (1987) Teaching cross cultural Psychology: Providing the missing link **Teaching of Psychology** 14 (4) 220-224

Community Relations Commission (1986) **Between Two Cultures.** London: Community Relations Commission.

Cheng, Y., Payne, J. and Witherspoon, S. (1995) **Science and Mathematics in full time education after 16: England and Wales Youth Cohort study.** Department for Education and Employment.

Chitty, C. (1992) **The Privatisation of Education: Education for Economic Survival-from Fordism to Post-Fordism.** London: Routledge.

Cohen, S. (1980) **Folk devils and Moral panics.** New York: St. Martins' Press.

Cohen, L., and Manion, L (1994) **Research Methods in Education.** London: Routledge

Cohen and Smith (1976) **The Critical Incident and growth groups theory and technique** Cambridge University Associates.

Coulter, J. (1989). **Mind In Action.** Oxford: Polity.

Crawley, F. E. and Black, C. B.(1992) Causal Modelling of Secondary Science Students intentions to enrol in Physics. **Journal of Research in Science Teaching.** 29(6), 585-599.

Crawley, F., Coe and Koballa, T (1988) Attitude and Related concepts in Science Education. **Science and Education.** 72 (2) 115-126.

David, M. (1993) **Parents, Gender and Educational Reform.** Oxford: Polity Press.

Deem, R. (1989) The new school governing bodies- are gender and race on the agenda? **Gender and Education.** 1, 247-260.

Deem, R., Brehony, K. and Heath, S. (1995) **Active Citizenship and the Governors of Schools.** Buckingham: Open University Press.

Dennick, R. (1992) **Multicultural and Antiracist Science Education: Theory and practice.** Nottingham: Nottingham University.

Denzin, N. K. (1992) in J.A. Hatch and R. Wisniewski (Eds)(1995) **Life History and Narrative** London: Falmer Press.

Denzin, N.K. and Lincoln, Y.S. Eds. (1994) **Handbook of Qualitative Research.** Thousand Oaks, California: Sage.

Deutscher, I. (1973) **What we say, what we do.** Brighton: Scott

Department for Education (DFE) (1994) **Our Children's Education: The updated Parent's Charter.** London: HMSO.

D.E.S. (1967) **Children and Their Primary Schools**: A Report of the Central Advisory Council for Education (England). Volume 1: The Report (Plowden). London: HMSO.

Department of Education and Science (DES) (1991) **The Parent's Charter.** London :HMSO.

D.E.S. (1985) **The Curriculum from 5 to 16: Curriculum Matters 2**: an HMI series. London: HMSO.

D.E.S. (1985a) **Better Schools Cmnd 9469** (White Paper) London: HMSO.

D.E.S. (1985b) **Better Schools; a summary.** London: D.E.S.

D.E.S. (1988) **Education Reform Act 1988:** Chapter 40. London: HMSO.

D.E.S. (1988b) **Science for Ages 5 to 16; proposals of the Secretary of State for Education and Science and the Secretary of State for Wales.** London: HMSO.

D.E.S. (1989) **The Education Reform Act 1988**: The school curriculum and its assessment. Circular No 5/89 22nd February 1989. London: HMSO.

D.E.S. (1989)Statutory Instrument: **The Education (National Curriculum) (Attainment Targets and Programmes of Study in Science)** Order 1989. London: Her Majesties Government.

DfEE (1997) **Connecting the Learning Society: National grid for learning**. The government's consultation paper. London: DfEE.

DfEE (1997) **Circular 10/97 Requirements for Courses of Inital Teacher Training.** London: DfEE.

DfEE (1998) **The Learning Age: a renaissance for new Britain.** London: DfEE.

DfEE (1998a) **Circular 4/98 Teaching: High Status, High Standards.** London: HMSO.

Derrida, J. (1967) **De la Grammatologies.** Editions de Minuitt,Paris.

Derrida, J. (1972) Structure, Sign and Play in the Discourse of the Human Sciences. In R. Macksey and E. Donato (Eds) **The structuralism controversy: the languages of criticism and the sciences of man.** Baltimore: Johns Hopkins University Press.

Descartes, R. (1968) **A Discourse on Method.** Paris: Bordas.

Doherty, J. and Dawe, J. (1988) The relationship between development maturity and attitude to School Science. **Education Studies.** 11, 93-107

Driver, R., Guesne, E., and Tiberghien, A. (eds) (1985) Children's ideas in Science. Milton Keynes: Open University Press.

Driver, R. and Oldham, J.(1986). Attitudes To Science: Issues and Concerns. **School Science Review**. 79 (288) 27-33

Drory A and Romm T (1988) Politics in Organization and it's perception within the organization. **Organization Studies** 9(2) 165-179

Ebenezer, J. V. and Zoller, U. (1993) Grade 10 Student's Perceptions of and Attitudes toward Science Teaching and School Science. **Journal of Research in Science Teaching.** 30(2), 175-186.

Eco, U. (1989) **Foucaults' Pendulum** New York: Ballentine.

Edmondson and Novak, J. (1993) How do we learn our lesson? **Science Teacher** 60 (3) 50-55

Edwards, R. and David, M. (1997) Where are the children in Home-School relations? Notes toward a research agenda. **Children and Society.** 11, 194-200.

Eiser and Van der Plight (1988) **Attitudes and Decisions.** London: Routledge.

Eland, S., Jackson, P., Johnston, J., Snow, N. (1995)a **Let's investigate Electricity!** Teachers' booklet. Nottingham: Nottingham Trent University, Department of Primary Education.

Eland, S., Jackson, P., Johnston, J., Snow, N. (1995)b **Let's investigate Energy!** Teachers' booklet. Nottingham: Nottingham Trent University, Department of Primary Education.

Eland, S., Jackson, P., Johnston, J., Snow, N (1995)c **Let's investigate Materials!** Teachers' booklet. Nottingham: Nottingham Trent University, Department of Primary Education.

Eland, S., Jackson, P., Johnston, J., Snow, N. (1995)d **Let's investigate Light!** Teachers' booklet. Nottingham: Nottingham Trent University, Department of Primary Education.

Eland, S., Jackson, P., Johnston, J., Snow, N. (1995) **Let's investigate Sound!** Teachers' booklet. Nottingham: Nottingham Trent University, Department of Primary Education.

Emihovich, C. (1993) Computer Discourse- conversations with a machine. **Education and Urban Society.** 24 (4) 498-506

Emihovich, C. (1995) in J.A. Hatch and R. Wisniewski (Eds.)(1995) **Life History and Narrative.** London: Falmer Press.

Erickson, G. and Erickson, L. (1984) Females and Science Achievement: Evidence, explanations and implications. **Science Education**. 68, 63-89.

