PUPILS' ATTITUDES TOWARDS PRIMARY AND SECONDARY SCIENCE

By

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ABSTRACT

Through teaching science, my own experience has increased my awareness of pupils displaying less interest in, and poor attitudes towards, science lessons at school. This is a cause for concern, as scientific development and industry require pupils of today to have a thirst for knowledge so that they can move scientific discovery to the next level in the future in and move forward technology (Kind et al., 2007). Pupils who are uninterested in science can be more disruptive in lessons and this can interrupt other pupils' learning. The decline in progress at the beginning of secondary school is a well-known topic amongst teachers and this decline is worse for science than English and mathematics (Galton, Gray and Rudduck, 1999). Recent concern following girls out performing boys at GCSE (General Certificate of Secondary Education) and A Level (Advanced Level) (TES, 2002) could be a result of poor attitude to their work.

This work aimed to investigate pupils' attitudes towards science education in England and it may be an aid for science teachers, at both the primary and secondary level, to become aware of when attitudes are likely to change and what some of the possible influences are. The research used a variety of schools in the East Midlands. Unless stated, the schools were from the state sector (see Appendix 1 for details).

Pupils' science education in England follows the National Curriculum. The main assessments that are taken (which are used in the age range being studied) are National Curriculum Assessments at the end of the each Key

Stage. At age 16 the pupils in England are assessed via their GCSE examinations in normally nine subjects.

The aim was achieved by the use of questionnaires, small group work and interviews. These methods were the simplest and quickest methods to use for a variety of schools and a large number of pupils. The questionnaire was based on Fraser's TOSRA (Test Of Science-Related Attitudes) Test (1981) and given to pupils in Yrs 6, 7 and 9. Any interviews were carried out from pupils at School B. The small group activities for Yr 2 children, and the basis of all questionnaires was on Klopfer's themes (1971).

The key findings in this research were:

- Each age group of pupils have a strong, positive attitude towards the social implications of science in the TOSRA Test and a negative attitude towards leisure interests in science and career interest in science;
- Yr 2 pupils have a good knowledge of scientists and lots of enthusiasm for their school science lessons although mixed attitudes towards a career interest in science and in their leisure activities;
- Teachers in the primary schools used enjoyed teaching science and were positive about their lessons;
- The Yr 6-7 Transition did not seem to affect pupils' attitudes towards science.

To conclude, this piece of work aims to help teachers in both primary and secondary schools see when pupils' attitudes to science change and what influences pupils' attitudes.

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Outline of the Timings of the Research Undertaken in the Investigation

Yr 1

Pilot Study – Ledbetter and Nix Questionnaires to Yr 7 and 9 Pupils; Case Study (interviews and diary)

Pilot Study Questions

1 How do pupils feel about their school science lessons?
2 If pupils expect to always do some form of practical in a science lesson, what are their aims of doing them, i.e. is an experiment good to find out new ways to explain new ideas of the world around them?
3 What features of lessons tend to bring out positive attitudes towards science lessons?
4 How do pupils relate science to their everyday lives and future careers?
5 Are there any differences in how girls and boys feel about science?

Yr 2

Turner Questionnaire – 21 Questions to Pupils in Yr 6, 7 and 9

Main Research Questions

1 How do pupils feel about the activities undertaken in school science lessons?
2 When do pupils' attitudes towards science tend to be fixed? Primary school? Secondary school?
3 What affects a pupil's attitude? Parents? Teachers? Friends? Media?
4 Are there some of Klopfer's themes that are positive and others negative in each age group and for each gender?
5 Which of Klopfer's themes are a concern to society due to causing a decline in pupils displaying positive attitude towards science and hence not taking up a scientific career?

Yr 3

Turner Questionnaire – 14 Questions to 2 Schools per Year Group (Yrs 6, 7 and 9) and Ranking of School Subjects/Activities in Lessons; Yr 2 Pupil Activity; Teacher Questionnaire; Yr 6-7 Transition Questionnaires and small group interviews

1. Introduction

When pupils were asked what they liked to do the most in school science lessons, they responded that they liked, "doing experiments" (Murphy and Beggs, 2003). The pupils' reasoning was that practicals are fun and they found things out for themselves. With the image of science being a 'hands-on' subject, it is perhaps no surprise that pupils enjoy the practical aspects. A pupil's attitude not only relates to what is done in the classroom; a pupil's overall image of a subject can be much deeper and other factors can affect a pupil's attitude. It is both these factors which this study intends to investigate.

The approach taken in this study is practitioner research. McNiff (1988) talks about this type of research as a tool for a teacher being:

> *'... reflective of his own practice in order to enhance the quality of education for himself and for his pupils' (p. 1).*

During research of this type, McNiff (1988) outlines some implications.

- Thinking will change – different outcomes than those expected and so changing what is being questioned;
- Mistakes may happen since schools are changing and unpredictable places;
- Politics – at the school or within the classroom.

1.2. Methods of Research to be Used

In order to investigate pupils' attitudes, pupils needed to be involved at many different levels, for example in answering questionnaires and in interviews. Questionnaires were analysed, initially at the Pilot Study level and then, using the knowledge gained as a basis for further work, in the Main Study to provide more robust evidence into how pupils think and feel towards science. In order to triangulate the questionnaires, more than one school was used for the adapted TOSRA Test and a small group interview was held to support the attitudes towards Secondary School questionnaires.

The order of the research undertaken is shown in Figure 1.2.1:

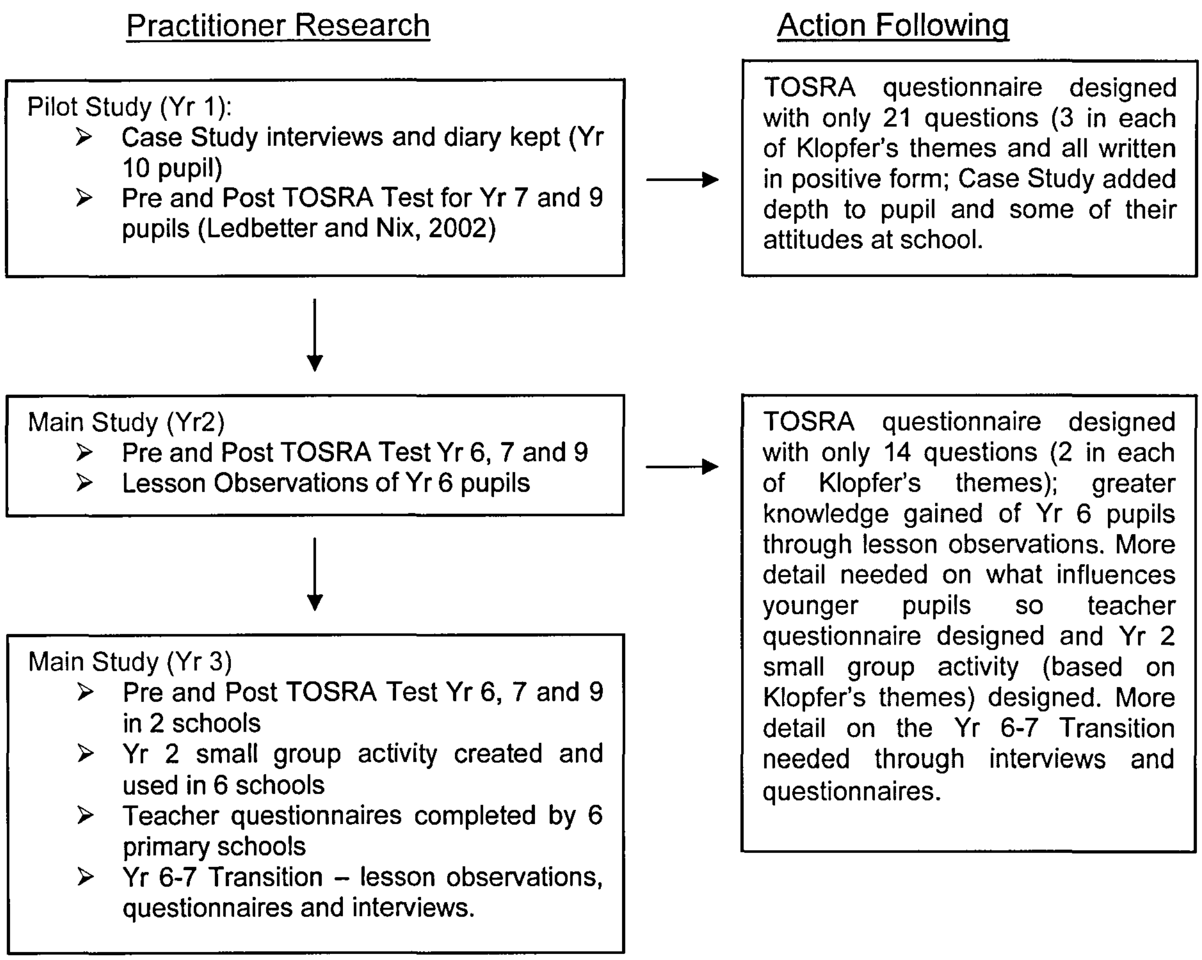


Figure 1.2.1: Figure showing the order of research undertaken in this study.

In conclusion, this research, being a more personal form of enquiry, its heart is allowing the practitioner researcher to be open to new experiences and processes (McNiff, 1988) which will allow for progress to be made within the classroom regarding pupils' attitudes towards science.

1.3. Rationale

Studies into pupils' attitudes are vast despite it being difficult to measure and to learn exactly, from pupils, what causes the change in attitudes. Attitude is a complicated word to define and it is not well understood (Osborne, 2003).

> *'There seems to be many concepts that relate to attitudes that may or may not be included in their definition; for example, feelings, motivation, enjoyment, affects, self-esteem and so forth. A common definition has involved describing attitudes as including the three components of cognition, affect and behaviour' (Kind et al., 2007, p.872).*

Here are some definitions of attitude:

> *'The person's collection of beliefs about (the subject), and episodes that are associated with it, that are linked with emotional reactions. The stimulation of these reactions affects decisions to engage in behaviour, such as choosing to take a science course' (Bagozzi and Burnkrant, 1979, p. 101).*

Whereas Sears (1997) defines it as:

> *'...a learned state that creates a disposition to respond in particular (consistent) ways to particular objects' (p.1).*

With Bennett (2001):

> *'...pupils' feelings about the science that they are subjected to in the classroom and how their feelings relate to their existing scientific knowledge and how this may influence their behaviour' (p. 60).*

Allport (1935):

> *'...a mental and neutral state of readiness, organised through experience, exerting a directive or dynamic influence upon the individuals' response to all objects and situations with which it is related' (p. 24).*

And Bandura (1986) defined it as:

> *'...people's judgements of their capabilities to organise and execute courses of action required to attain designated types of performance' (p. 22).*

In this piece of work, **attitude** will be defined as:

> *'pupils' feelings about science and science lessons that cause them to act in either a positive or negative way towards it'.*

Pupils' attitudes are complex and therefore they are difficult to measure. Attitudes are frequently changing for some pupils, for example, some pupils may change their attitude toward science each term/year of study. Attitudes will be identified when pupils seem excited to give their comments about certain statements or show anger towards them (Oppenheim, 1992). When the researcher observed pupils completing the questionnaires, some pupils were observed to complete the task quickly and irrationally. This observation resonates with Oppenheim (op. cit.) who was of the opinion that this could reflect either a positive or, to the opposite extreme, a negative attitude towards science.

Bennett (2001) writes of the continuing unpopularity of science in schools and in higher education. She recognises that many surveys indicate that pupils find science uninteresting and irrelevant to their life, science causes social and environmental problems, at school the subject is hard, scientists are very odd and that science is a subject for boys. Much research was undertaken in the 1970s and 1980s about pupils' attitudes towards science (Choppin, 1974; Hadden and Johnson, 1983; Simpson and Oliver, 1985). However, less research has been taken in latter years as it was seen to be difficult to implement any strategies to make an improvement.

At this point, another misunderstanding to address is the question of is the work assessing 'pupils' attitudes towards science' or 'scientific attitudes'? Gardner (1975) stresses that there is a difference between these two statements. This work will solely be looking into pupils' attitudes towards science at school, however, since the TOSRA test is being used and this is based upon Klopfer's seven themes of different behaviours towards science, this touches upon pupils adopting a scientific attitude.

In conclusion, despite being a complex subject, attitudes towards science are interesting to teachers. This section has aimed to clearly define the term 'attitude', some reasons why pupils may have changing attitudes and the aspect of attitude towards science being investigated in this research.

2. Review of Literature

2.1.

The aim of this chapter is to acknowledge the relevant literature in this field.

It will be set out in the sections as below:

- Attitudes towards Science - relevant literature
- Teaching Strategies
- Attitude and Behaviour
- Gender Preferences towards Science
- Achievement in Science
- Fraser's TOSRA Test
- Gardner's Intelligences and Learning Science
- Piaget's Model of learning
- Key Stage 2 vs Key Stage 3 Science
- Primary School
- National Curriculum

The key areas of the literature review, which link into researching pupils' attitudes towards science, can be summarised in a diagram showing the pupil at the centre and the factors affecting attitude around it.

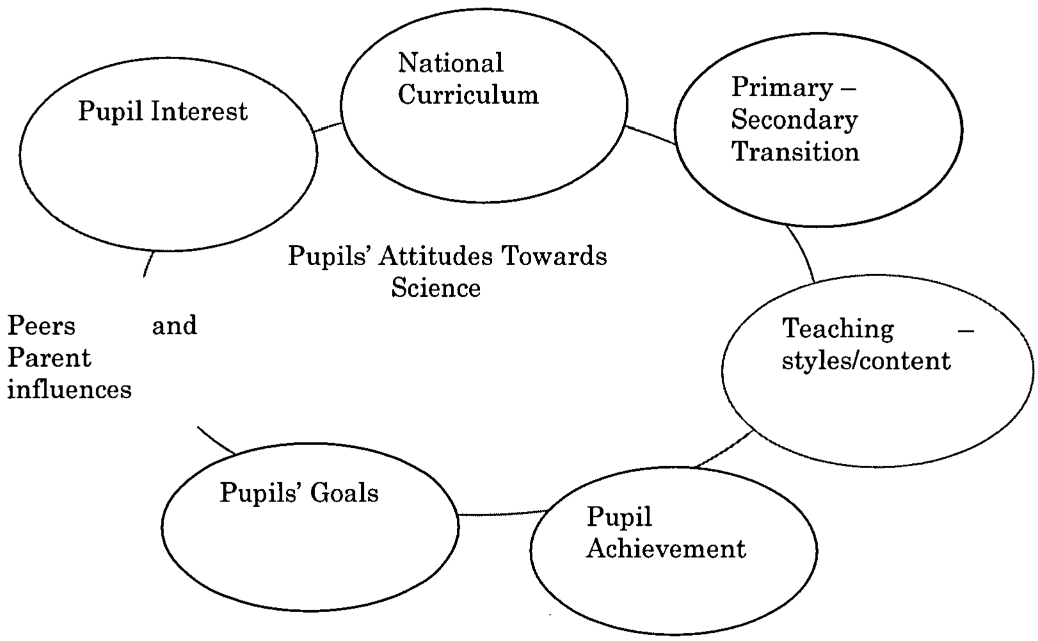


Figure 2.1.1: Factors Affecting Pupils' Attitudes towards Science

2.2. Attitudes towards Science

The general public's attitude towards science is important. Today, we are living in a time of great scientific discovery and advancement of many things, for example computers and medicine (Dowling, 2001). In the view of the author, the science taught in school is a main source of influence on pupils' attitudes. Teachers play an important role in delivering science to pupils in school and they need to make it easily accessible for pupils to understand and relevant to the world which we live in (Dowling, 2001).