Etter-Lewis, G. (1993) **My Soul is My Own: oral narratives of African- American Women in the professions.** New York: Routledge.

Everly, G (1994) Short term Psychotherapy of acute adult onset of Post traumatic stress disorder **Stress Medicine** 10(3) 191-196

Fazio, R. and Zanner, M (1987) **Social Influence**. Hillsdale, NJ, US: Lawrence Erlbaum.

Festinger, L. (1962) **A Theory of Cognitive Dissonance.** London: Tavistock

Fishbein, M. (1981) **Readings in Attitude Theory.** New York: Wiley.

Flanagan, J (1954) The Critical Incident Technique **Psychological Bulletin** 51 (4) 327-358

Foucault, M. (1973) **The archaeology of knowledge;** translated from the French by A.M. Sheridan Smith. London: Tavistock Publications.

Foucault, M. (1980) **Power and Knowledge: Selected Interviews and Other writings.** New York: Panteon.

Freeman, J (1984) The Feminist Scholar in Rose, H. (1994)**Love, Power and Knowledge-Toward a Feminist Transformation of the Sciences.** London: Polity.

Freud, S. (1940) **Collected Papers.** London: Hogarth.

Gardner, H (1994) **Frames of Mind: the theory of multiple intelligence.** New York: Basic

Gardner, P. (1975) Attitudes to Science. **Studies in Science Education.** 2, 1-41.

Gardner, P. (1980) **Science; Good, Bad and Bogus.** Oxford: Oxford University Press.

Gardner, P. (1995) Measuring Attitudes to Science. **Research in Science Education.** 25, (3) 283-289

Gergen, K.J. (1985). The social constructionist movement in modern psychology. **American Psychologist**, 40, 266-75.

Gergen, K.J. (1994). **Realities and Relationships: Soundings in social construction.** Cambridge, Mass.; Harvard University Press.

Gergin, M.M and Gergin, K.J, (1987) The Self in Temporal Perspective. In R. Abeles (Ed) (1987) **Life span perspectives and Social Psychology**. Hillsdale:Erlbaum.

Glaser, B. and Strauss, A. (1967) **The discovery of grounded theory: Strategies for Qualitative Research.** New York: Aldine de Gruyter.

Gogolin, L. and Swartz, F. (1992) A Quantitative and Qualitative Inquiry into the Attitudes toward Science of Nonscience College Majors. **Journal of Research in Science Teaching.** 29 (5), 487-504.

Goodenough, F.L. (1926) **Measurement of intelligence by drawing.** New York: Harcourt, Brace and world.

Goodson, I. (1993) **School subjects and curriculum change.** London: Croom Helm.

Gauld, C.F. (1980) Scientific Attitudes: a review. **Studies in Science Education**, 7, 129-161.

Grant, C. A. (Ed.) (1992) **Research and Multicultural Education: From margins to mainstream.** London: Falmer Press.

Greenfield, T.A. (1995) Sex-differences in Science Museum Exhibit Attraction. **Journal of Research in Science Teaching.** 32 (9), 925-938

Gregg (1965) in Lawson, J. and Silver, H. (1973) **A social history of education in England** London: Methuen.

Griffiths, M (1998) **Educational research for social justice: getting off the fence.** Buckingham: Open University Press.

Grumet, M. (1988) **Bitter Milk: Women and Teaching.** Amherst: University of Massachusetts Press.

Gumaer J (1982) Ethics and the experts. Insight into critical incident . **Journal for Specialists in Group work** 7 (3) 154-161

Guttman A (1973) Reduction of defensive behaviour of counsellor trainees during counselling supervision **Counsellor Education and supervision** 12(4) 294-299

Habermas, J. (1984) **The theory of communicative action:** translated by Thomas McCarthy. Vol.1: Reason and the rationalization of society. Boston: Beacon.

Hammersley, M (1993) **Educational Research: Current Issues**. London: Open University Press.

Hannon,V. (1992) **Ending Sex Stereotyping in Schools- a source book for school based teacher workshops.** Manchester: Equal Opportunities Commission.

Harding, J. (1983) **Switched off: The Science Education of Girls.** New York: Longman.

Harding, S. (1991) **Whose Science, Whose Knowledge? Thinking from Women's Lives.** Milton Keynes: Open University Press.

Harding, S. (1993) After the neutrality ideal, science, politics and 'strong objectivity'. **Social Research** 59 (3) 567-587.

Harré, R. (1979) **Social being: a theory for social psychology.** Oxford: Blackwell.

Harré, R. (1992). **Personal Being: A theory for individual psychology**. Oxford; Blackwell

Harvard, N. (1996) **Student Attitudes to Studying A level Sciences.** Public Understanding of Science.

Harvey, D. (1982) **The condition of post-modernity.** Oxford: Blackwell.

Head, J.O. (1985) **The Personal Response to Science.** Cambridge:Cambridge University Press.

Hendley, D., Stables, S., and Stables, A. (1996) Pupils' Subject Preferences at Key Stage 3 in South Wales. **Educational Studies.** 22 (2), 177-187.

Hollway, (1989) **Subjectivity and Method in Psychology: Gender meaning and science.** California: Sage.

Houston, W. (1995) Classroom Activities That Have Stood the Test of Time (What Works for Me). **Journal of Economic Education**. 30 (2) 141-47.

Hymer, S (1984) The self in Victimization: Conflict and development perspectives. **Victimology** 9 (1) 142-150

Jessop, B. (1994) The Transition to post- Fordism and the Schumpeterian workfare state, in : R.Burrows and B. Loader (Eds) (1994) **Towards a post Fordist Welfare State?** London: Routledge.

Johnston, J. (1993) **Grant application to the Royal Society's Committee on the Public Understanding of Science:** Held by Nottingham Trent University.

Johnston, C. (1996) **Learning how to learn**. awaiting publication.

Johnston, J. (1996) **Early Explorations in Science.** Buckingham: Open University Press

Josselson, R. (1993) A Narrative Introduction. In R. Josselson and A Lieblich (Eds) **The narrative study of lives.** Newbury Park: Sage.

Jung (1973) in Cohen A and Smith R (1976) **The Critical Incident and growth groups theory and technique** Cambridge University Associates.

Kaczkowski H (1984) The Critical incident as a source of structured experiences of group therapy courses. **Teaching of psychology** 11(4) 233-235

Kahle, J. B. and Lakes, M. K. (1983) The Myth of Equality in Science Classrooms. **Journal of Research in ScienceTeaching.** 20, 131-140

Kahneman, D. and Tversky, A. (1973), Judgement under Uncertainty: Heuristics and Biases, **Science**, 185, 1124-1131.