There is an increasing cause for concern about pupils' attitudes towards science. The statistics showing the number of pupils taking A level science and mathematics in schools are shown in table 2.2.1:

Subject	1996	2000	2005	% Change from 1996-2005
Biology	43,398	46,190	45,664	+5.22
Chemistry	34,677	35,290	33,164	-4.36
Physics	28,400	28,191	24,094	-15.16
Mathematics	54,125	53,674	46,037	-14.94

Table 2.2.1 A Level Entries for Science and Mathematics in schools and colleges (The United Kingdom Parliament, 2006) and the Percentage Change from 1996-2005.

Fewer pupils have taken chemistry, physics and mathematics in 2005 than 1996, however, the number of pupils taking biology has increased. The percentage change that was calculated shows the decrease in physics and mathematics to be approximately 15%. However, although this is concerning this does not reflect the whole population who are taking A Levels. Considering the percentage of all of the A Level entries in the sciences is shown in table 2.2.2 below:

	% of all A Level Entries	
	1995	2005
Biology	7.16	6.88
Chemistry	5.79	4.96
Physics	4.76	3.59

Table 2.2.2: Percentage change of pupils taking Science A Levels from 1995-2005 as a proportion of the whole A Level cohort (AQA, 2006a).

These data were derived from the website: www.epolitix.com. The data clearly show the concern regarding less pupils taking science options at A Level since all three sciences have decreased from 1995-2005 but also that less than 16% of the whole A Level population is studying a science at this level.

A pupil's attitude towards a subject can be influenced, from my teaching experience, by many things. These might be broadly broken down into two main areas: influences within the pupil's control and influences outside the pupil's control. Influences within the pupil's control are, typically, personal organisation, desire to succeed, and positive attitude to all subjects. Outside the pupil's control are things like the drabness of the classroom, the enthusiasm (or lack thereof) of the teacher, the social interaction of the pupil's classmates. Bennett (2001) reports research showing that pupils respond differently to biology, chemistry and physics. Since at secondary school these may be taught by different specialist teachers at KS 3 and 4, how the pupil feels about a particular science could be related to the enthusiasm and teaching style of the teacher.

From a teacher's perspective, if all pupils are working with a positive attitude, then they will learn more effectively and are more likely to achieve their potential. This is an area where little research has been undertaken and White (1988) suggests that this is because if a pupil is interested in science, (or in any other subject), then they will take the time to go away and learn it. Conversely, if they are uninterested, their learning will be less effective. In order to empower students to become effective learners, it is important to recognise and study these influences. However, since 1989 the National Curriculum was implemented in state schools and physics, biology and chemistry are taught as 'science', often by one teacher, which could imply that a specialist biologist may not be confident or enthusiastic if teaching physics or chemistry. From 2007 all Yr 9 pupils in state schools who achieve level 6 or better in KS3 National Curriculum assessments have the entitlement to separate science at GCSE (House of Lords, 2006). This will lead to teachers teaching their specialism at KS4 and therefore enthusiasm for teaching should be improved. However, this could have impacts on science departments in schools.

The setting of where learning will occur can help to promote a positive attitude of pupils towards school science (White, op. cit.). Therefore, it must be beneficial to the pupils if the teacher provides interesting, relevant, colourful displays in the classroom. From personal experience, pupils like to see their work on the wall and topical displays can promote pupils' interest in what is being studied and its relevance to the world in which they live.

Goal setting for each pupil can be an aid to motivation and this in turn can help instil a positive attitude amongst the pupils. Some pupils may have ideal goals (Magill, 1980). For example, it is reasonable to suggest that those wanting to go into medicine will activate different thoughts and feelings towards the sciences to those aiming for a career in politics (White, 1988). Other pupils can be motivated by action goals (Magill, op. cit.) and these can be used in individual lessons. From personal experience, pupils setting internal goals will help their performance in the subject by increasing their self-motivation.

In order to want to learn, Donaldson (1978) suggests that pupils must enjoy a challenge. That is to say, a subject or topic must not be too easy or pupils will simply lose interest. Science education, however, must not discourage pupils and make them withdraw from trying hard in lessons or choosing to take it further in school. This is often seen at school when a pupil decides that they cannot cope with the task (either an experiment or a subject) and then, instead of persevering, they give up. Learning should be matched with a pupil's development. The 'actual development level' is the established development of a pupil's mental functions and can be determined through tests (Vygotsky, 1978). However, pupils that were thought to have the same mental level varied greatly when a teacher helped each pupil (Vygotsky, op. cit.). This difference is called the 'Zone of Proximal Development' which Vygotsky, defines as:

> *'... the distance between the actual development level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers' (Vygotsky, 1978, p. 86).*

The Zone of Proximal Development is of use to teachers because it helps them to not only see the learning cycles that have been completed by the pupil but also make them aware of what levels are just beginning to mature and develop and how they can help their pupils to go that bit further.

School can be an enjoyable experience if pupils are good at subjects and if they want to learn and constantly achieve good marks for their ability. However, as pupils get older, there are those who perhaps have not reached the required level of thinking for the demands of the tasks which they are undertaking, and who are seen as not meeting the school requirements. Some pupils may feel that they are underachievers. This reduces their morale even further which Bruner (1966) summarises as;

> *'...we get interested in what we get good at' (Bruner, 1966, p. 124).*

It is therefore down to the teacher to enhance and develop the pupils' interest, work with each individual and help them to work to the best of their ability. Does this tie into the background of the individual child? For example, from the author's experience, a child whose parents are both doctors is likely to have a high opinion of studying and of the sciences. Conversely, a child whose parents have never held a full time job and who hold education in slight regard, is unlikely to develop a high opinion of studying and of the sciences. The child's ability is of no relevance in these cases, nor is the ability of the teacher.

Sears (1997) studied pupils' attitudes to science and their post-sixteen choices at a time when pupils were taking dual award science at GCSE as opposed to the single sciences. He found that more pupils from a dual award science background were undecided about their future career and that they were less positive towards science. Many pupils had a reason for taking 'A' level science subjects particularly in terms of career choices as well as for liking them. In addition children who had taken dual award science at GCSE were less likely to have a career path in mind than their counterparts who had taken single sciences. It also emerged that those who had taken single sciences had a wider range of positive reasons for taking individual sciences at 'A' level. These included genuine enjoyment of the subject as well as clear career path choices. This could be linked again to the background of the child. However, Osborne (2003) cites Whitfield's 1971 IEA data for English pupils showing that physics and chemistry were two of the least favourite subjects post-14.

Biology and physics are seen as being more accessible than chemistry to pupils (Shayer and Adey, 1981). Chemistry is seen as a "hard" subject at school and pupils become disheartened and de-motivated quite easily if they do not understand. When pupils arrive at secondary school they tend to be very excited at the prospect of chemistry and the practicals that they will perform, particularly with Bunsen burners. However, by the end of Year 7, Matthews et al., (2002) found that pupils nearly always feel less positive towards science lessons. The author questions if this is the case with other subjects too? This resonates with the view of Murphy and Beggs (2003) who argue that children's interest in science deteriorates between the ages of 9 and 14. Some pupils may be put off chemistry in Yr 9 because it is too difficult for them to comprehend; they have simply not reached the required level of understanding at that stage in their development. Pupils who have a genuine interest in, or need for, the sciences in a future career path persevere and by the end of their GCSE, in the author's experiences, tend to find that all of what they have learnt so far in science 'fits' together neatly.

In a smaller-scale research project of Yr 10 and 11 pupils, the correlation between a pupil's favourite subject and the subject that, in their opinion, they were best at, was quite strong (59% for each age group) (Turner, 2002).This again supports Bruner's view of 'we get interested in what we get good at'.

In a similar vein, Parkinson et al., (1998) researched pupils' attitudes to science in South Wales. Using 11 year old pupils in their study they found that the aspect of science the pupils were fascinated by was the practical work involved and it was the chemistry practical work that was enjoyed the most. Pupils' reasoning for disliking science was because they found it difficult.

If pupils are to make progress, teachers would agree that pupils need to put in some effort towards their work. Wong and Wong (1991) point out that for pupils to learn anything entails effort; the pupil has to work in order to learn.

Working with undergraduates, Coll et al., (2002) developed a 'Chemistry Attitudes and Experience Questionnaire (CAEQ). This incorporated all of the different experiences that undergraduate students would experience, such as practical classes, laboratory sessions, lectures and tutorials. The framework for this questionnaire was based upon Allport's (1935) definition of attitude stated earlier. A conclusion emanating from this study was that first year undergraduate chemistry students in New Zealand prefer to have a structured class style. It would appear that A Level students in England (from my own experience of teaching at this level) also prefer to have a structured lesson and prefer not to have to think and find out information themselves.

Age is also a factor which contributes to a child's attitude towards science. A study into pupils' classroom environment perceptions, attitudes and achievement in science at the upper primary level was undertaken by Chin and Wong (2000) in Singapore. The data showed a positive relationship between the nature of science, classroom environment and attitude. The only negative was the aspect of difficulty of the subject, and this is in support of Parkinson et al., (1998) findings. The research reiterated the importance of integrating theory and practical in lessons and needing adequate equipment to ensure that teachers have the resources to help pupils learn science. Primary science teaching can have a serious impact on the pupils' attitudes towards secondary school science.

If pupils display a positive attitude they are assumed to work hard. Being well-motivated will also relate to working hard at school. However, Cambridge University researchers (2003) found that although pupils' attitudes towards school declined through the transfer period, their motivational levels stayed high. Further research showed that a pupil may have different reasons why they need to work hard – this is more to do with the extrinsic motivational factors rather than the intrinsic motivational factors (Kershner, 1996). Some pupils feel if they work hard they will get good grades and would therefore get a good job afterwards.

Even though we are considering science as an overall appreciation of biology, chemistry and physics, if we were to analyse them separately, there would be differences. For example, human biology is appealing to pupils interested in knowing about health and disease. However, chemistry has been found not to be a popular subject. Pupils do not understand the relevance of the periodic table, the Haber Process and the blast furnace (Osborne, 2003).

In summary, this section has considered why there is a need to explore pupils' attitudes towards science and some of the factors that can cause negative and positive attitudes. It has also considered the differences in the three sciences, the perceived difficulty of each one and how pupils can move forward in their learning by different approaches.

2.3. Teaching Strategies

It is the teacher who must promote their subject to ensure that it appeals to all of their audience. Given that pupils enjoy the practical aspect of lessons, other innovative teaching ideas must be incorporated to motivate pupils when there is no practical in a lesson.

For pupils to show a positive attitude towards science, a study by Myers and Fouts (1992) showed that teachers had their pupils:

- highly involved in lessons;
- receiving a high level of personal support in the classroom;
- demonstrating good relationships with classmates;
- engaged in a variety of teaching strategies and unusual learning strategies.

Practical work is an activity which enables pupils to solve problems or discover information themselves (Delargey, 2001). The pupils are encouraged to work alone or in pairs during practicals and this independence allows them to be a 'real' scientist (Delargey, 2001). The danger with practical lessons is that some pupils do not wish to learn but only enjoy 'playing'. Within the constraints of a specification, the demands on the amount of theory that is required for external examinations can restrict the amount of practical in lessons, particularly at GCSE level.

One way of using a different approach to teaching could be group work. Research undertaken (Blatchford et al., 2006) showed that pupils liked this approach since group work could help pupils settle into secondary school and so provide an opportunity for them to get to know other pupils in their class better. Research by Matthews et al., (2002) reported that pupils felt more positive about the science lessons; with boys feeling that learning science was the main reasoning behind them working together whereas the girls enjoyed the social aspect of this activity. The Secondary Strategy

(2005) (formerly the KS3 Strategy) [1]can be applied to science. This introduces science teachers to the use of spelling, speaking and listening and vocabulary in their lessons. Staples and Heselden (2002) give some suggestions for incorporating this strategy into their teaching:

- Group talk
- Role-plays
- Debates
- Short plays
- Poetry
- Rap
- Writing frames for videos
- Cloze activities
- Word banks
- Vocabulary books
- Word games – hangman, crosswords, anagrams

Fisher and Rickards (1996) investigated the association between teacher-pupil interpersonal behaviour and pupil attitudes in mathematics classes. The outcome of the research showed that the pupils' attitude scores were higher in classrooms where the pupils perceived greater leadership and helpful/friendly behaviours in their teachers. From a teaching perspective, teachers who have a good rapport with any subject class will find that they

[1] The Key Stage 3 Strategy (piloted 2000 and launched 2001) is aimed at Literacy and Numeracy and can be applied to other subjects. In teaching, a lesson would have a starter, main and plenary.

too will have pupils displaying a positive attitude.

In order to meet all pupils' needs, Her Majesty's Inspectorate (HMI) used the term 'differentiation' to try and ensure that teachers were catering for the 'more able', the 'less able' and the 'middle group' in being able to challenge these pupils (Hart, 1996). Differentiation in lessons enables each pupil to work at their level and each will then gain something. From the author's experience, a teacher being committed to a pupil and believing in their true potential helps the pupil to achieve their goals and aspirations.

When learning a new concept, the adult emphasises crucial actions and provides guidance at choice points. Vygotsky (1962) argued that

> *'...it is educationally more informative to know what a child can do with 'some slight assistance' than to know what he succeeds at unaided. The essence of the teacher's art, lies in deciding what help is needed in any given instance and how this help might be offered' (p. 101).*

Teachers can also indicate important alternatives in the solution of the problem in hand. The child's state of understanding and contribution to the activity also helps them to make progress (Rogoff et al., 1984). Over time, the need for an adult to intervene becomes less and then, when a new challenge is embarked upon, the adult can help move the child forward again.

'Piaget's findings and arguments are complex, but one point that emerges very clearly is that awareness typically develops when something gives us pause and when consequently, instead of just acting, we stop to consider the possibilities of acting which are before us. The claim is that we heighten our awareness of what is actual by considering what is possible' (Donaldson, 1978, p. 94).

Pupils often make mistakes in their work and it is how they deal with them dictates whether or not they go on and succeed. Donaldson (1978) supports the idea that errors can be a sign of progress which can help the pupil to develop their thinking skills. With the right encouragement, a positive outcome is more likely.

It is most rewarding for the child if they solve a problem by themselves with a few pointers on the way. However, within the classroom, there are many quiet pupils who do not feel confident to ask for help and therefore they struggle alone.