Kant, I (1933) **In Critique of Pure Reason.** New York: Haffner.

Koballa, R. T. (1995) Children's attitudes toward learning science. In S. Glyyn and R. Duit (Eds) , **Learning Science in the Schools**. Mawhas, New Jersey: Lawrence Erlbaum.

Krebs, H. (1981) **Reminiscences and reflections.** In collaboration with Anne Martin. Oxford: Clarendon Press.

Kuhn, T. (1963) **The Structure of Scientific Revolution** Chicago: University of Chicago Press

Krippendorff, K. (1991) **Content analysis : an introduction to its methodology** Beverly Hills : Sage Publications

LaLumia J and Baglan T (1981) Choice of Strategies for Attitude Change: An exploratory Analysis **Psychological Reports** 48(3) 793-794

Latham G, Fay C, Saari L (1979) The development of behavioural scales for appraising the performance of foremen **Personnel Psychology** 37(2) 299-311

.

Latour, B. and Woolgar, S. (1986). **Laboratory Life: the construction of scientific facts** (2nd Ed.). Princeton; Princeton University Press.

Lawson, J. and Silver, H. (1973) **A social history of education in England** London: Methuen.

Lincoln, Y. and Guba, E. (1985) **Naturalistic inquiry.** Beverley Hills: Sage.

Lincoln, Y. and Guba, E. (1986) But is it rigorous? Trustworthiness and authenticity in naturalistic evaluation. In D. Williams (ed.) (1986) **Naturalistic Evaluation.** San Francisco: Jossey Bass.

Lyons, W. (1990) **The disappearance of introspection.** Cambridge: MIT press.

Lyotard (1984) **The Post-modern condition.** Manchester: Manchester University Press.

McArthur, J. and Wellner, K. (1997) a rejoiner to Roychoudhury, A., Tippins, D. and Nichols, S. (1995) Gender inclusive science teaching: A feminist-constructivist approach **Journal of research in Science Teaching**. 34, 897-924.

McEwen, A., (1986) Teacher's Values: A case study of Northern Ireland. **Research Papers in Education**. 10 (1) 131-141

McEwen, A., Curry, C. A. and Watson, J (1986) Subject Preferences at A level in Northern Ireland. **European Journal of Science Education**. 8 (1) 39-49.

McGurk B, Platton T, Gibson R. (1994) Detectives: A job and training need Analysis. **Issues in Criminology and legal psychology**. 21 24-31

Maclachlan, K. (1996), A hypothetical dilemma. **Adults Learning**. 10 (4) 22-24.

McKenna (1990) in J.A. Hatch and R. Wisniewski (Eds.)(1995) **Life History and Narrative.** London: Falmer Press.

McKenzie, R (1987) Therapeutic factors in group Therapy: A contemporary view **Group** 11(1) 26-34

Manstead, A., Profit, C. and Smart, J. (1983) Predicting and Understanding Mothers Infant feeding Intentions and Behaviour- testing the theory of reasoned action. **Journal of Applied Social Psychology.** 44 (4) 657-671.

Manzer, A. (1980). Let the Happy Children Learn. **Journal of Research in Science Teaching.** 11 (4) 21-25.

Measor, L. in Goodson, I. and Ball, S. (1987) **Teacher's lives and Careers.** East Sussex Falmer Press

Measor, L. and Sikes, P. (1992) **Gender and Schools.** London: Cassell.

Merttens, R. (1993) in O' Grady, C. In the Family Way. **Times Educational Supplement.** 7.5.1993.

Merttens, R. and Vass, J. (1990) **Bringing School Home. Children and Parents Learning Together.** London: Hodder and Stoughton.

Miles, M. and Huberman, M. (1984) Rethinking the Quest for School Improvement. **Teachers College Record** 86 (1) 34-54

Mischel, N. (1968) **Introduction to Personality.** New York: Holt, Rinehart and Winston.

Mischel, N. (1973) Toward a Cognitive Social Learning Reconceptualisation of Personality. **Psychological Review.** 30 (4) 252-253.

Mishler (1986) **Research Interviewing: Context and Narrative.** Cambridge: Havard University Press.

Mulkay, M. (1979). **Science and the Sociology of Knowledge.** London; Allen Unwin.

Myers, R.E. and Fout, J.T. (1992) A cluster analysis of High School science classroom environments and attitude toward science. **Journal of Research in Science Teaching.** 29 (9) 929-937.

Newton (1988) Special Educational Needs in the Ordinary School. **Remedial Education,** 20 (4).

Nott M, and Wellington J (1995) Critical Classroom Incidents and the Nature of Science Unpublished paper given at the **European Conference on Research in Science.** Leeds.

O'Brien G et al (1973) The Critical Incident approach to cross-cultural training **New Guinea Psychologist** 5(1) 5-14

Ogbu, J. (1981) **Schooling in the Ghetto: An Ecological perspective on community and home influences.** Washington, D.C.:National Institute of Education.

Oliver, J. S. and Simpson, R. D. (1988) Influences of attitude toward science, achievement motivation and science self concept on achievement in science: A longitudinal study. **Science Education**. 72 (2) 143-155

Ormerod, M. B. and Duckworth,D. (1975) **Pupils' Attitudes to Science.** Slough: NFER.

Patton, M. (1987) Teaching Program Evaluation. **Teaching Education** 1 (1) 73-75

Peacock, A. (Ed) (1991) **Science in Primary Schools: The Multicultural Dimension.** Basingstoke: Macmillan Education.

Peaker (1967) In the Plowden committee report. **Children and Their Primary Schools.** London: HMSO.

Piaget, J (1965) **Play, Dreams and Imitation in Childhood**. London: Routledge.

Piburn, M. D. (1993) If I were the teacher....Qualitative Study of Attitude Toward Science. **Science Education**. 77(4) 393-406.

Polkinghorne, D. E. (1988) **Narrative knowing and the Human Sciences.** Albany: New York State University Press.

Polkinghorne, D. E. (1993) in J.A. Hatch and R. Wisniewski (Eds.)(1995) **Life History and Narrative.** London: Falmer Press.

Polkinghorne, D. E. (1995) A path of understanding for psychology. **Journal of Theoretical and Philosophical Psychology** 14(2) 128-145.

Potter, J and Wetherall, S (1987) On the Relationship Between Attitude Involvement and Attitude Accessibility: **Psychologist**, 21, (1). 81-106.

Powney, J. and Watts (1987) Teacher Appraisal: The Case for a Developmental Approach. **Educational Research.** 33 (2) 83-92.

Radin (1926) **Crashing Thunder: the autobiography of an American Indian.** New York: Appleton

Randall R and Altmaier, E (1990) Job analysis of psychology interns in Counselling centre settings. **Journal of Counselling Psychology** 37(4) 459-464

Reiss, M. (1993) **Science Education for a Pluralist Society.** Buckingham: Open University Press.