When learning new things, pupils need to repeat and rehearse information so that it is stored in the long-term memory. One method of helping pupils to retain a large amount of detail could be by 'chunking' the information. This is when the information is broken down into smaller bits suitable for the learner.

'Teachers find it much easier than children to take an overview of topics.

That is because teachers have learned to use bigger chunks. But when it comes to teaching, the skill is to find learner-sized chunks' (Wellington, 2000, p. 85).

Training pupils to learn things in chunks could be a valuable learning tool. White (1988) suggests chunking information as being a good learning strategy and that it will vary with each person as to how well they know the topic. Therefore it is much easier for the teacher to break down, to chunk, the topic before teaching it, but it is a more difficult skill for the younger pupil to do (White, op. cit.). However, all pupils must still be challenged so the size of chunk for each individual must be monitored.

Shayer and Adey's (1994) work in science has led to the CASE Project (Cognitive Acceleration through Science Education). This project draws upon the work of Piaget and Vygotsky and enables us to see how pupils' thinking is developed from the concrete to formal operations and how well pupils could work with some assistance. The learning theories of constructivism and, in particular, social constructivism, which emphasises:

'how meanings and understandings grow out of social encounters' (Atherton, 2005, p. 1).

relates to Vygotsky's 'Zone of Proximal Development' – what pupils can do with some help will enable them to move forward in their learning and the teacher can use this knowledge to be able to apply it to their pupils' learning.

This CASE project was aimed at pupils to enhance their higher-order thinking skills (Adey, 1999).

> *'By 'cognitive acceleration' we mean the process of accelerating students' 'natural' developmental process through different stages of thinking ability, towards the type of abstract, logical and multivariate thinking which Piaget describes as 'formal operations'. Formal operational thinking is characterized by the ability to hold a number of variables in mind at once' (Adey, 1999, p.5).*

The CASE project helps to encourage pupils to think for themselves. However, Cambridge University researchers (2003) found that the fortnightly lessons were very different to their 'normal science lessons'. However, this was the intention of the project! From personal experience, the pupils' general thinking of science concepts and group work skills have much improved since delivering the CASE project and certain skills such as graph work has been much better higher up the school. In the initial intervention by Shayer and Adey (1994) there was evidence that pupils' GCSE results were enhanced through participating in the 'Thinking Science' programme compared with the control group.

Breakwell and Beardsell (1992) found that the older pupils in their 11 -16 yrs sample were more positive towards science which contrasts with the findings of many other researchers who report that that as pupils get older, their attitude towards science deteriorates (Choppin, 1974; Hadden and

Johnstone, 1983; Simpson and Oliver, 1985; Kelly, 1986; Hofstein et al., 1990). Each school subjects' level of difficulty increases each academic year so is science more affected than other subjects? Junior school pupils enjoy science and exploring why and how things work so why is there a change at GCSE age?

To sum up, the teacher has an important role in promoting science in lessons through a variety of teaching activities, creating a positive atmosphere, meeting each pupil's needs, co-ordinating group work, organising CASE project activities coupled with understanding how pupils learn so that each pupil can be brought on individually.

2.4. Attitude and Behaviour

The difference in pupils' attitudes is also apparent in their general classroom behaviour. The author's experience has shown that those pupils who are least motivated tend to rely on the practical component in a lesson so if there is not a practical they are the worse behaved and vice versa. This is not always linked to the pupil's level of attainment. Research into whether or not there is a link between attitude and behaviour has been rather difficult, though on the rise, since the 1970s. Ajzen and Fishbein (1980) comment that:

'a person's behaviour is determined by his intention to perform the

> *behaviour and that this intention is, in turn, a function of his attitude toward behaviour and his subjective norm' (p. 62).*

Poorly behaved children are sometimes a result of the work being too difficult or they have misunderstood or they have completed the tasks given. However, Osborne (2003) comments on other reasoning behind poor behaviour:

> *'Behaviour may be influenced by the fact that attitudes other than the ones under consideration may be more strongly held; motivation to behave in another way may be stronger than the motivation associated with the expressed attitude; or, alternatively, the anticipated consequences of a specific behaviour may modify that behaviour so that it is inconsistent with the attitude held' (p. 1054).*

Understanding that a pupil's behaviour could often be related to a poor attitude due to finding the work difficult or too easy is a factor in addressing attitude in lessons. For teachers, an awareness of reasons for poor behaviour could help them to build up a rapport with the child in order to provide for their individual learning, thus improving their attitude and consequently their behaviour.

2.5. Gender Preferences towards Science

Gender preferences towards science is a changing domain with the original perception being that boys prefer sciences, however, Smist et al., (1994) and Shaw and Doan (1990) found no gender differences with attitudes towards science. Achievement in the science domain is regarded to favour boys also, nevertheless, Ventura (1992) reported no gender differences in the achievement of boys and girls in science. The learning environment of the pupils has shown to be a determinant of attitude towards science; Ormerod (1975) showed that girls in a single sex school much preferred science to girls in a coeducational school. This may be due to the girls responding better to teaching when there are not boys to distract them or boys wanting to outperform the girls. Ndunda (1990) reported that girls in coeducational schools felt more negative towards science and had less positive experiences in science than boys which is in agreement with the findings of Young and Fraser (1990) who report that girls in a single sex learning environment achieved higher than those in a coeducational one.

Smist et al., (1994) found that males and females differ in their attitude towards science with more males going into science-related careers than girls. In agreement with this, when Sears (1997) investigated pupils' attitudes to science and their post-sixteen choices he found an apparent gender difference; girls were less positive about science than boys. However, Sears (op. cit.) reported that the dual award science has appeared to have made this gap between the girls and boys smaller. Sears also found that pupils were aware of the social impact and use of science. Younger pupils, especially girls from a single sex school, had a more positive attitude toward science than girls from a coeducational background

(Colley et al., 1994) and, as pupils mature, it is the boys who show stronger preferences towards the subject.

Grant and Hodgson (1913) declared that the boy's:

> *'breezy attitude to life.... successfully secures him from morbid concentration on the acquisition of knowledge' (p.27).*

In contrast the girl:

> *'broods over her tasks and reproaches herself her imperfections (p.27)'.*

Although these statements are dated, they still apply today. From a teacher's perspective, there has been little or even no change over time from when these statements were written to present day.

A ranking system was used by Lightbody and Durndell (1996) to see which subjects boys and girls liked. This research showed that boys were more likely to report that they liked science than the girls. Osborne (2003) states, however, that:

> *'it is possible for a student with an extremely positive attitude to all school subjects to still rank science as the least popular, and yet still have a much more favourable attitude than another student who has a strong dislike for all subjects and ranks science first' (p. 1056).*

Research by Jovanic and King (1998) suggests that a major factor why girls dislike science is that they feel that they are better at other school subjects. Some reasons why boys and girls differ in their attitudes could be related to their brain structures. From the author's experience, some males find it difficult to cope with emotional-centred tasks whereas girls prefer these. Males also prefer thinking tasks and action ones (Hannan, 1996). In everyday classroom practice, teachers structure their lessons with reflective tasks and thought provoking work which appeal to girls but which boys find difficult (Reed, 1998). Another reason can be linked to how boys perceive they should act at school:

> *'Not working hard at school can be seen as a defensive strategy by some boys to distance themselves from an academic world that is perceived as dangerously 'weak" (Jackson, 1998, p. 89).*

In contrast, girls are notoriously known for their hard work and it is this that gives them success (Epstein, 1998).

Kelly (1987) also writes on the choice of boys versus girls choosing science:

> *'Science is a conventional and acceptable career choice for boys; moreover it appears to offer clear and firm answers. Girls at a similar stage of development tend to avoid science because it is not a conventional choice. Girls who do choose science are likely to be more*

emotionally mature, and to have considerable self-knowledge which helps them to sustain unusual choices' (p. 2 and 3).

Osborne (2003) reported that from 1980 to 1993 the gender ratio for choosing science A Levels were: 3.4 :1 (male:female) in physics; approximately 50:50 in chemistry and 1:1.6 (male:female) in biology. Recent data (AQA, 2006b) shows that in 2006 the gender ratios were quite similar to these perhaps indicating within a cohort of pupils the gender split follows a trend. The 2006 date showed approximately 4:1 (male:female) in physics; approximately 50:50 in Chemistry and 2:3 (male:female) in biology. It has also been reported (by the Higher Education Funding Council, 1992) that the calibre of students entering higher education in science and engineering has declined.

A huge factor deciding whether or not a student likes a subject is related to the attitudes of their peer group and friends (Breakwell and Beardsell, 1992). Simpson and Oliver (1985) found that this relationship was greatest with pupils between the ages of 11 and 14. In contrast, at this time of puberty, the pupils could be only trying to find their own identity and therefore are led by the 'normal' pathway of their peer group (Head, 1985).

It is the teacher's responsibility to meet the needs of both boys and girls in their lessons through a variety of activities and to show understanding to both girls and boys with what tasks they find easy in lessons and which they find difficult.

2.6. Achievement in Science

Practical work is, as noted earlier, a popular aspect of school science. One component of OCR's[2] (1998) GCSE specification is 20% coursework (new specification, 2006). With this type of work, pupils are allowed independence to find things out for themselves. However, it is often not viewed like this by the pupils. Nott and Wellington (1999) reported that pupils felt that scientific investigations were a series of steps they had to go through rather than their attempt at being a 'real' scientist. A negative aspect of this investigative work is the write-up that follows it. Girls didn't mind doing the write-ups as much as boys (Nott and Wellington, op. cit.). They also found that more pupils wanted to do the practical part than the write-up part. A perception from pupils was that it was more important to get a good mark in the coursework than actually learning the science involved.

Since coursework is an important aspect of secondary school science, the more able pupils at GCSE found the practical work easier than those that were less able (Nott and Wellington, 1999). In their research, three groups of pupils preferred traditional practicals because they knew that they were doing it right! This, perhaps, shows a lack of confidence that pupils face when doing independent scientific work.

In summary, despite practical investigations being popular with some pupils, there are gender differences in this approach and certainly differences in how the pupils perceive the task. The new specifications (2006) (AQA

[2] OCR Oxford, Cambridge and RSA

(Assessment and Qualifications Alliance), OCR, Edexcel, CCEA (Council for the Curriculum, Examinations and Assessment), WJEC (Welsh Joint Education Committee), Cambridge International Examinations, see www.QCA.org website for full specifications) ensure practical investigations are competed in lessons followed by a short exam taken on the topic which differs from the old nature of coursework being a long project and detailed account written on planning, analysing and evaluating the practical. From personal experience of this new approach, the pupils have found new terminology difficult to use correctly and have felt stressed during the exam part. This could be due to the necessary independent learning of the key terms and application of what they have found out in the investigation.

2.7. Fraser's TOSRA Test

Fraser (1977, 1978, 1981) has developed a TOSRA Test. There are seven scales in this test and they are based on Klopfer's scheme (1971). They are:

- social implications of science;
- normality of scientists;
- attitude toward scientific inquiry;
- adoption of scientific attitude
- enjoyment of science lessons;
- leisure interest in science;
- career interest in science.

These seven themes encompass the whole area of science from a pupil's point of view. In each theme, there are ten questions. The first theme investigates pupils' ideas of how science can affect the world in which they live, for example medicine, and is there life on other planets? The second theme looks into a pupil's perception of a typical scientist. This can be rather inaccurate since old videos and stereotypical views of scientists give pupils the idea that scientists are old men with grey hair and a white coat. The third theme looks at pupils' attitude towards investigating science. It is a large area of science but one that is feared and disliked by pupils in the author's experience. In the GCSE and A level specifications, pupils have to undertake an investigation as part of their coursework. From personal experience, pupils tend to dislike adopting a scientific attitude, such as taking repeats in experiments. This could be due to this modern society in which answers can be achieved via the Internet within seconds. Enjoyment of science lessons can be due to the specification, the teacher and the teaching method, as well as the willingness of the pupil to learn. The sixth theme investigates pupils' enjoyment of science outside the classroom. Science is all around us but many pupils do not associate photography, computers or hairdressing as science. Finally, the seventh theme looks into pupils' interest in a scientific career.

The TOSRA Test's reliability was achieved by using the Cronbach alpha coefficient and the results for each year group were high enough to indicate that each TOSRA scale had quite good internal consistency (means around 0.8 (Fraser, 1978). The test was reduced from 70 questions to firstly 35 (by Ledbetter and Nix, 2002) and then by the author to 21 questions being written with the positive response always scoring five and then finally to 14 questions. This will be discussed further in the methodology section. The TOSRA Tests used are in Appendices 3 and 4.

In summary, the TOSRA Test is a valid test to determine pupils' attitudes towards science and the seven themes have been referred to during this work to give structure to exploration of attitude to science.

2.8. Gardner's Intelligences and Learning

If we consider 'intelligence' to be made of seven or more distinct themes as Gardner (1983) suggests, then we might display a poor attitude if the work is not in the style of our preferred intelligences. Pupils will therefore learn best if the teaching is in his/her preferred learning style so that it coincides with their 'intelligence'. Gardner (1993) realises that pupils:

> *'have quite different minds from each other and that education should be so sculpted that it remains responsive to these differences' (p.2 cited in White, 1998).*

Gardner suggested that each individual will possess at least seven relatively independent mental abilities or intelligences. The seven intelligences are: linguistic, musical, spatial, bodily kinaesthetic, interpersonal, logical-mathematical and intrapersonal and the new one to the original seven is naturalist. There has been a case made for the addition of spiritual to this

(Harvard Project Zero, 1999). Pupils may find that they use few of their intelligences, for example if they play a musical instrument or are good at physical education and not all of them will have been developed properly. However, White (1998) criticises Gardner's theory of intelligences being too biased towards artistic characteristics.

Pupils learn in different ways. The three modes of learning are: visual, auditory and kinaesthetic. Therefore teachers need to adapt their teaching style to cope with these differences between pupils. In science, teachers can, for example, show experiments and videos (visual), explain a concept (auditory) and allow pupils to try out concepts, by practicals, themselves (kinaesthetic). The advantage for science teachers is the range within the subject to allow these learning strategies to be used each lesson. However, from a teacher's perspective, the argument that how much effort a pupil puts in to a task is also a factor of their learning.

Biggs (1994) suggests that learning comes from the way in which pupils undertake their tasks. Chin (2003) says, that in terms of a pupil learning,

> *'...the deep approach is associated with intrinsic motivation and meaningful leaning where the learner focuses on understanding the meaning of the material to be learnt and attempts to relate parts to each other, new ideas to previous knowledge, and concepts to everyday experiences'* (p. 97) .

Chin (2003) believes that pupils need to be encouraged to think 'deeper' in order to develop their learning. The teacher's role is to help pupils to be able to question a concept, motivated to try out new things, give and want detailed examples which have everyday life examples and puzzles/hypothesises. Zoller (1999) stated that the success in environmental education is:

> *'the development of students' higher-order cognitive skills (HOCS), such as critical thinking, decision making, problem solving' (Zoller, 1999, p. 357).*

These HOCS are transferable and therefore, using this in science teaching in tasks such as evaluating, should enable pupils to think critically about what they are doing, have done and why.

An alternative theory to Gardner's Multiple Intelligences is the General Intelligence theory ('g' factor) (Deary, 2001).

> *'The 'g' factor intrinsically encompasses a base theory of multiple intelligences simply by saying that there are facets to be controlled in the first place. However, it goes further to define them as all related to the overall capacity of an individual's intelligence' (Guzman, 2006).*

Intelligence can be viewed in different ways, as explored in this section. This is useful when faced with a class of different pupils and trying to gain an understanding of each pupil's way of thinking and learning. Personal experience suggests that pupils have multiple intelligences and once they are aware of that, they are able to understand how and why they learn or prefer certain subjects at school.

2.9. Piagetian Model of Learning

This leads us into considering the stages in which pupils learn and the different levels of cognition. Piaget (1953) writes that,

> *'psychologically, operations are actions which are internalizable, reversible, and co-ordinated into systems characterized by laws which apply to the system as a whole' (p. 81).*

So when pupils are learning these operations they are embedded within them and can be transferred to other situations, in schooling to other subjects.

The Piagetian model shows that the two measurable instruments are:

> *'1 for measuring the level of development of pupils' mental schemas,*
>
> *2 for determining the level of cognitive complexity of curriculum material. If both of these measures are made on the basis of the same set of postulates then logically it should be possible to determine the*

upper limit of the level of curriculum material that can be handled by each pupil or group of pupils' (Shayer and Adey, 1981, p. 6).

The model in which Shayer and Adey match their findings is:

1 **Pre-operational**

2A **early concrete operational** (aged 10yrs approx. 90% children)

2B **late concrete operational** (aged 10yrs approx. 30% children; aged 13yrs 70% children; aged15yrs approx. 80% children)

2B/3A **transitional**

3A **early formal operational** (approx. 30% children aged 16yrs)

3B **late formal operational** (approx. 20% children aged 16yrs)

White (1988) writes that what Piaget inferred from his research is that operational thinking develops in all people in a sequence of stages. Relating to science learning, a child cannot think through a hypothesis until they are at the final stage of formal thinking and obviously pupils will reach this level at different times. Some topics are, therefore, better left until later in their education when pupils are more likely to be able to cope with the higher levels of thinking. White (op. cit.) comments that this also explains failure from some pupils; it is not that the teacher did not teach the pupils well, or that the pupil did not put in enough effort, it is because they were not at the right stage of thinking and learning. This is also a reason why pupils may appear unmotivated in certain topics. Teachers need to be aware of such topics and be sensitive in their distribution of certain concepts i.e. a curriculum scaffold based on logical progression matched to pupil need and developmental stage.

At secondary school, the less able pupils may only use concrete operational thinking whilst more able pupils may be able to cope with formal operational thinking (problems with many tasks such as practical skills and write-ups). In science, an example of concrete thinking could be the practical investigating what can speed up the rate of reaction between marble chips and hydrochloric acid. At this level, pupils would only investigate one independent variable. Formal operational thinking would allow pupils to have two independent variables in this practical.

An alternative theory to Piaget is that of Montessori's. This theory also agrees that pupils learn in sequence, however, the timings are different and Montessori believed that:

> *'while children had specific 'sensitive periods' for development, they should be encouraged to develop all of their senses from a very early age, and that self learning would be based on the way the senses develop' (Dryden and Vos, 1999, p.1).*

In summary, Piaget's model of learning helps explain why some pupils grasp certain scientific concepts at different times and not necessarily at the same age. Alongside that, teachers must consider developing pupils' senses from a young age and therefore their self-learning would be developed as a consequence of this sense-learning.

2.10. Key Stage 2 vs Key Stage 3 Science

An interest in science is initiated from a young age. It is the primary school teachers who make a valuable contribution to laying the foundations of knowledge and to incorporate a desire to experiment and find out things for themselves (Dowling, 2001). It appears that primary school pupils establish their attitude towards science very early on in their school life and, as they get older, simply adapt their behaviour according to the teacher (Galton and Hargreaves, 2002). However, some primary school teachers are not well qualified in science and therefore lack confidence in delivering it effectively (Dowling, 2001).

Jenkins (2004) reports on how primary school science has been transformed over the last fifty years. More science is now being taught at this level as a result of the statutory requirements under the National Curriculum in England and Wales (1989) and this will have an influence on pupils coming through into secondary school. However, Bennett (2001) reports those pupils in primary schools see it solely as a means of doing well at school, passing tests and getting a good job. Galton and Hargreaves (2002) found from primary school pupils what they were looking forward to in their secondary school.

> *'Before transfer most pupils said that one of the things they were most looking forward to was science. When pupils were asked what 'doing science' involved they talked about 'doing experiments' of 'making bangs*

and smells'. The reality, however, was somewhat different' (p. 7).

The transition from primary to secondary school is one which has been researched in detail since the ORACLE study in the 70's. The ORACLE study (Observation, Research and Classroom Learning Evaluation – 1975-1980) followed pupils in Yr 5 and 6 and into their first two years at secondary school. This project investigated how teachers taught the curriculum and how the pupils responded to it. Also, pupils' academic ability was tested as the pupils left primary school and during the first year at their new school. The project also monitored the pupils' attitude levels throughout the year (Galton and Hargreaves, 2002). A summary of the ORACLE study findings is given below:

- Little continuity between the curriculum – some teachers start at the beginning and revisit many topics. This meant that pupils became bored from repeating work;
- New subjects were a problem – the perception of science and what they actually did were different and often disappointing;
- Pupils' attitudes had been established during primary school and pupils changed their behaviour according to the teaching style of the teacher.

In secondary schools, to make the transfer easier and more accessible to children, Galton and Hargreaves (op. cit.) suggest the following:

- More detail on pupils' attainment in primary school given to the secondary school teacher so that appropriate work could be set;

- Teaching methods could use more teamwork and interactive approaches.

Teachers need to be aware that suddenly these children are subjected to many new things all at once. They have left primary school, which is a lot smaller and so all the pupils know each other, where they are the oldest and most experienced in the school and now they are the young ones again in a large school with pupils many years older than them (Comber and Galton, 2002).

Ryan (2002) states that it is known that, as children move from the primary to the secondary school, there is a dip in their achievement in science. This was a reason for the introduction of the KS3 Strategy (now the secondary strategy). For secondary school teachers to successfully bridge the gap between primary and secondary science, an appreciation of what is taught at KS 2 is necessary. National Curriculum Test results and a KS 2 syllabus are a start for the secondary school teacher but with the pupils, for the first time, studying separate sciences under the headings of biology, chemistry and physics and having specialist teachers (not in all schools). Prior knowledge, by the teacher, of how their specific science is taught could be the key to a successful transition at this age.

The fact that pupils' attitudes towards science decrease as they ascend through secondary school could be matched with their progress. Galton et al., (1999) show that the pupils' achievements in KS3 National Curriculum Tests show a lack of progress from their results at KS2. The results show this lack of progress is more apparent in science than English or mathematics. This could be from pupils concentrating less in science lessons than in English or mathematics lessons (Galton and Hargreaves, 2002). Comber and Galton (2002) state how pupils know that things such as daily routines will be different at high school and that they are excited about new lessons and making new friends. But also, some pupils may be put off secondary school by the lack of challenge they experience in lessons. This can be even more disheartening in science because, on some induction days, exciting experiments have been shown to them and, in reality, these are not used on a daily basis.

Secondary school teachers know that their pupils arrive in Yr 7 excited about science lessons and wanting to do practicals, particularly involving the Bunsen burner (62% of around 2000 pupils in Northern Ireland; Jarman, 1993). However, as their KS3 science progresses, they begin to realise that the work is not what they had expected. The experiments are ones they had done before, repetition of scientific concepts from KS2 and KS3 (25% of pupils in a study by Davies and McMahon (2004)) and 'exciting' experiments are not undertaken every lesson. Braund et al., (2003) do say, however, that:

> *' ...attitudes to science remain positive (until year 8 at least) is perhaps a testament to pupils' resilience and to their latent, natural curiosity and*

interest in science as a subject' (p. 117).

Jarman (1993) carried out research with pupils asking them about their first term at secondary school. A summary of her findings include:

- Many pupils gave examples of topics that were the same as those studied before, the natural world being the most frequent, e.g. animals and water;
- 27% of pupils said that they had done the same/similar activities at primary school;
- Working with different equipment and in laboratory settings were the most commonly mentioned differences. 62% mentioned the Bunsen burner;
- Pupils commonly regarded secondary science as: sophisticated, real/proper science rather than play;
- Some secondary pupils claimed that they now took more responsibility in practical work;
- 20% remarked on an increase in depth of study in secondary science. Girls were more likely to say this.

Pupils' backgrounds will of course vary and some primary schools will do more science than others. Some pupils will have had little or even no practical work at all at primary school (Braund and Driver, 2002). Jarman (1993) did suggest that pupils are prepared to put up with repeated concepts and this could be comforting for pupils since one of pupils' biggest worries on approaching secondary school is being able to cope with the work (Braund et al., 2003).

To help ease the move from primary to secondary school, many schools now have an induction day. For science these can involve showing the pupils many exciting experiments such as using the Van der Graff generator and Bunsen burners. The pupils have their first experience of a 'science laboratory' and see teachers in 'white coats'. The pupils have high expectations and are enthusiastic about the secondary school science that they will experience, but perhaps this enthusiasm declines quickly when they reach secondary school and they find out this is not what lessons are actually like (Braund et al., 2003).

Another initiative that was trialled was the Science Transition AstraZeneca York (STAY) project bridging units. The practical work in the project progressed in all areas (context, practical nature and conceptual demand) from Yr 6 to Yr 7 (Braund and Hames, 2005). They conclude the successes of this bridging unit were:

- That pupils felt a sense of comfort and familiarity with the bridging work;
- It improves the confidence in the Yr 7 pupils;
- The work is new and not repetitive.

Although pupils may feel nervous before their first day at the new school, pupils will often feel excited as well and eager. Having been to induction days and become familiar with the school site and some teachers, it is not as big a hurdle as perhaps it once was (Rudduck, 1996). Also, pupils are aware of the fun experiments they might be doing in science and know of all of the resources that are on offer. However, the new school is a lot bigger, they don't know everyone (teachers or pupils), and there are new subjects and different expectations and teaching styles to adapt to in lessons. Lessons can vary according to the teacher and pupils reported that they liked the teachers who could show humour and seriousness, and also who helped them and made their lessons interesting (Wallace, 1996).

A study by Cambridge University (2003) found that attitudes towards enjoying school were highest amongst primary school pupils. As the first year at high school progresses, the enjoyment has changed; from September to November the scores are similar to those at primary school, however, this then declines to a score lower than that of primary school. However, personal experience would suggest this enjoyment increases again once the pupils are in Yr 8 where they are not the youngest pupils in the school again and new pupils come in who they know from primary school. The pupils are more established in their friendship groups and they are settled in new subjects and knowing more teachers and hence they can enjoy their schooling once again.

This section has reviewed the transition period from Year 6 to Year 7 and the factors that affect a pupil at this time. The common 'dip in achievement' noted by secondary schools has started many schools trying to help bridge this gap and make the transition period more accessible to pupils and therefore to maintain or improve pupils' attitudes towards science.

2.11. Primary School

Science in the primary school within the National Curriculum should prepare pupils for their study of science for all of their schooling and life beyond. Its full capacity and importance are often forgotten and pupils miss out on feeling like scientists and perhaps feel they just have a set of rules and definitions to learn not to explore any of the topic themselves. However, the National Curriculum Council, 1989, states that:

> *'School science is a reflection of science in the 'real' world, where scientists learn from each other and extend the boundaries of knowledge by research' (p. 5).*

If we were to ask pupils at primary school what they thought of science, would they come up with a statement like this? Some schools opt out of following the National Curriculum and therefore the science education the pupils are given could be just as good as following the National Curriculum, better or even worse for pupils.

It is a hope that in primary science enjoyment, exploration, questioning are skills that are instilled into pupils and ones that they respect and see why it is needed. If this is to be achieved by teachers, they too need to be enthused and have a heart to understand the nature of science and be able to pass it on (Ratcliffe, 1998).

Even at primary school, there is a practical nature to science and these experiences, early in life, are ones that encourage pupils to move up the learning curve (Johnston, 1998). Learning through doing can also help pupils to understand the concepts behind the task and motivate them to want to do more things like it. However, Pollard et al. (1994) found that pupils prefer to do physical education, painting and home corner play in their lessons. The pupils disliked engaging in writing, mathematics and science. However, Sherrington (1993) offers some suggestions for increasing pupils' approach to writing in science if:

- *'there is a good reasons for doing it which the children can understand;*
- *There is a good reason for doing it in terms of learning science;*
- *It is about something the children have done themselves;*
- *It is in their own language;*
- *There is an opportunity to share the writing task;*
- *When the writing picks up aspects to focus on;*
- *The children see their work is valued by being put on display or read aloud;*
- *The work takes a variety of forms;*
- *The work takes a variety of formats;*
- *The children can use up-to-date information technology;*
- *The children see writing as a process which can involve note making, conferring, redrafting and presenting;*

- *Children and teachers see the writing as a part of, and not just evidence of, learning' (Sherrington, 1993, p. 205-206).*

Pollard et al. (op. cit.) also reported that the pupils liked curriculum subjects if they found them easy and had success, they were interesting, fun, had activities and autonomy in what they were doing. In this study, pupils also showed that they valued teachers praising them and that they did not like doing things wrong.

So, a way in which this motivation, scientific enquiry and practical approach can be delivered is through pupils having opportunities to 'play' with new materials such as mirrors and equipment such as magnets (Jarvis, 1991). Also, tasks with an 'open-ended' element can encourage pupils to think for themselves and develop their thoughts and not just learn what the teacher says. These tasks allow pupils to work at their own level and to develop at their own pace and therefore all pupils should leave a lesson feeling that they have accomplished something (Jarvis, op. cit.).

The ability of a teacher to link together the core subjects English, mathematics and science at school can provide a context for learning a new topic (Sherrington, 1993). If pupils have success in each of the subjects this can contribute to each pupil developing their own positive learning attitude and include:

'...curios, co-operation, responsibility, critical and open-mindedness, creativity and inventiveness, confidence and enjoyment' (Sherrington,

1993, p. 191).

Differences in primary and secondary school science can cause either a positive or negative impact on their attitudes towards science. Secondary school teachers do need to be aware of the science and how the science has been taught earlier in their schooling to ensure that they are moving pupils forward as they move through secondary school.

2.12. National Curriculum (based on National Curriculum Council Document, 1988).

In 1989 the National Curriculum (NC), following the 1988 Education Reform Act, was introduced into England and Wales (Braund and Hames, 2005). The NC for English schools is based upon Attainment Targets and in 1989 there were 21 Attainment Targets with levels assigned from 1 – 10. The average level, from the 21 Attainment Targets, was calculated and then pupils received one level for Science. These were subsequently reduced to 17 Attainment Targets. However, from 2000 – 2006 there were just 4 Attainment Targets written on 30 pages: Scientific Enquiry, Life Processes and Living Things, Materials and their Properties and Physical Processes. The present National Curriculum has changed again. From 2006, there are 5 Attainment Targets, there are no level descriptors, the Programme of Study is concisely written on two sides of A4 for Key Stage 4.