Rennie, D. L, Quartaro, G.K., (1988) Grounded Theory. A promising approach to conceptualisation in psychology. **Canadian Psychologist** 29 (2) 139-150.

Ricoeur (1983) Questions of Proof in Freudian Psychoanalytical writings: Translation of **Rensta de Piscoanalisis** 40(5-6) 1053-82

Rosaldo, M. (1984) in Toward an antroplogy of self and feeling in Schweder, R. A and LeVine R.A. (Eds) **Culture theory: Essays on Mind Self and Emotion.** Cambridge: Cambridge University Press.

Rose, C. (1997) Women's work, Women's Knowledge. In Mitchell, J. and Oakley, A. Eds. (1998) **What is Feminism?**

Roseberg and Hovland (1960) in Eiser, J. and Van der Plight, J. (1988) **Attitudes and decision.** London: Routledge.

Rosenberg , S. (1965) **Directions in Psycholinguistics**. New York: McMillan.

Roychoudhury, A. and Nichols, S. (1997) Gender Inclusive Science Teaching: a rejoiner to McArthur and Wellner. **Journal of Research in Science Teaching.** 34 (1) 97-99

Roychoudhury, A., Tippins, D. and Nichols, S. (1995) Gender inclusive science teaching: A feminist-constructivist approach **Journal of research in Science Teaching**. 32, 897-924.

Ruth, J.E. and Ögberg, P. (1992) in J.A. Hatch and R. Wisniewski (Eds.)(1995) **Life History and Narrative.** London: Falmer Press.

Rutter, M. and Madge, N (1976) **Cycles of Disadvantage.** London: Heinemann

Sacks, O. (1992) **The Man who Mistook his Wife for a Hat.** London: Duckworth.

Schmelzer, R et al (1987) Using Critical Incident technique to determine reasons for success and failure of university students.
Journal of College Student personnel 28(3) 261-266

Sears, J. (1997) Computers and the Curriculum: Teaching from a Critical Perspective. **Teaching Education.** 2(1) 96-99.

Shotter, J. and Gergen, K. (1994). In T.R. Sarbin and J.I. Kitsuse (Eds) **Constructing the Social**. London; Sage.

Shrigley, R. (1990) Attitude and behaviour are correlates. **Journal of Research in Science Teaching** 27(2) 97-113

Shrigley, R. and Koballa, T. (1992) Decade of Attitude Research based on Hovland's Learning Theory Model. **Science Education** 76(1), 17-42

Sigston, A and Stratford, R (1994)
All in a day's work: A qualitative analysis of the work of educational psychologists. **Educational and Child Psychology**. 11(1) 44-53

Smial, B. (1984) **Girl-friendly science; Avoiding Sex Bias in the Curriculum** Longman: New York

Smail, B and Kelly, A. (1984) Sex differences in Science and Technology among 11 year old school children: II Affective. **Research in Science and Technology Education.** 2, 87-106

Smith, D.J. and Tomlinson, S. (1989) **The School Effect** Oxford: PSI publications.

Solomon, J. (1993) **Teaching Science, Technology and Society**. Milton Keynes: Open University Press.

Solomon, J. and Lee, J. (1991) **Home School Investigations in Primary Science. (SHIPS)** Hertfordshire: Association for Science Education.

Solomon, J. (1994) Towards a notion of home culture: Science education in the Home. **British Education Research Journal** 20 (5) 557-565

Stewart, I and Joines, V. (1987) **TA Today: A new introduction to transactional analysis**. Nottingham: Lifespace Publishing

Strauss, A. L. (1959) **Mirrors and masks : the search for identity.** London: Martin Robertson

Strauss, A. L. (1987) **Qualitative Analysis for Social Scientists.** Cambridge: Cambridge University Press

Strauss, A.L and Corbin, J. (1990) **Basics of qualitative research: Grounded theory procedures and techniques.** Newbury Park: Sage.

Sutton- Smith, B. (1986) Children's Fiction Making. In T.R. Sarbin Ed. **Narrative psychology: the storied nature of human conflict.** New York: Praeger.

Talton, E. L. and Simpson, R. D. (1985) Relationships between Peer and Individual Attitudes toward Science among Adolescent Students. **Science Education.** 69 (1) 19-24.

Talton, E. L. and Simpson, R. D. (1987) Relationships of attitude toward classroom environment and achievement in science among adolescent students. **Science Education.** 74(1) 1-18.

The Royal Society (1985) **Public Understanding of Science.** The Royal Society.

Times Educational Supplement. **Head Calls for Slow down in Final Changes to Curriculum.** 24-12-1990

Times Educational Supplement. **Implementation of Curriculum Threatened.** 27-12-1990

Tizard, B., Mortimore, J. and Burchell, B.(1981) **Involving Parents in Nursery and Infant Schools.** London: Grant McIntyre.

Tizard, B., Schofield, W. and Harrison, J. (1982) Collaboration between Teachers and Parents in Assisting Children's Reading. **British Journal of Educational Psychology.** 51 1-15

Tomlinson, S. (1998) **Home and School in Multicultural Britain.** London: Batsford.

Topping and Wolfendale, S. Eds. (1985) **Parental Involvement in Children's reading** London: Croom helm.

Travis, C. (1992) **Mismeasure of woman.** New York: Touchstone

Times Educational Supplement: Where boys can still out number girls Editorial 11-4-97

Times Educational Supplement: Report Warns of Gender Apartheid 2-5-97

Tripp, D. (1993) **Critical Incidents in Teaching.** Routledge London.

Tripp, D. (1994) Teachers' lives, critical incidents and professional practice. **Qualitative studies in Education** 1 (7) 65-76.

Turney, J. (1997) **Frankensteins footsteps: Science, Genetics and Popular Culture.** London: New Haven.

Vincent, C. (1996) **Parents and Teachers: power and participation.** London: Falmer press.

Vincent, C and Tomlinson, S. (1997) Home- School Relationships: ' The Swarming of disciplinary Mechanisms?' **British Educational Research Journal.** 23 (3) 361-377.

Vygotsky, L (1962) **Thought and Language.** Cambridge: MIT press.

Walkerdine, V and Lucey, H. (1989) **Democracy in the Kitchen.** London: Virago

Warman, P.C. (1910) **A plea for better science.** Washington: McQueen Press.

Weinburgh, M. (1995) Gender different in students attitudes towards science and meta-analysis of the literature from 1970-1991. **Journal of Research in Science Teaching** 32(4) 387-398.