'The new two-page key stage 4 programme of study covers the core of science, equivalent to a single GCSE. This new programme of study has

> *the flexibility to be the common basis for all science qualifications. It provides a common foundation of the fundamental skills, knowledge and understanding' (QCA, 2005, p. 6).*

For example, for 5 -7 yr olds the main profile components to be achieved are 'Exploration of Science' and 'Knowledge and Understanding of Science'. The essential elements being pulled out for the pupils are their communication skills and being able to develop an awareness of science in their everyday life.

Activities to be included for pupils to explore science are:

- Involve children in promoting ideas and seeking solutions;
- Encourage an appreciation of the need for safe and careful action;
- Develop an understanding of the importance of recording results;
- Develop reporting skills.

These elements are part of developing a child as a 'scientist' and these skills are valuable to pupils if they are to think and to appreciate what scientists do. How well these activities are presented to children may have an impact on how they view scientists and perhaps put them off being like one, hence a poor attitude. However, this is a key time for teachers to use imaginative and creative tasks to promote curiosity in their world and to make writing reports an important task and link it to their literacy and numeracy work. Braund and Hames (2005) comment on the development of science education in primary schools since the introduction of the NC.

In terms of the content of work to be covered in the Programme of Study see Appendix 10 for the full document. Some of the key topics are:

- Care of living things and being healthy;
- Everyday materials such as paper, plastics, cans;
- Weather changes and rocks;
- Earth's magnetic field.

As pupils get older, this framework is built upon and the topics are revisited and developed further. This can be argued as a good point as it always gives the teacher a starting point to see what the pupils already know, increase their knowledge and lead into new skills on that topic. However, it could be seen as 'boring' for the pupil and if they had not understood it the first time or the second time, it could be very disheartening and completely put them off science. Also, the pupils may still not be at the appropriate level of thinking, it may seem hard and pupils may display a poor attitude for science because of it.

How to deliver the National Curriculum effectively comes down to the classroom teacher and hence their specialism and enthusiasm. The many changes that have occurred take time to be refined in schools, however, the simpler guides should enable teachers to explore how science works more with pupils and focus on those topics that pupils can relate clearly to everyday life.

2.13. Summary of Chapter

This chapter has considered the relevant literature in the main 11 areas affecting pupils' attitudes towards science. It has addressed the concern of pupils displaying poor attitudes in science lessons and how it could be overcome by a clearer understanding of pupils' needs, their gender, how they learn, differences in their primary and secondary schooling, the transition period from Key Stage 2 to Key Stage 3, whether pupils have general or multiple intelligences and the affect of the changing National Curriculum. This shows the complexity of attitude and of the number of factors that can affect a pupil and their attitude to school science.

3.1.1. Methodology

This chapter aims to outline how the research, both Pilot Study and Main study, was undertaken and why these methods were chosen.

The order of the section will be as follows:

3.1. Type of research methods to be used

3.2. Analysis Statistics

3.3. Pilot Study and Main Study

Methods to Research Attitude

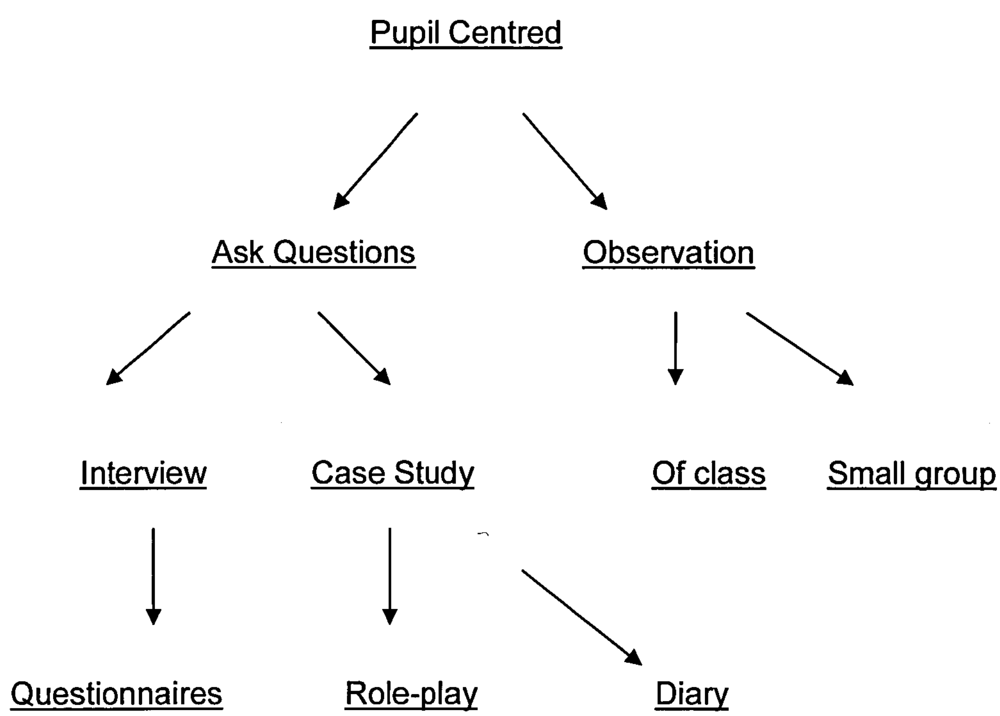


Figure 3.1.1: A Flow Diagram showing the methods of researching Pupils' Attitudes towards Science at school.

3.1.2. Types of Research to be used

The literature suggests a variety of research methodologies suitable for this study including:

- Interviews
- Questionnaires
- Role-play
- Case-study
- Diary
- Personal construct analysis

In addition, use could be made of lesson observations.

Each of these methodologies will be outlined in this section.

An interview of either an individual or a group is a useful technique in gathering detailed information by being able to probe deeper into an answer and receive a clearer picture of the situation. Holding an interview, particularly for a pilot study, can be useful when there are complex ideas involved in a topic (Moser and Kalton, 1977) so that more in-depth and specific questions can be asked. If the interviewer builds up a rapport with the participant, or group of participants, and if the participant(s) are well-motivated, then this method allows accurate and useful data to be gathered (Kitwood, 1977). However, this method takes time to carry out and to process the findings (Drever, 1997). For a single researcher it would be time-consuming to perform in a main study so this method cannot cover a large number of pupils and if a variety of interviewers were used to help, interpretations of answers could be different.

Questionnaires are a useful tool in research as they enable a researcher to gather a large amount of general information from a wide number of people. For this study the Test of Science-Related Attitudes (TOSRA Test) was used (Fraser, 1978; Ledbetter and Nix, 2002). In addition, questionnaires are useful as they are an efficient use of time, the respondent can be anonymous, high return rates are possible if appropriately planned and they employ standardised questions (Munn and Drever, 1990). However, the reliability of the responses is not one hundred percent clear and may not be interpreted by the researcher as intended by the child answering (Brown and Dowling, 1998). In order to give an indication of the reliability of questionnaires, statistical methods, such as Cronbach alpha can be used. This will be revisited in section 3.2.

Another suggested method of data collection is role-playing. This idea is based upon giving participants a 'real' life situation and observing the responses being made (Cohen and Manion, 2007). A role-play exercise could be used by asking a pupil to imagine a situation and then to act it out or give verbal/behavioural responses to certain given scenarios. The pupil may be asked to act as themselves or to imagine being another pupil. However, this method is unreal, the behaviour is not spontaneous and it is not sensitive to pupil-pupil complex interactions (Cohen and Manion, op. cit.). It is also time-consuming and decisions whether a role-play be created by the researcher or an existing one borrowed (and adapted if necessary) needs to be made.

> *'The limitations as applied to evaluating classroom simulation and games are obvious: not only are the inputs multiple, complex, and only partly known, but the outputs are disputed, difficult to isolate, detect or measure and the interaction among participants is considerable' (Cohen and Manion, p. 289, 1980).*

A case study increases a teacher's sensitivity toward the topic by the asking of questions that need answering and listening to the given responses. It is unclear from the literature how data captured in this way is to be processed (Winter,1982). However, the advantages do outweigh this. For example, case studies provide an honest opinion of the situation in question and can allow participants to draw on their own experiences.

> *'...case studies are down-to-earth and attention holding, in harmony with the reader's own experience, and thus provide a 'natural' basis for generalisation' (Adelman et al., 1980, p. 146).*

A diary is a quick way of gathering information from participants in the study and it has a broader and more honest set of responses from the case study (Hopkins, 1993). A diary provides information from the pupil's perspective, giving information relating to the general atmosphere within the classroom and as Hopkins (op. cit.) points out diaries help in identifying problems that pupils are experiencing and improves the quality of the class if used appropriately by the teacher. However, a good scientist may not necessarily be an expressive writer and some pupils may not want to take part because they may not like writing and therefore would not want to participate.

An analysis technique, often referred to as 'personal construct theory', is based on elements, in this case events in the classroom such as activities (video, practical) and bipolar constructs (in this case makes the pupil feel happy or sad). This theory was stated by George Kelly (1955) in his book *The Psychology of Personal Constructs*. These results can then be placed in a grid and analysed (Cohen and Manion, 2007). The grids have the essential characteristics of:

> *'constructs - the dimensions used by a person in conceptualising aspects of his world; and elements – the stimulus objects that the person evaluates in terms of the constructs he employs' (Cohen and Manion, 1980, p. 316).*

This is called the Construct Repertory Grid Test. The grid reflects a conceptual structure which the constructs are linked to characteristics of the same person – the elements (Cohen and Manion, 2007). The advantage of this grid is that it gives the researcher a lot of material such as understanding what some of the activities mean to the pupil(s) participating, changing relationships within the classroom, and can be adapted to suit the needs of the problem. However, the rating scale can cause problems in the grid (Yorke, 1978) and researchers must ensure that they listen to the responses given from their participants and that they do not force constructs (Cohen et al., 2007).

Since my experience is mainly secondary school based, lesson observations were taken to enhance my knowledge of primary school science and how it was taught. This had benefits such as:

- Observing teacher technique through using existing university observation forms especially focussing upon open/closed questioning;
- Observing the level of science taught at Key Stage 2;
- Observing pupil behaviour such as: activities enjoyed, motivation, interest for science, level of work able to produce, amount of teacher input.

However, from personal experience and discussion with colleagues the disadvantages are:

- Pupils might react to someone observing so it may not be a true reflection of behaviour towards activities;
- Isolated lessons observed – not a full topic, and therefore the observer will not have seen the previous lesson, or observed any of the pupils in that lesson, with that teacher;
- Teachers themselves may behave differently in the presence of an external observer;
- No recognised methodology for the analysis of these data.

It was decided that the approach to be taken in this research would be a mixed method combination of questionnaires and interviews. However, in the pilot study a case study was used with the participant keeping a diary. In addition, lesson observations were used to focus the questions used in the main study.

In order that robust conclusions can be drawn from a data set, two or more methodologies should lead the researcher to the same conclusion. This is known as triangulation (Brown and Dowling, 1998).

> *'… triangular techniques in the social sciences attempt to map out, or explain more fully, the richness and complexity or human behaviour by studying it from more than one standpoint, and, in so doing, by making use of both quantitative and qualitative data' (Cohen and Manion, 1980, p. 254).*

In the pilot study 'between methods' triangulation will be used. This is when more than one method is used to see the outcome of an objective, for example, a case study, completing a questionnaire, keeping a diary and undergoing an interview. For the main research 'within methods' triangulation will be used. This is when, for example, a questionnaire will be repeated the following year with a different set of pupils in that year group. This would check on reliability and theory confirmation (Cohen and Manion, 2007).

The type of research to be carried out in an educational context, by a classroom teacher, can be defined as action research:

> *'Action research is small-scale intervention in the functioning of the real world and a close examination of the effects of such intervention' (Cohen and Manion, 1980, p. 208).*

Action research depends on the situation and it is concerned with diagnosing a problem in a specific context; in this research, pupils displaying poor attitude towards science lessons. There are two stages to consider: a diagnostic stage where the problems are analysed and hypotheses developed and a therapeutic stage where hypotheses are tested (Blum, 1955).

The term 'action research' can be overlapped with that of 'practitioner research':

> *'Because action research is done by you, the practitioner, it is often referred to as practitioner research, or a similar name such as practitioner-led or practitioner-based research. It is a form of research which can be undertaken by people in any context, regardless of their status or position. It involves you thinking carefully about what you are doing, so it can also be called self-reflective practice' (McNiff, 2002, p. 15).*

Practitioner research can be undertaken by a teacher aiming to solve a problem in the classroom and Groundwater-Smith and Mockler describe it as bringing about 'professional transformation' (2005, p.9).

> *'At the heart of every practitioner research project there is a significant job of work to be done that will make a small contribution to the improvement of the human condition in that context. Good practitioner research, I believe, helps to develop life for others in caring, equitable, humanising ways' (Dadds, 1998, p.7).*

For simplicity, I will use the term 'practitioner research' to mean the type of methodology undertaken since the aim of the research is based upon pupils' attitudes towards science and this would give the teacher suggestions of how to improve this within the classroom context.

This study was classed as longitudinal since data were collected over a period of time. With no evidence to the contrary, it was assumed that any of the schools who participated were, in statistical terms, a 'normal population'. The pilot study was a short term study (six months) that provided a focus for the main study which lasted two years. The sample for the questionnaires part of the main study included pupils of different backgrounds and ages from two schools for each age group. The sampling process was, due to access, an opportunity sample. This must be done with caution as there may be a sampling error;

> *'variations may occur due to the chance selection of different individuals' (Cohen and Manion, 1980, p. 102).*

The cohort used for this study was useful in showing how pupils' attitudes change in a social scenario, i.e. their attitudes to science lessons (Cohen and Manion, 2007). One potential danger in the research was that some of the researcher's pupils were used in the study and this could affect some of the results. Therefore, it was necessary to have other schools to aim to eliminate this potential problem. More than one school is also useful to ensure valid data as the results may be valid for that particular school but not for another one. However, longitudinal studies can be difficult.

> *'There is the difficulty of sample mortality. Inevitably during the course of a long-term cohort study, subjects drop out, are lost or refuse further cooperation' (Cohen and Manion, 1980, p.71).*

Permission from all schools was granted before the research was conducted and within the classroom, participation being 'voluntary' was emphasised. (see Appendix 3b 'Guidelines for Teachers' and Appendix 13 for letters requesting permission). As it is hard to motivate a group of people to participate for a long period of time and repeating factors can be uninteresting for the participants, in order to help maintain their interest, chocolate was given to each participating pupil after completion of each questionnaire and at each interview.

Lesson observations as a focus for simply 'just looking' at the pupils in science lessons at a primary school were used (Simpson and Tuson, 1997).