Weiner D, Russell D, Lerman D (1979) The cognitive emotion process in achievement related contexts. **Journal of personality and Social psychology** 37 (7)

White, R. (1988) **Learning Science.** Oxford: Blackwell Limited.

Whitehead, J.M. (1996) Sex-stereotypes, gender identity and subject choice at A' level. **Education Research.** 38(2) 147-160.

Whitfield, K (1979). Just What Is a Gram, Anyway? **Science Scope**. 16 (2). 32-34

Willis, P. (1977) **Learning to Labour. How working class kids get working class jobs.** Farnborough: Saxon House

Wolfendale, S. (1992) **Empowering Parents and Teachers.** London: Cassell.

Wolfendale, S. Ed. (1989) **Parental Involvement: developing networks between school, home and community.** London: Cassell.

Wolpert, L (1993) **The unnatural nature of science** London: Faber and Faber.

Wolpert, L (1995) Genomes. **Genes and Function,** 1 (1), 3-4

Wolpert, L. (1997) in Levinson, R. and Thomas, J, (Eds) **Science Today :Problem or Crisis?** London: Routledge.

Woodrow, D. (1996) Cultural inclinations towards studying science and mathematics. **New Community** 22(1) 23-38.

Woolnough, B. (1991) Changing Pupils Attitudes to Careers in Science. **Physics Education.** 31 (5) 301-308

Woolnough, B. (1994) **Effective Science teaching.** Buckingham: Open University Press.

Woolsey L (1986) The critical incident technique: An innovative qualitative method of research. **Journal of Counselling** 20 (4) 242-254

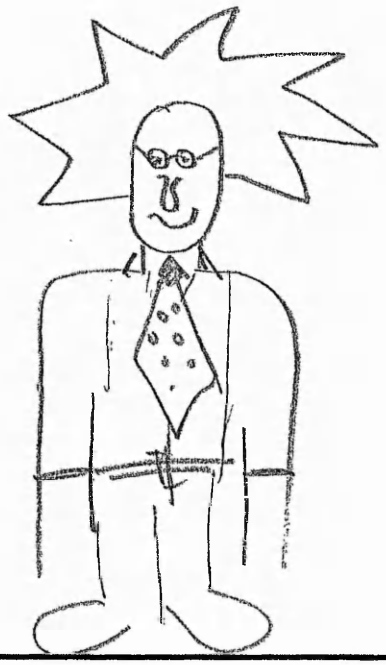
Wragg,T. (1988) **Education in the market place. The ideology behind the 1988 education bill.** London:National Union of Teachers

Wragg, T. (1997) "Oh Boy" **Times Educational Supplement** 16-5-1997, 4-5

Appendix One: Draw a Scientist

WANTED.....a Scientist

Draw a picture of a scientist here

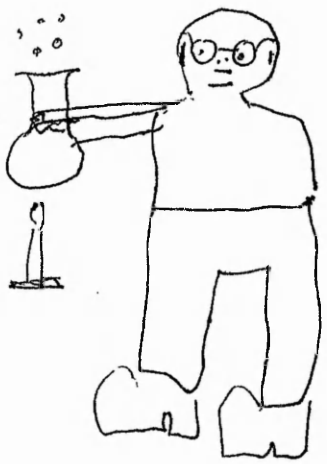


Describe your scientist

Wanders about aimlessly - deep in Thought

WANTED.....a Scientist

Draw a picture of a scientist here



Describe your scientist

Bald, glasses, excentric, academic.

Appendix Two: Note sheet for observation

Note Sheet.

Time: 7-9pm
Date: 5-3-97

School: Catherine Infants
Area: Central Leicester

Weather/Other: Coldish, windy + wet but not too windy

Notes on Advertising: Used flyer, Creche available (60) returns

Schools comment of attendance: - Reasonable. Better than expected (due to children not invited) 200 for last Science/children's workshop. Part of set of curriculum workshops

Parents: 59 Male: 30 female: 29 ages: early 30s

Teachers: 3 Children: in creche Ø

Notes on Catchment Area: Leicester, Asian Gujerati. Nice school in what appeared to be a rough area (large superstores, kids hanging about on streets.)

Most Popular Activities:

General Notes: Fairly warm welcome, parents fiddling with activities before start.

+A ... mother ... after ... [illegible]

Appendix Three: Information Sheet

Information for Interviewee s

Nature of the research

M.Phil./PhD thesis researching nature of critical incidents and the formation of attitudes to science.

Researcher Adelaide Gray
Room 410c ext. 3711
Primary Education Department
New block at Clifton Hall

Supervisors Jane Johnston
Sue Eland
Peter Jackson
John Bastiani

About this Interview

This interview is being conducted to gather information on critical incidents and how they might influence the formation of attitudes to science.

Use of Information

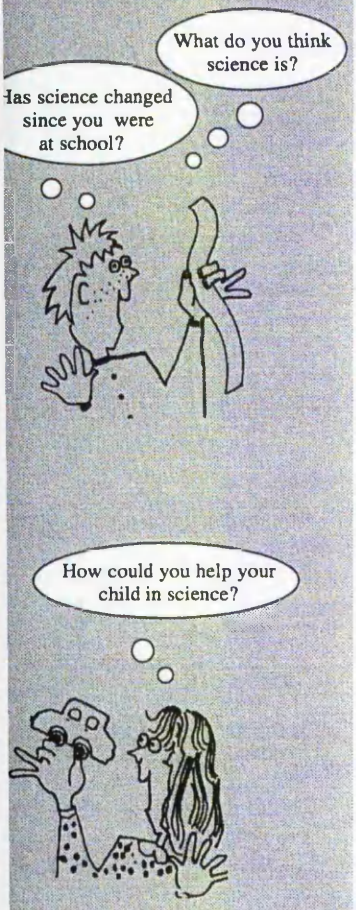
The data collected in this interview will be used as part of the above study to produce an MPhil or PhD thesis. It may also be used as part of a published paper. It will be used as a basis of a further piece of work researching attitudes to science in parents attending the parent workshops run by the primary science department.

In order that the conduct of this research can be properly supervised, full and partial transcripts of this interview may be made available to and discussed with Jane Johnston. You have the right to view or amend any transcripts of this interview and should anyone else require to view this information your permission will be sought before any access is granted.

Appendix Four: Workshop Flyer

Example of Invitiation to Parents

SCIENCE IS FUN WORKSHOP



An experiential workshop developed by The Nottingham Trent University, Department of Primary Education (science), with funding from The Royal Society's Committee on the Public Understanding of Science.

DEVELOPMENT TEAM

SUE ELAND
PETER JACKSON
JANE JOHNSTON
NIGEL SNOW

You are invited to the SCIENCE IS FUN WORKSHOP

at Primary School on

Monday 13th February 1995 6.00pm - 8.00pm

I/We will be attending the SCIENCE IS FUN WORKSHOP

Name/s _____

Parents/guardians/friends of _____ Class _____

We would welcome feedback about this booklet and the ideas contained in it. We would especially like to hear about any workshop activities you have tried. Please send any information to:

Jane Johnston
Department of Primary Education
The Nottingham Trent University
Clifton Hall
Clifton Village
Nottingham NG11 8NJ

Appendix Five: Circle Sheet

SCIENCE WORKSHOP.

We are asking you to complete this questionnaire to help us to developing new workshop ideas. Please take a few moments to fill it in and return to school.

1. What do you think science is?

2. Circle any of these words which best describe science for you?

interesting	dull	chemicals	tentative	important
irrelevant	fun	difficult	astronomy	industry
precise	relevant	frightening	everyday	useful
repetitive	technology	ethical	fascinating	home
exploratory	boring	logical	tedious	earth
school	laboratory	exciting	qualitative	factual
experimenting	physics	investigating	immoral	quantitative
exacting	complicated	discipline	curious	essential
nonsense	medicine	pointless	biology	creative
computers	imaginative	horrid		

You can add words here.....

3.Please circle: Male/Female
Age:under20/21-30/31-40/41-50/over 50

Many thanks for your help.

Appendix Six: Sample Interviews

INTERVIEW JB-1-1F

Really, what I'm very interested in is your early experiences of science. Throughout your school life and...

Well, I don't really remember doing any science at primary school at all. I don't recall: my memory's a complete blank but we did at secondary school.

We did, I went to an all girls school and we did biology and physics and chemistry. I did chemistry at O level but the other two I dropped two years before. Because physics, though I really enjoyed it and was interested in it I found it very hard to understand (comment unhearable).

And Biology , I had aspirations to be doctor (laughs self-depreciating), because my brother had gone into medicine before me and I umm, but I remember having to cut up a bull's eye and fainting in the lesson. And that's when I dropped that out, but what do I remember about it.
[0 10]

I remember doing things like, erm, .in biology things like, dissecting flowers and drawing pictures of them, I enjoyed that and studying local trees. I don't remember doing a lot about animals or about humans. I think I actually missed out on a lot of that because I dropped humans.. .1 not sure (pause) I think I can't remember a lot more than that really.

That's great, could you say some more.. [016]

We had things in tanks and things, but we had a very frightening teacher I Remember (hesitant laughter). She was a really, she was the deputy head of the school and she was a very big woman She was really, sort of, you know a large, well she seemed to me as a child.

yes

But I think she was a fairly big woman and she was very frightening. She used to shout at people and that used to terrify me. (laugh) Completely. The Chemistry we did which I did 'til O level, I remember (something) of that, I liked using the Bunsen burner, I'm struggling to see how much I remember, I mean I remember some very boring stuff like learning the formula and the signs for chemicals and things like that. And we did a few experiments and that was fun. It was just testing things and putting chemicals into test-tubes and mixing things and seeing how they reacted. What did we do? (something) That was quite nice. Again we had an aggressive teacher but she was very interesting and I remember being quite interested in what she did.

What did you find so interesting about it?

Well, I remember actually I do remember one thing. (voice speeds up, leans closer to tape) I'll tell you what was interesting about it. She had an ability to relate it with everyday life. That was the thing. I remember her telling me one thing and I've never forgotten that, you had **better heat**

insulation (emphasised) if you wear two jumpers not one, if you wear a cardigan, you know, two thin ones and one thick one, you know this sort of thing.

Yes.

I remember that being interesting and I think that was the thing that made it interesting because I suppose I could see the **relevance of** it and understand what it was about. [036] I wasn't just being set a task and doing a task. I must say that with physics and chemistry well I can't remember relating it to anything at all. You know. It was an experiment that we did and I can't remember relating it to anything in the real world at all.

Erm, but physics was very interesting , we did a lot of things about electricity and light , but I remember that I didn't understand physics. I was very interested I wanted to know about it but I couldn't, I just couldn't understand it. And I think I would probably continued with that had I been conceived better at it , I don't think it was particularly my choice, I think it had more to do with the school (voice fades) they most probably thought I wouldn't get the O' level or something like that so therefore perhaps shouldn't do , continue with that, perhaps do some more humanities type subject.

Do you have any idea why you found these ideas hard to grasp?

I don't really, I just remember that I found it very hard to wrap my mind around it. erm (pause) [048]

I mean when we were shown, I think we were shown demonstrations and things I don't think honestly think we ever did things. Like kids do now, for ourselves, we were in laboratories, we were definitely in laboratories, I remember, I remember we had lab coats to wear, obviously in biology we had to cut things up, I remember that but I don't recall using the equipment, but I still can't believe we didn't, I remember some scales on switch, there must have been something but I can't , but I don't remember actually playing with things the children are doing in school at the minute, I don't remember anything like that , but I may just not, but I certainly don't remember it.

I mean, I did go to an all girls school, I mean we did have all female teachers(contemplative) But when I was at school the laboratories, teachers were older, and it was a very different type of set up and I don't think that probably helped. [060]

I think if we'd been in a more pleasant environment, I mean it was grim the laboratory, I remember it was, you know, the teacher had a raised platform it was very dark and dour and all the rest of it, erm, but I think it was more umm, you were really under the thumb, you know. You were really, sort of you know, you just sat still and shut-up and kept quiet and I'm sure that had its disadvantages, being shut up as we were girls, may be I would have learnt more because maybe I would have been able to ask more questions.[097]

So I think, you know, not being able to ask questions or doing about the experiment that didn't quite work, may be it helped me understand, maybe I just, but I don't actually believe that people

can't understand, everybody can understand everything if they're, you know, if it's presented in the right way, and I was quite and motivated child as well, because I could do well in other subjects, you know. [101]

I always liked maths in that way. It was wonderful to see all the numbers working out. It didn't matter to me that sometimes it wasn't quite right. It was the pattern that mattered. Seeing things slot into place, more fun than that. It wasn't great for impressing the lads though.

I would've thought that...

My boyfriend at the time, well I was only young and you know how it is, you think they're wonderful and really they're one year older than you and far more immature. Anyway he said that girls were rubbish at science and science was for boys anyway and was I a boy? and all that sort of thing. Anyway, that made me really cross so I took science instead of art, which I'd been planning. I didn't do so well in the end but there was no way I was going to give in after that little incident. Oh no. I've never regretted it.

So what do you think of science now, when you see it in more 'real life' terms, science on the t.v.?..