> *'For many observation studies this act of standing back, making the familiar activities of a situation into objects which you observe in a detached way – 'making the familiar strange' – is an essential factor for success. Success is measured by the extent to which you see things which you otherwise would not have noticed, or things which surprise you, or things which seem suddenly different in their significance from before' (Simpson and Tuson, 1997, p. 5).*

Recording data to describe the detail of the different activities happening in the classroom can be achieved by designing tally charts of pupils behaving in a certain way, a rating scale, an event recording schedule (Simpson and Tuson, 1997). Processing the data can be performed by using categories, tabulation and searching the data for interpretation of the evidence through the categories (Simpson and Tuson, op. cit.). The weaknesses with conducting lesson observations are the time/effort demands and the bias from the observer of what they see (Simpson and Tuson, op. cit.).

3.1.3. Detailed Methodologies Chosen

Having given an overview of available methodologies, this section explores more deeply the strategies chosen for this study.

Interview

An interview enables more information to be found out by the researcher. It can be a flexible and useful method to gather opinions, explore depth, correct any misunderstandings and, if unsure, to probe deeper for clarification (Drever, 1997). However, it can be a rewarding experience.

The interview will be based on both probes and prompts. Probes are questions which enable the interviewer to gain further information about something or:

> *'...seeks to access underlying causes or reasons for a particular response' (Brown and Dowling, 1998, p. 62).*

Prompts are when the interviewer suggests possible answers for the interviewee to choose from (Brown and Dowling, op. cit.). Interviews are useful ways of obtaining reliable evidence and any ambiguities can be solved there and then (Drever, op. cit.).

The first interview was structured with a list of predetermined questions (see Appendix 2b) (Brown and Dowling, 1998). However, care was taken to maintain flexibility and to have a 'conversational-style' approach if necessary (Drever, op cit). This is then known as a semi-structured interview (Drever, op cit). Of the questions asked, some were open (responses will have a wide range of choice) and some were closed (small scope of answer) (Drever, op cit). The questions were read from a clipboard and the interview was recorded onto a tape where possible. Answers were written down when necessary as the conversation can flow more if taped (Drever, op cit). However, there are limitations with a tape recorder: - pupils may feel inhibited, need a microphone and background noise may affect the recording and flow of the interview. The more general, closed, questions were read first, leading on to the main, open, questions (Drever, op cit). The questions were simple and in appropriate language (Drever, op cit). Adelman and Walker (1975) also state the importance of the interviewer being sympathetic, neutral, at ease and reassuring to the pupil that their views are really important to the researcher (Appendix 2b for interview questions).

Despite the limitations of time and processing of interviewing, it was still used in the pilot study and in some parts of the main study. The difficulty of summarising what has been said without distorting or omitting anything important and the skill in delivering a formal interview to pupils whom I sometimes teach (Drever, 1997), were minimised by detailed notes being written up and clear aims delivered to pupils of what the interview was about and why. Interviews took place in a comfy meeting room that gave a more informal environment than a classroom so that all could relax and sensitively respond.

Questionnaires

Questionnaires were being used in this research as they gather a large amount of general information from a wide number of people. For this study the Test of Science-Related Attitudes (TOSRA Test) was used. Fraser's original TOSRA Test was adapted by Ledbetter and Nix (2002) (see Appendix 3 for the pre and post TOSRA Test) so this was used to get a scale of attitudes of the pupils. Klopfer's classification is linked to the TOSRA scale questionnaire and provided a theme to look into these science attitudes.

Munn and Drever (1990) suggest constructing a questionnaire that is attractive to look at, easy for the respondent to understand and quick to complete. Once the Ledbetter and Nix (2002) version of TOSRA had been used in the pilot study, it was rewritten so there were 3 questions in each of Klopfer's categories and questions were written in the positive form so they were more accessible to younger children (see Appendix 3d). This conclusion came from discussion with primary teachers (face validity) and Pell and Jarvis (2001). Also, the researcher would analyse the questionnaire and see if the smaller number of questions produced more pupils answering all of the questions. The font was made bigger and the boxes clearer to read. Munn and Drever (op. cit.) further suggest that if the questions are too factual people won't put in the extra effort to complete them to the best of their ability (see Appendix 4 for TOSRA questionnaire for Yr 2 work). All of the questions asked were choices of responses or in later versions, ranking subjects (see Appendix 5 for final year TOSRA questionnaire).

Administration of questionnaires must be done sensitively. On distributing questionnaires to pupils, it was stressed that their participation was voluntary and that the data will be treated confidentially; no name was required on the questionnaire but they must have included their age. Pupils were reminded to read, and answer, all questions and their answers must be their own and their honest answer. In schools where the questionnaire will be given out by other teachers, a guidelines sheet to be read out (see Appendix 3b) was given and the researcher then relied on the teacher's professionalism to maintain confidentiality

To interpret the data provided in the questionnaires, an ordinal scale was used. Cohen and Manion (2007) suggest this should be used when ranking is needed. The responses were ranked from the positive response scoring five and the negative response scoring one. This approach to scoring is not without its problems - the 3 in the middle could be used if pupils have no idea and do not wish to make a choice. However, this could be a reason why it must be there as some pupils will feel this and honestly do not know so therefore need a 'not sure' option. This is called the Likert Scale (Oppenheim, 1992) and it was chosen as there are five responses from strongly agree to strongly disagree on the TOSRA questionnaires. These types of scales are widely used in research and therefore they can be used with confidence (Osborne, 2003). However, this type of scale has been criticised by Munby (1983) who feels that it gives inconsistent results which lack reliability. Osborne (op. cit.) writes that although these attitude scales help to identify the problem, they do not help us to understand the problem. The scalogram analysis, developed by Guttman (1944), was not used in this instance because, although it treats the data both in an ordinal and cumulative fashion, simply saying 'yes' for a positive response and 'no' for a negative response was not enough detail. The questionnaire was scrutinised to check for questions where the wording gave a negative response and, if this was the case, the scoring was reversed. Oppenheim (op. cit.) stresses that it is important to be consistent in the scoring that has been chosen. One criticism of this scale he points out is that it is not clear to say where in the middle range is the change from mildly positive to mildly negative. This middle range could relate to a lack of knowledge or attitude and therefore the neutral point would be hard to find. Oppenheim (op. cit.) states that:

> *'....identical scores may have very different meanings, the Likert scales tend to perform very well when it comes to a reliable, rough ordering of people with regard to a particular attitude' (p.200).*

Firm decisions regarding missing data must be made. As Oppenheim (op. cit.) suggests, when the main research is undertaken, to minimise these problems it is best to omit questionnaires with missing data as it is better to have a smaller sample without risking bias. However, from the TOSRA questionnaires, there will be questions not answered by pupils and perhaps two answers given for one question therefore with having a small sample (n= 21 for Yr 7 and n=20 for Yr 9 pupils) for the pilot study, it was decided to give the score of zero to any response unanswered. If two responses were circled, the question scored three which stood for 'not sure'.

In summary, the two main methodologies to be used were interviews and questionnaires. Together, weighing up the pros and cons of each, substantial and useful data can be collected.

3.2. Analysis Statistics

The chi square test was chosen to analyse the data from both the pilot and main study questionnaires. The formula is (Clarke and Cooke, 1978):

$$\chi^2 = \Sigma \frac{(O - E)^2}{E}$$

O = observed value

E = expected value

χ^2 = chi square

The formula that has been used from Brown and Dowling (1998) has included Yates' correction (that is, the inserted part is the minus 0.5) (see below). Brown and Dowling suggest using this correction if the sum of the frequencies is less than 25. This makes the test more demanding since there are similarities in the pre and post test results. Therefore the formula to be used is as follows:

$$\chi^2 = \Sigma \frac{(|O - E| - 0.5)^2}{E}$$

The reason that this test was chosen is that it shows the probability that two samples have or have not been drawn from the same population. In this case, the pre- and post-test results have been drawn from the same population so this test shows this. Brown and Dowling (1998) say that if the probability is found to be less than 0.05 then the samples were drawn from different populations (the null hypothesis, H_0, can then be rejected). Charles (1998) says that the chi square compares what one would expect to see (from results in the pre-test) against what one actually observes (from results in the post-test).

The null hypothesis, H_o, can be written as:

There is no difference between the pre and post TOSRA test results. i.e. there is no change, over time, in the pupils' attitude towards science.

The chi square is then compared with a table of chi square probabilities. This will advise one if the value for chi square represents a significant difference (Charles, 1998).

The standard deviation of a sample can be calculated:

$$\text{s.d.} = \sqrt{\frac{\sum (x_i - x)^2}{N}} \qquad i = 1 \text{ to } N$$

If a small value is achieved, this demonstrates that the observations are clustered around the mean value. This was used in the main study analysing each of Klopfer's themes responses.

When analysing the questionnaires to measure the reliability Cronbach alpha test was used.

> *'When you have a variable generated from such a set of question that return a stable response, then your variable is said to be reliable. Cronbach's alpha is an index of reliability associated with the variation*

> *accounted for by the true score of the 'underlying construct'. Alpha coefficient ranges in value from 0 to 1 and may be used to describe the reliability factors extracted from dichotomous (that is, questions with two possible answers) and/or multi-point formatted questionnaires or scales (i.e. rating scale). The higher the score, the more reliable the generated scale is. Nunnaly (1978) has indicated 0.7 to be an acceptable reliability coefficient but lower thresholds are sometimes used in literature' (Reynaldo and Santos, p.2, 1999).*

In summary, the two main statistical methods used to analyse the results were chi square and standard deviation.

3.3.1. Pilot Study

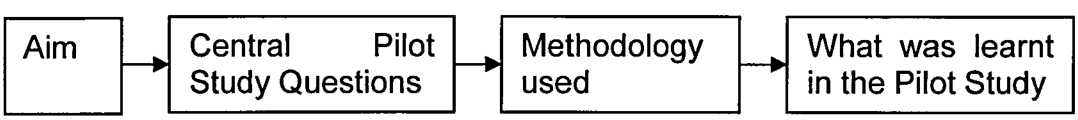


Figure 3.3.1: Flow Diagram showing procedure for the Pilot Study.

To aid the construction of main study key questions and to help plan the questionnaire and interview questions, a pilot study was undertaken. This comprised of a case study, lesson observations, questionnaires and small group interviews.

> *'Questionnaires have to be composed and tried out, improved and then tried out again, often several times over, until we are certain that they can do the job for which they are needed. Sometimes we can*

borrow or adapt questionnaires from other researches, but there still remains the task of making quite sure that these will 'work' with our population and will yield the data we require. This whole lengthy process of designing and trying out questions and procedures is usually referred to as pilot work' (Oppenheim, 1992, p. 47).

The pilot study was also useful to help the wording of the questions and to trial the design of the answer categories and how they were to be analysed. The case study aided with the writing of some questions as first the participant had been asked open questions on the topic (Oppenheim, 1992).

The Pilot research questions were:

- How do pupils feel about their school science lessons?
- If pupils expect to always do some form of practical in a science lesson, what are their aims of doing them, i.e. is an experiment good to find out new ways to explain new ideas of the world around them?
- What features of lessons tend to bring out positive attitudes towards science lessons?
- How do pupils relate science to their everyday lives and future careers?
- Are there any differences in how girls and boys feel about science?

The case study (see Appendix 2a for details) was used to give the researcher more information on pupils' attitudes towards science at school. The methods that the Yr 10 girl case study used were interview and diary.

In the interview, in the first instance the researcher's aim was to gather factual information about the case study such as likes, subjects studied for GCSE and then lead this on to have some of the individual's opinions on activities/teaching /learning strategies in the classroom as well as enquiring into what motivates the individual to learn (Drever, 1997). At the beginning of the interview the individual was reminded of why and what the interview is about (Drever, op.cit.). The final question was an open question in case she had something else that she wanted to add to the discussion (Drever, op. cit.).

One benefit of using a case study was that the individual gave her honest opinion of a particular social situation, was down-to-earth and linked her ideas to her natural experience (Adelman et al., 1980). The pupil in the case study was a mature girl for her age who gave serious and well thought-out answers. However, some pupils may not have found it so easy to be honest and may have agreed with the teacher or still not feel that they could be completely open on a topic so as not to offend the interviewer. Any bias towards science lessons could be due to her receiving this attention from the researcher, but it also helped the researcher, as the pupil knew the researcher quite well, and trusted that she could be honest. When leaving the school after her A Levels, the pupil did say to the researcher how much playing a part in the research helped her to understand herself in her learning and how she felt it motivated her and that she didn't think she would have achieved as well as she did had she not played a part in it (Full details of the interview and diary findings are in Appendix 2b).

The main conclusions from the three interviews are:

- She has enjoyed experiments in science lessons;
- She has enjoyed having her friend in her science lessons;
- She has found the work 'boring' that she had studied earlier in the school;
- She enjoyed a topic when she understood it;
- She has watched wildlife programmes on television;
- She enjoys topics in science that she is interested in such as human-based biology;
- She was very pleased with her examination result;
- She liked to see the relevance of what she was studying in her everyday life.

The main conclusions from the diary are:

- When she has been concentrating in lessons she has understood the work;
- She has been frustrated if she has not grasped a concept straight away;
- She could remember practicals, demonstrations and videos from the lessons as well as note taking;
- She has remembered demonstrations from lessons and activities that she has found enjoyable (teachers need to be dramatic!);
- She has understood things very well if they were topics previously

studied;

- She has found things that she would use in her everyday life useful but other parts not (only use was her GCSE examination!);
- She would like to follow a career in languages as she has seen the relevance of them in her life.

The individual participating as the case study provided useful information about enjoying practicals in lessons and how she could remember them so they were a good learning aid. Leisure interests in science do not mean the same necessarily to the pupil as they do to the researcher. Watching a wildlife programme is not considered to be watching something relating to science. A future career would be based on seeing the relevance of a subject in their everyday life and finding it interesting.

When considering the reliability of this type of information where it is judgemental and open to interpretation by the researcher, it is also important to remember that these are comments from one pupil in a particular school; another pupil would give a different opinion. More conclusive information could have been received if a boy had also been used and if other pupils in another school had been used. However, the results are a starting point for further investigation throughout the main study. The main reason that no more case studies were used was due to the time element. Interviewing pupils is time-consuming and difficult to organise within the researcher's and the pupil's school day.

In addition for the pilot study a pre- and post- TOSRA test was administered to a Yr 7 and Yr 9 group. The pre test took place in January 2003 and the post test in May 2003. A second post-test was also given out to Yr 7 to compare answers given when the questions were phrased differently (See Appendix 3 for pre and post TOSRA Test by Nix and Ledbetter and Appendix 4 for post TOSRA Test by Turner).

Questions that were omitted from the initial Ledbetter and Nix (2002) questionnaire were sorted via looking at the means for both year groups that were less than 3.5 and combining similar questions. For example, in the pre TOSRA test low means were common in questions 22, 23, 33 and 34 in both year groups so these were omitted. However, caution was taken due to this actually being pupils' true reflection of their attitude, and the low means being a true representation of their attitude. In the revised questionnaire, there will still be 3 questions in each theme, so if this is a true reflection, if should still be apparent but it will iron out the concern of whether it was due to the wording of the question. Combining questions such as questions 24 and 31 (from 'I would rather agree with other people than do an experiment to find out the information for myself' and 'I would rather do my own experiment than find out information from instructors' became 'I would rather do an experiment and reach a conclusion myself than just agree with other people' and 28 and 35 (from 'Working in a science laboratory would be an interesting way to earn a living' and 'a career in science would be dull and boring' became 'I would like to work in a science laboratory'.

The post TOSRA tests by Ledbetter and Nix, (2002), and Turner (2003), were compared. Theoretically there should be close relationships between them as they were undertaken within two weeks of each other by the same pupils. Turner's questionnaire was written with the questions worded so that a positive response was strongly agree and therefore would score five. This should be easier for the pupils to understand and therefore easier for them to think if they agree or disagree a certain statement without the wording of the question adding to the difficulty of the topic in question.

The results of the new post TOSRA Test where the questions were all worded positively so a positive response always scored 5, showed that the means in each themes were lower than the previous test (except in theme 7). This could suggest that these are the true attitudes and they are in fact lower than the first set of results, or that it was harder? Some of the pupils who participated in this questionnaire were a bit 'fed up' of answering the same questions again so this could be a factor. The researcher spoke to a small group of these pupils and their comments were:

- The second questionnaire was easier to understand;
- Some of the words were difficult;
- Some of the statements they couldn't agree or disagree with;
- The font was too small;
- Too much information on one page.

More work needs to be done on improving this questionnaire; it is repetitive and therefore it would be worthwhile to eliminate some questions as there were too many questions for the younger age group. Too many questions, as in this instance, could allow pupils to lose concentration before they have finished which will obviously affect the results. In the first instance, 21 questions written in the positive form will be the first change and subsequent changes were made after analysis of those results.

Other critical questions that arose that needed to be taken into consideration from the pilot study were the layout of the questionnaire. The gender boxes at the top were confusing so they needed to be made clearer. Oppenheim (1992) proposes that a poorly worded question will produce a narrow range of responses. From the TOSRA questionnaire, one could look at the number of responses in the 'not sure' column. This could have been ticked for two reasons: they are genuinely not sure about the answer to give or because they do not understand the question. Rewriting the questions in the positive form reduced this as the average was higher for the majority of themes. The pre-test must also be written in the positive form. The preliminary work only showed findings for a select sample: pupils in an independent school. In order to obtain results from a wider spectrum of the population, the main study also incorporated questionnaires being sent to state schools as well.

The font is small on the questionnaires therefore if the repetitive questions are eliminated, the font could be bigger; this would be beneficial for younger children. One problem with eliminating questions does remove the confidence that could be obtained if similar answers were given to questions in the same theme. However, care was taken on which questions were removed and some questions were merged together. The coloured paper was used simply as an administration aid; the yellow for the pre-test and blue for the post-test. The researcher hoped that this would help the reading of the questions as during some training, yellow paper was advised as useful for pupils with dyslexia and blue paper was good for poor lighting. This will be used again in the main study.

In summary, the pilot study used a variety of methodologies to answer some questions about pupils' attitudes towards science. Some of the methodologies highlighted a need for change for example in the questionnaire. Interviews and diaries helped give more detailed information on pupils' attitudes and deeper understanding of what they comprehend about science in different areas such as career or social implications. Therefore the main learning points from the pilot study were:

- Some pupils can find practicals a useful learning tool, however, they can be less confident about explaining their findings;
- Features of lessons that pupils like are: consistency in teacher, being with their friends and variety;
- Pupils do not necessarily classify watching wildlife programmes as a scientific past-time;
- In the TOSRA test, girls have higher mean values in the pre and post test in themes 1,2,4,5,6 and 7 (Yr 7);
- In the TOSRA test, girls have higher mean values in the pre and post test in themes 1, 2, 4, 5, 6 and 7 (Yr 9).
- For Yr 7 pupils the themes, in both the pre and post TOSRA Test,

with means greater than 3, implying a positive attitude are: themes 3,1,2,4 and 5;

- For Yr 9 pupils the themes, in both the pre and post TOSRA test, with means greater than 3, implying a positive attitude are: themes 2,3,1 and 4.

Therefore, considerations for the main study are that what answers the pupils provide are not necessarily what the researcher expected due to her teaching experience; girls appear to have a more positive approach to science than boys, their enjoyment has many factors attached to it and some of these relate to the circumstances of the nature of the setting. However, there are some positive attitudes towards science in this pilot study, perhaps confirming that attitude is a complicated and difficult term to use and explore, even with the help of Klopfer's themes to break it down.

3.3.2. Main Study

Research questions:

- How do pupils feel about the activities undertaken in school science lessons?
- When do pupils' attitudes towards science tend to be fixed? Primary school? Secondary school?
- What affects a pupil's attitude? Parents? Teachers? Friends? Media?
- Are there some of Klopfer's themes that are positive and others negative in each age group and for each gender?

- Which of Klopfer's themes are a concern to society reflecting a decline in pupils displaying a positive attitude towards science and hence not taking up a scientific career?

In the first year of the main study (referred to as Yr 2), the Turner (2003) TOSRA questionnaire was given to Yr 6, 7 and 9 classes at two different primary and secondary schools, one independent and one state school for each (see Appendix 4).

After the first year of the main study, the TOSRA questionnaire was scrutinised for improvement (see Appendix 5 for final questionnaire for Yr 3 work). The basis for improvement was based on the responses that year. For example, if not all questions were answered, perhaps fewer would be used, or if a particular question received a lot of '3' responses, then the wording or question would be changed. Some similar questions in a theme were combined to eliminate a question and reduce repetition for example question 7 'I would like a job as a scientist' was omitted and simply 'I would like to work with people who make discoveries in science' and 'I would like to work in a scientific laboratory finding out new things' were the two questions in theme 7. If the responses do not give significant change or is not producing the information needed, it was redesigned, for example by having fewer questions, or by adding in questions of a ranking nature, but some longer responses maybe as well. In order for triangulation, the questionnaire was given to the same year groups a second year.

The questionnaire was the main method of collecting data in the first and second year so it was monitored with care. However, it appeared that the work need to be addressed for a younger audience therefore a new assessment tool, a group activity, was introduced in the third year. This was aimed at Yr 2 pupils and it had a question addressing each of the Klopfer themes. From speaking to primary school teachers, it was decided that the pupils would work together on the activity in pairs and chose their picture responses to the questions and placed them in a smiley face, unhappy face or not sure face. This would aim to make the pupils feel more at ease when participating in the research with someone whom they do not know. The teacher's were offered the choice of choosing pairs for the researcher, either based on ability/confidence but not on friendships (as this may influence a child's responses) so that the pupils had a 'known' face with them during the activity, and one that may 'help' them with words or speaking to a stranger, but could also give their true opinion. Six schools participated in this activity.

The TOSRA questionnaire was also amended in the third year to have only two questions in each of Klopfer's themes giving a total of 14 and also had some questions on their school subjects. Pupils had to rank their favourite subjects from a selection of five given and give their favourite activities in lessons (see Appendix 5).

A questionnaire was also designed to send to teachers to complete in order to find out their attitudes towards science teaching and whether this affected how they portrayed science at school. (See Appendix 6 for questionnaire sent to teachers).

The Yr 6 and Yr 7 pupils and the transition period they undergo were also monitored with care, in particular how their attitudes towards their subjects changed (see Appendix 7 for questionnaire and Appendix 8 interview with Yr 7). Observation of Yr 6 lessons were also undertaken to give the researcher further knowledge of the capabilities of the pupils in that age group (see Appendix 9 for lesson observation notes).

A summary of the Main Study work went as follows:

- ✓ Yr 2 – questionnaire to Yr 6, 7, 9 (21 questions)
- ✓ Yr 3 – questionnaire (amended) to Yr 6, 7, 9; Yr 2 group activity; teacher questionnaire; Yr 6-7 Transition Period monitored.

In summary, this chapter has highlighted the different methodologies that could be used in the study, detailed methodologies of those chosen to use in the study, an outline of the statistical analysis to be used, questions and conclusions from the pilot study and an outline of the main study.

Chapter 4

4.1 Analysis of Data – Introduction

Largely the final analysis will be based upon the final year 'main study' results (Yr 3 – Turner TOSRA Test) with previous material included where appropriate (Yr 2 work using TOSRA questionnaires based on Turner adapted Ledbetter and Nix (2002) and the Pilot Study based on Ledbetter and Nix (2002)).

It will follow in this format:

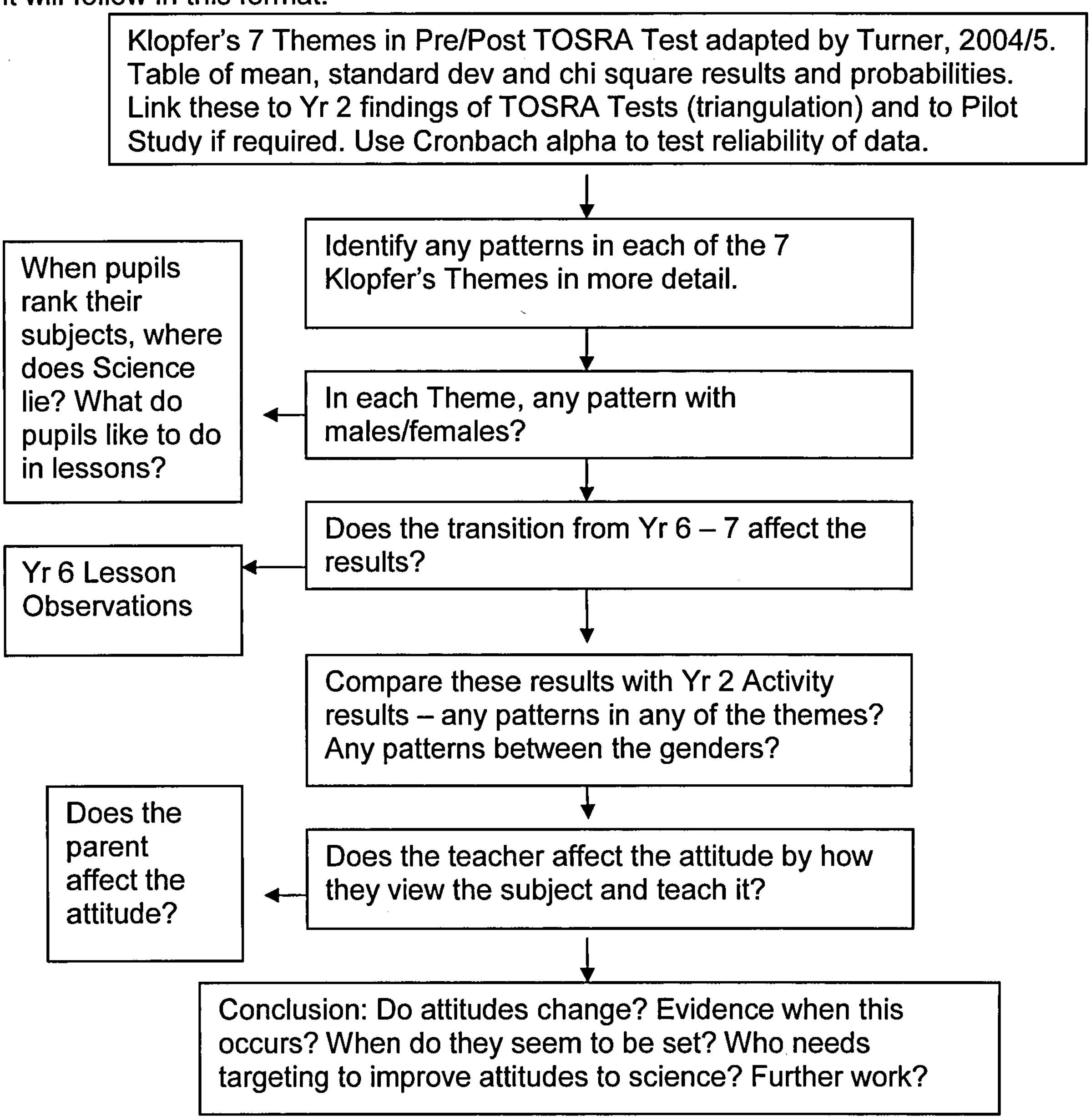


Figure 4.1.1: A Flow Diagram showing the order of the Analysis.

Chapter Outline

Introduction

The TOSRA Test provides a ranking based on a Likert Scale of pupils' attitudes towards science and so this will be analysed first. With the results being numbered in a ranking system, the means and standard deviations were taken and compared for each year group and pre and post test. The reasons why these statistics were chosen is commented on in the methodology section.

When comparing means and standard deviations it is useful to point out the following:

- TOSRA answers have been ranked in the following way:

Choice of Answer to Question	Score
Strongly Agree	5
Agree	4
Not Sure	3
Disagree	2
Strongly Disagree	1

Table 4.1.1: A table showing the Scores for each type of question response.

- Klopfer's 7 Themes are:

Klopfer's Theme Number	Questions relating to the Theme (Final year work)	Klopfer's Theme
1	1 and 8	Social Implications of Science
2	2 and 9	Normality of Scientists
3	3 and 10	Attitude toward Scientific Inquiry
4	4 and 11	Adoption of Scientific Attitude
5	5 and 12	Enjoyment of Science lessons
6	6 and 13	Leisure Interest in Science
7	7 and 14	Career Interest in Science

Table 4.1.2: A table stating Klopfer's 7 Themes.

- A normal distribution curve and how it is related to the standard deviation is explained below in Figure 6.1.2:

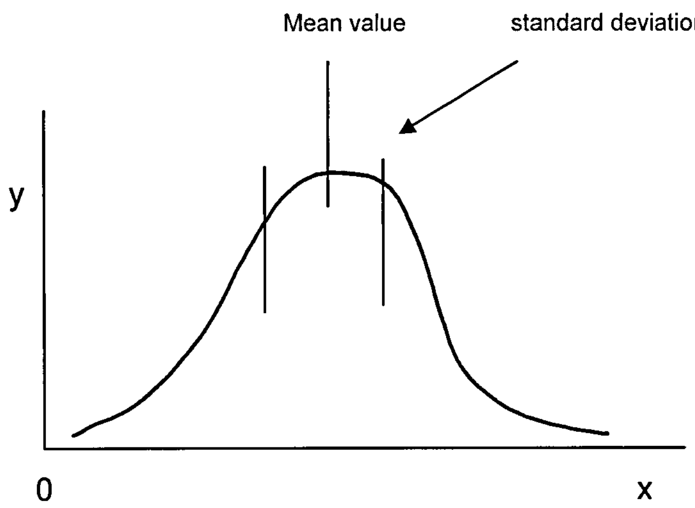


Figure 4.1.2: A normal distribution curve.

For example, mean value of 3.79 and the standard deviation shows the spread around the mean so 3.79 + 1.15 (standard deviation) = 4.94 which would indicate a high positive attitude or 3.79 – 1.15 = 2.64 which, since the number is below 3 would indicate a negative attitude.

On the final study data Cronbach alpha was used to test the reliability of the data.