I think it's fabulous I really do. I mean I think it would be of tremendous value to actually understand more about it and I see, it's interesting because I'm divorced I'm on my own because I now have to deal with things I would previously left to my husband, and lots of things I don't understand like about electricity, for example, I have to call the electrician to sort out what's the problem, (unhearable) I haven't got the confidence to do it, because I don't understand the basics, even something like building the circuit that I did recently and the students teach the children to do, sorry I forgot what the question was that you asked me (laugh)

Your images of science now..

Oh now, I think it's a lot more fun, what they do, I think they **learn,** they learn through doing and I think that what they learn is of much greater value, you know, and it will be of value to them because they understand how things work, in the way that I don't understand things now.[115]

How do you see science in schools relating to outside science, science in the media and from scientists themselves? (long silence) Am I asking two questions? Perhaps if started off by asking what do you think of science as shown by media?

There are a lot of different images of scientists aren't there, of scientists. Tomorrow's world is sort of ground breaking stuff, or so it seems to me because I know nothing about such stuff, but I think if it's ground breaking it's absolutely fascinating the way we will be able to control the environment, in the future. B.S.E, that was a huge political thing wasn't it? Because you feel, I suppose there is still a feeling that scientists do have the answers, that may be that for political reasons they're not always shared with the general public, but because I am not a scientist I feel I

tend to look at scientists as the professional experts, you know, who do, because of their science knowledge, do understand all kinds of things. Which probably means on the inside there are more problems with science but that's how I see it from the outside. And I suppose I just have the (unhearable), I just feel they're much more specialist [138], you know, than what the children use in general, outside.

How important do you feel it is, inside the classroom, for it to be raised, you know, what science is like outside?

I think it is, I think it is. Because I don't, I think it's crucial, for children to understand so that they can question and inspect the, the evidence put before them because there is a tendency, because I am a non-scientist, I've got no means, way of analysing what they're telling me, I've got no facility to you know, you look at what they're saying and you look at might be the weaknesses of it and I think for them to learn those skills, (comment fades to unhearable)

It's more that now I have Matthew of course things are even more important. I was never really worried about my own science education or really education at all until he started at (the local primary school). Then all of a sudden I was really interested to know what the school was doing for him and I was concerned about education and the curriculum. It's funny how children focus your mind. I'm sure you'll understand.

What do you feel about the way science is portrayed?

In a way I think that's true, I mean I think there are always some people aren't there who are sort of facilitators who want the general public to know and try to put that across but I do, yeah, I do think there's degrees of professionals hanging on to a level of knowledge. Umm, or maybe I , or perhaps I just see what we know, it's taken years to understand, you know, maybe and therefore it's very difficult for an outsider to actually go in and understand all what the issues are, you know, I feel like I actually need to know a **great** deal more than I do to understand these issues in science, but I mean, partly I think all professions have a tendency. Hang on to their knowledge (162)(laugh) certain ones do. Obviously in certain areas, like, like in the drug companies, they specifically try to exclude other people from knowledge until their drugs are ready, you know, to come out. Like I said, when they've got a new thing to come out, they like to keep it close to their chests.

How do you feel about the periphery of science, things like perhaps, psychology?

I study psychology myself at the moment. Erm, I think that psychology is an incredible band of things I think there's an incredible lot of things within it some of which are more science-y, some of which are more what I would call humanities.

yes.[175]

Type area. I mean I think that they, psychologists tend to be presented as a bit weird (laugh) the ones that are concerned with psychiatry who have got the more biological **bent** to their work, and I do think they have a tendency to be regarded as rather bizarre, and I think you get quite

negative images of them. I think there are an awful lot of people who are called psychologists, I mean there are an awful lot of different things within that aren't there.

Yes.

Like a good one last, I was telling my students about this morning was a chat show, not Oprah Winfrey but the other one, the other one, Rikki Lake, they were saying how they bring on psychologists at the end to give their opinion, various comments were made and they were rather odd. I think there is a tendency, and I think people tend to dismiss it because they tend to see it as too analytical, I think that what out, outsiders, it's not necessarily what I think but that's what I think outsiders think. They want you to see it that way anyway.

So do you see it as in with science or pushed apart from science?

Well, I think that there are bits, bits of it that are linked up to science and bits, there are biological sort of studies of brain based work which does seemed linked with science. I think that the more realistic side , I feel there is a sort of element to which they can do that, perhaps there's a contradiction but there are, you know, elements in which they can try to be scientific and do things in the same way.. (pause) (laugh) I've forgotten completely what I was trying to say

Images of science and psychology?

Science. Yeah. Freud is always a very scientific image..precisely science but bizarre, and I think they are a lot of different kinds and I've done quite a lot of realistic psychology that, and I think they're just fascinating and I don't personally find them weird Although I know that other people find them quite threatening and quite frightening. If you say there's a real interest in a set of theories here and this is what they are, I've been astonished by work colleagues reactions who I really would have thought would have known different. There is that , I think that there is that sort of **fear** and I think there is a sort of , I don't know actually, I think there is a sort of anti-intellectualism in the country, I really do.

There is a sort of anti- intellectualism culture, anybody who probes or tries to analyse anything,"Oh I can't be bothered with that", you know, but I think you're right the more biological side of science and all sorts of psychoanalysis say Freudian you get this picture of the round rimmed glasses, or the monocle and the white coat and really, something very, really quite bizarre.[221]

But I also think because I know people who are counsellors and I know people who are psychiatrists I have slightly different images. You see what I mean? I have other views as well.

Yes. What you've said so far is great, really interesting. But moving on a bit, you attended one of the science workshops?

I think, I think I would have liked to have more time to play with thing s, that's one thing I would have liked. I remember playing with circuits, I remember that, I remember there were other things but I can't remember what they were. Umm. I think it was a great thing and I think it

was really something that I would like to have had more time to do and to look at, to play with it.Umm, and a situation where we could play with it because it was quite difficult what with a lot of people to talk to. What do I remember? I remember that we did that exercise at the beginning, didn't we? We had draw a scientist, what is your particular image of a scientist, erm, I would be interested to know what more people said, personally I would have been really interested to hold it up and see what other images, what other people had drawn. Because a lot of them had glasses didn't they?

Yes.

Because I looked around and the people I could see there were a lot of people who'd got glasses, this sort of intellectual, you know, image.

Yes

1 I think the way I thought about it, all scientists were men, and I think initially that would be my first reaction, to draw a man, even though I **knew** that women could be scientists, sounds ridiculous really but that would be my first reaction. I think it's important to understand that they're just humans doing a job for money. Of course they are going to make mistakes, be good and bad just like everyone else. It's too easy to forget that they're just normal. I have to say though that it's a huge disappointment when you feel the scientists are just doing silly stuff, like searching for the Loch Ness monster or doing experiments on why coffee drips leave brown rings.

You mentioned the circuits and I noticed you on that activity for some time

Yes, suppose I went for something I was interested in, you know, something I knew I needed to know more about. It was a bit awkward when the men took over, I wanted just to look, you know, have a play. I wasn't actually doing any thing, just looking...but perhaps they thought, well . I wasn't doing anything constructive, I was just thinking how nice the little components were. Where do you get that sort of thing? I'd love to get some bits like that for my two.

Maplins stock a lot of bits and bobs or there are kits from Boots, a bit expensive. [300]

Interview ends but continues chatting about availability of items for exploration and psychology. Also where the interviewee and interviewer came from and how they ended up in Nottingham. Also covered in more depth the purpose of the research.

Interview B (N-2-1M)

Would you tell me about your earliest memories of science in the classroom?

Personal memories?

Yes

I think science when I went to this at this level infant junior school was very much nature study when I went to school and I can't remember anything at all from primary school regarding science itself as such and about science. It just doesn't register at all. I can't remember science until I got to secondary school.

I particularly like biology I found chemistry and physics quite hard, in, in a similar way. fairly easy to learn as facts but the understanding wasn't necessarily there.

Were you happy with that sort of?

It was a miserable subject?

or did you think of?

Fortunately for me I I had a fantastic teacher who was really good., the biology, the chemistry and physics was miserable hated it. umm and although I can't remember much that I learnt from biology I can remember the teacher and I can remember the teaching staff but I don't know whether he was a particularly good science teacher, but he was a good teacher.

What was his style like?

Umm very pally very friendly very jokey and as a person I really liked him but I can't remember much. I enjoyed science because I liked facts anyway but I think I mean I had a particularly good was because she was quite young and quite enthusiastic friendly and did a lot of practically based work in biology as opposed to being told it made it a bit different perhaps [028]

ah but you said you said you quite liked facts

But I'm the sort of person who likes facts anyway I don't have a problem learning facts so perhaps that's why I like science I don't know but with other language for instance you have to thinkin a different sort of way

So do you like sort of quizzes?

Yes

The sort of 'spot knowledge'
That's right. Because I don't really have much to do with science now so (I can't), I don't really learn much about science you know unless I need to. I like to learn in quite a structured way I should think I like to write things down, read them, reflect on them.

Process them? Could you explain a bit more?

I'm just the sort of person who is a mine of useless information basically I'm good at trivial pursuits. I like to know is when the teachers to input into your work, give you information, useful stuff. It's like it's completely changed now, because then there was no input other than writing down what the teacher had told you so there was no opportunity to explore science at all but I think we just accepted that, yes because that was the way things were.

Could you tell me a little about what you think about science education now?

well I I personally think it's great but it's very difficult organise within the classroom. Ideally yes you should talk whichever subject you're talking about you should talk to your child and find out what they doing in school before you do anything else but the other side that's quite hard I don't know how you would go about managing it. I think it's quite idealistic isn't it?

umm (agreement)

I've tried with science certainly with Laura starting science this term because it's a sort of science project she's doing. I've tried to get at her ideas and the class teacher has as well obviously it's very limited what you can find out in a short space of time. [067]

So do you feel umm you attitude science has changed from when you first had your science experiences?

Yes, yes possibly. Shame really yes it's a sad state of affairs (much laughter). But that doesn't mean I think badly about science really. In fact I'm perhaps not convinced it has...no I don't think it has really I'm not convinced it has. No.

No I'm, it was really difficult for me to change from how had been taught at school science and it was like quite an eye opener to see that there was a completely different way to teach and that was really good but I still think but when it comes to it it's very very difficult to let children just have this free exploration so erm yeh I've got more ideas I've got you know a better understanding of how science can be taught but when it comes down to the nitty gritty I I find it

difficult to do these things [094]

So what else has affected your view of science?

Well, I've worked as a scientist for thirteen years so I've got a pretty fair idea of what science is like in the real world I think (pause) again being idealistic the way it should be in the real world is is this thing where everyone's idea is valued and you know we've all got something to contribute in reality I don't think it is like that but if it is out there that people they try and value your contribution to science I think but it's like everything else isn't it?

umm (agree)

It falls by the wayside [107]

Ahh so you feel , you know , you've worked and it's been quite a structured sort of environment and science in the classroom is quite structured umm these days

Yessss, I think it is for many people yes

Do you feel you've changed your view, do you think that science is fun today?

Think it was awful and now it's awful? (giggles) I think it's awful I hate it I hate science I really do It's too much it's too open try to teach it now with the experiments and I think where are we going'? I think there needs to be more structure than we've been told about and I like to see structure just slightly more. [117]

So that when they've got the experiments and then you say to the children well what have you learnt? (pause) In my experience they sort of look at you blank You know whether that's just because it's I'm mine are infants and it's a lot different to being with older kids but they a lot of the time they they don't seem to know they've done at school, done the experiment so I think that it's important you do need some structure there so the children know why you're doing this (pause) free exploration [125]

It's true though that quite often ideas flow and once you've started something you'll get, you know' ideas form that and you'll know where to go but quite often it's the actual base line of things to do.

But I can't really criticize school. Well yes yes it's very hit and miss because obviously all the teacher's experiences are quite different as well it depends on the school

Do you feel they have the same sort of views as you?

I think they do probably at least the ones I've come across , you know, see science as an experiment gives the kids a work-sheet and they find out this, this and this

So quite structured really?

You've got to fit in because if you change things too much the children wouldn't cope I mean and if you upset them so much that you know they throw wobblies all the time then obviously it's going to reflect on your parenting you've got to cope with the situation you've got so you do tend to follow the way the teacher goes on to some extent you might try your other ideas as well , and anyway my children sometimes like to, no some people prefer to work alone.

And do you feel it's not really practical to do it at the same same time I don't suppose you can have one child doing another, at least my two can't be left.

Can I ask if there's any particular anecdote you can remember about science?

Well, the teacher was talking about living and growing things that were alive and things that weren't alive. I can't remember, one little boy thought that grass was dead but it grew I can't remember exactly what he said but it was like some magic wand you waved on it, it was dead usually but when you cut it it grew so you had to cut it.

I can remember questioning my own ideas, yes science did make me think. It was like the mind was ticking over the people said something that was totally against what they'd just said and they thought stand back and oh dear how am I going to reconcile these two things? That's not saying the thing was we were to say who was right and who was wrong.

But you were saying (refers to notes taken in observation of workshop) something whether it works with moral its a bit [324]

Then again some scientist people just won't change mean I know it's a completely different thing but that thing on a Friday night central television live or whatever it is. It's not a factual thing it's a moral thing but whatever they are discussing over the weeks that I've watched it that they never ever change their minds.