> *'The Cronbach Alpha provides a coefficient of inter-item correlations, that is, the correlation of each item with the sum of all the other relevant items and is useful for multi-item scales' (Cohen et al., 2007, p. 148)*

A score that is higher than 0.7 is considered reliable (Nunnaly, 1978). Cohen et al. (2007) offer some guidelines on the reliability level:

- >0.90 very highly reliable
- 0.80-0.90 highly reliable
- 0.70-0.79 reliable
- 0.60-0.69 marginally reliable
- <0.60 unacceptably low reliability (Cohen et al., 2007, p. 506)

The Cronbach alpha was found using the Statistical Package for Social Sciences (SPSS 14.0). This was used as it compared all combinations of the data.

School	Year Group	Cronbach Alpha Score	Reliability
D	6	0.805	Highly reliable
A	6	0.809	Highly reliable
B	7	0.829	Highly reliable
C	7	0.834	Highly reliable
B	9	0.815	Highly reliable
C	9	0.779	Reliable

Table 4.1.3: A table showing each school and the Cronbach Alpha score.

4.2. TOSRA TEST ANALYSIS: Yr 3 (Final Year Results)

	Qu	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Yr 6	$\bar{x}$	3.80	2.99	4.32	3.84	3.46	2.63	2.79	3.11	3.58	3.84	3.64	2.78	3.14	2.33
	s.d.	0.73	0.90	0.85	0.75	1.25	1.33	1.17	1.25	1.08	1.10	1.04	1.39	1.36	1.33
Yr 7	$\bar{x}$	3.79	3.18	4.29	3.48	3.40	2.39	2.90	3.05	3.68	3.82	3.82	3.13	2.71	2.81
	s.d.	0.85	1.08	1.10	1.07	1.17	1.25	1.12	1.11	1.17	1.33	0.93	1.34	1.34	1.28
Yr 9	$\bar{x}$	3.75	3.03	3.01	3.64	4.25	3.89	3.62	3.73	2.88	2.60	1.88	2.43	2.64	2.36
	s.d.	0.71	1.01	0.92	0.90	1.13	0.93	1.13	1.05	0.98	1.09	0.86	1.24	1.26	1.09

Table 4.2.1: Results table for Yr 6, 7 and 9 of means and standard deviations for each of the questions in the Turner Pre TOSRA questionnaire.

Year Group	Total Number of Pupils
6	103
7	164
9	156

Table 4.2.2. Total number of pupils in the Pre Test for each Year Group.

Post TOSRA Test

	Qu	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Yr 6	$\bar{x}$	3.55	3.78	3.92	3.18	3.65	2.28	1.77	3.64	3.63	3.89	3.44	3.06	2.08	2.82
	s.d.	0.70	1.08	1.16	1.18	1.02	1.18	0.98	1.09	0.87	1.04	1.12	1.01	1.10	1.33
Yr 7	$\bar{x}$	3.45	3.36	3.98	3.79	4.06	3.60	2.59	3.54	3.26	3.12	1.99	1.84	1.86	2.62
	s.d.	0.94	1.17	1.16	1.15	1.06	1.01	0.94	1.07	1.03	1.19	1.13	1.09	0.99	1.17
Yr 9	$\bar{x}$	3.92	3.68	4.11	3.79	3.86	3.64	3.02	3.87	3.51	3.09	2.17	2.03	1.80	2.59
	s.d.	0.79	1.02	1.17	1.15	0.98	1.08	0.92	1.08	0.89	1.00	0.94	0.97	1.09	1.14

Table 4.2.3: Results table for Yr 6, 7 and 9 of means and standard deviations for each of the questions in the Turner Post TOSRA questionnaire.

Year Group	Total Number of Pupils
6	100
7	162
9	168

Table 4.2.4: Total number of Pupils in each Year Group for the Post Test.

Year Group	Theme 1	2	3	4	5	6	7
6	3.46	3.30	4.08	3.74	3.12	2.89	2.56
7	3.42	3.43	4.06	3.65	3.27	2.55	2.86
9	3.74	2.96	2.81	2.76	3.34	3.27	2.99

Table 4.2.5: Results table for Yr 6, 7 and 9 Turner Pre TOSRA questionnaire showing the means for each of Klopfer's Themes.

Year Group	Theme 1	2	3	4	5	6	7
6	3.60	3.71	3.91	3.31	3.36	2.18	2.30
7	3.50	3.31	3.55	2.89	2.95	2.73	2.61
9	3.90	3.60	3.60	2.98	2.95	2.72	2.81

Table 4.2.6: Results table for Yr 6, 7 and 9 Turner Post TOSRA questionnaire showing the means for each of Klopfer's Themes.

These tables will be used when comparing with results from earlier work.

The analysis of the means and standard deviations will be addressed by looking at the questions in each of Klopfer's themes, firstly the Turner Pre TOSRA Test and then the Post TOSRA Test. Then the overall mean for each of the themes will be addressed.

Klopfer's Theme 1: Social Implications of Science

In the Turner Pre TOSRA Test in question 1 all three year groups have similar means and standard deviations. If the standard deviation was added to all three means, the value would be over 4 and this relates to agree so gives a positive attitude (see Cohen and Holliday (1983) for further details on practical application of the normal probability curve). If the standard deviation was subtracted from the mean for year groups 6 and 9, the value would still be above 3 showing pupils are not sure, but generally a positive attitude. In question 8, there was more variation which would not be expected since the questions are in the same theme. Years 6 and 7 were similar but much lower than Year 9. However, Year 6 had a very high standard deviation showing a significant number of pupils did score this question highly. Mean values over 3 are classed as a positive attitude.

In the Turner Post TOSRA Test in question 1, Years 6 and 7 had similar means but Year 9 had a higher mean showing that this age group are more aware of the social implications of science. Question 8 all had quite similar means over 3 but also high standard deviations showing both a positive and negative feel to this theme from the spread of data.

Overall, in both the pre and post TOSRA test the means in each age group for each theme are very similar (Pre Test 3.46, 3.42 and 3.74 and Post Test 3.60, 3.50 and 3.90). This shows that there is a positive attitude towards the social implications of science because all of the means are greater than 3. Pupils' attitudes towards this in these age groups are reasonably stable over a period of time shown as there is not a great deal of change in the pre and post test.

Klopfer's Theme 2: Normality of Scientists

In the Turner Pre TOSRA test in question 2, the means are above 3 for Yrs 7 and 9, however, below for Yr 6 (2.99). There are quite high standard deviations showing a spread in the data. Question 9 in the same theme showed years 6 and 7 having high means of 3.58 and 3.68 respectively but also high standard deviations showing there are a large number of pupils still scoring it highly but a large number scoring it rather low. Yr 9 has a lower mean than 3 suggesting a negative attitude and a low standard deviation (less than 1) compared to the other year groups.

In the Turner Post TOSRA test in question 2, the means were in the 3's, the highest being in Year 6, which is a change from the pre test. All age groups had standard deviations above 1 showing there is a large number of pupils either side of the mean. Question 9 showed Year 6 with the highest mean but Yr 7 with the lowest, again showing that the younger pupils think scientists are normal.

This theme relates to the normality of scientists and the older pupils question this as younger pupils think scientists are normal, however, an idea has intervened into their lives by Yr 9 for the mean to drop. However, the means for the overall theme are rather different for Yr 9 pre and post test in this theme so this could be due to the question and either misunderstanding it or having a stronger view on one of the questions. At the beginning of Yr 9, from the author's experience pupils can be rather awkward, trendy or opinionated. However, this adolescent feature tends to be grown out of during the year and perhaps this is shown in the results. Yr 9 negativities could also be due to eccentric secondary school teachers or programmes they have seen on the television giving a more extreme view of what it is to be a scientist. Younger pupils may not watch such television programmes and are only exposed to their primary teacher (Yr 6) or unsure of new teachers at secondary school for Yr 7.

The means for this theme are greater than 3 in Yrs 6 and 7 but below in Yr 9 in the Pre TOSRA test for this theme. However, in the Post TOSRA test all of the means are above 3 for each age group with Yr 7 being the lowest mean. Over time, the Yr 9 pupils' attitudes towards the normality of scientists have improved. This overall, gives a positive feel to the question of pupils feeling that scientists are normal.

Klopfer's Theme 3: Attitude towards Scientific Inquiry

In the Turner Pre TOSRA Test in question 3, both Year 6 and 7 have high means (above 4 – 4.32 and 4.29 respectively) and if the standard deviation is added to the mean, the value is above what the scale is (1 – 5) so giving a very positive extreme to the theme of attitude towards scientific inquiry. Year 9 mean (just above 3) is not quite so high even with adding on the standard deviation. This could show that pupils are less interested in trying things out for themselves at this age or due to repetition of classroom work and so tasks of this nature are not as enjoyable to pupils. Within schools, there may be pupils who are less interested in independent learning and prefer to be taught rather than find out for themselves. Other year groups could be quite different to this. In the same themed question, number 10, the same trend is observed; a higher mean (3.84 and 3.82 Yr 6 and 7 respectively) and standard deviation and a lower mean (2.66) for Year 9, although there is a high standard deviation (although not as high as that for Yrs 6 and 7) showing there is a spread in what pupils are saying.

In the Turner Post TOSRA Test in question 3, very high means (3.92, 3.98 and 4.11) in all age groups and adding on the standard deviations in all cases gives values over 5 so a very positive feel to scientific inquiry. On the other extreme, subtracting the standard deviation shows there is a number of pupils in disagreement. Interestingly in the post test, Yr 9 had the highest mean value. Question 10 was also high for Year 6 but not quite so high for Years 7 and 9 (just above 3). Adding on standard deviations to the mean in both cases gives a value around 4 so for some pupils quite positive for this theme, but also subtracting the standard deviation some pupils are in disagreement.

The overall means in the theme in the Pre TOSRA Test are high (over 4) for Yr 6 and 7, showing a positive attitude for the younger year groups, but low for Yr 9 (less than 3). However, in the Post TOSRA test all of the means are above 3, with Yr 9 being much higher than the Pre Test, showing a positive feel to this theme.

Klopfer's Theme 4: Adoption of Scientific Attitude

The Turner Pre TOSRA Test has Question 4 showing the means in the 3's and Year 6 is the highest, then Year 9 and then Year 7. However, adding on each of the standard deviations gives around 4.5 for all three year groups so giving quite a positive feel to pupils' attitude towards them adopting a scientific attitude. However, subtracting the standard deviation shows for Yr 6 the value is still above 3, however, for Yrs 7 and 9, the value is below 3 so a negative attitude. The curiosity factor is still there for many pupils. This is encouraging for teachers to see. In question 11 within this theme, Year 7 have the highest mean and Year 9 have a very low mean (1.88) stating a negative attitude. In this year of choosing GCSEs, some pupils in this age group are not interested in finding things out about the world in which they live for themselves. This could be seen as a hard skill and the independent work required may not be in line with their level of ability, their learning or simply lack of confidence.

Interestingly in the Turner Post TOSRA test in question 4, Years 7 and 9 are the same both in means and standard deviations. Year 6 was a bit lower perhaps because this age group are less exposed to scientific attitudes and thinking through for themselves. In comparison in the same theme, question 11 is lower for Years 7and 9 (1.99 and 2.17 respectively) and higher for Year 6 relating to Year 6's being more curious in the world around them. From lesson observations, Yr 6 pupils are inquisitive; love to ask questions and to experiment with not as much fear of not knowing the 'correct' answer than from that author's experience of teaching Yr 9 pupils.

The overall means for theme 4 for the Pre TOSRA test are high (above 3) for Yrs 6 and 7 and low for Yr 9 (less than 3). In the Post TOSRA test only Yr 6 has a mean greater than 3. This does not show a stable attitude over time and shows that as the pupils get older, they do not display a positive attitude towards adopting a scientific attitude themselves.

Klopfer's Theme 5: Enjoyment of Science Lessons

In questions 5 and 12 of both the Pre and Post Turner TOSRA Test the enjoyment of pupils' science lessons are investigated. It is reassuring and encouraging that Yr 9 has the highest mean in question 5, with a value of over 4, of the Pre TOSRA Test despite what other questions have shown! With adding on the standard deviation, the value is over 5 which is suggesting a very positive attitude! Subtracting the standard deviation also gives a value over 3. Yrs 6 and 7 have means around 3.4 whereas Yr 9's mean is 4.25. However, Yr 6 has a very high standard deviation showing a large number of pupils have scored this highly and do enjoy their science lessons but with also a large number who do not enjoy their science lessons. Having observed many Yr 6 lessons, this is apparent! A large number of pupils asked intelligent questions, enjoyed their simple experiments and writing about them. Yr 7 is, at one school, when science is studied separately as biology, chemistry and physics with different teachers so this could have an impact on this age group. Some pupils might like one of the sciences more than another or like one of the teachers more than another. These observations and transition issues will be dealt with in more detail. In question 12, the responses are less convincing with Year 7 scoring the highest mean just above 3. However, all three of the standard deviations are very high which could give 4's for Year 6 and 7 but still only 3's for Year 9 and therefore showing that a negative response is quite apparent amongst the pupils with them now enjoying their science lessons.

In the Turner Post TOSRA Test in question 5, the most positive result was for Yr 7 and adding on the standard deviation gives a value over 5 so very much this year group enjoy science lessons and know they relate to their everyday life. Subtracting the standard deviation still gives a value of about 3 so a positive attitude can be stated. Yrs 6 and 9 were quite high means also. However, in contrast, question 12 shows Yr 7 having the lowest mean (1.84) and a high standard deviation showing a spread in responses (however this still does not give a value of 3 so a negative attitude indicated) but Yr 6 and especially Yr 9, having lower means showing that these pupils have not found the material in science lessons interesting. This could be an area for further work to incorporate a more exciting curriculum. Yr 6 and Year 9 are SATs years so repetition may be a factor for consideration here.

The overall means in theme 5 in the Pre TOSRA test are all above 3 for each age group showing a positive attitude to enjoying science lessons. However, only Yr 6 maintains this enjoyment in the Post TOSRA test and is above 3, whereas both Yr 7 and 9 are below 3. Therefore, this suggests that throughout the academic year, the enjoyment factor has changed for these year groups.

Klopfer's Theme 6: Leisure Interest in Science

In the Turner Pre TOSRA Test in question 6, Yrs 6 and 7 have low means in the 2's but Yr 9 has a much higher mean of 3.89. Despite high standard deviations, this shows a less positive feel to pupils' leisure interest in science by the younger age groups. Year 9 is interesting being the highest here but perhaps this year group does show pupils becoming more individual and confident to stand up for what they think and like as they go through adolescence. Many have started thinking about career aspirations or studying sciences for GCSE. Many television programmes or developing interest in areas of science such as astronomy aid the leisure interest in science. Question 13 shows an opposite relationship – Years 6 and 7 have the highest means and they are higher than the means in question 6 and Year 9 is a much lower mean. Each year group does show a very high standard deviation showing some pupils to have a positive attitude and others that do not.

In the post TOSRA Test in question 6, the lowest mean was in Yr 6 (less than 3) and Yr 9 is the highest mean and this is good to see that this age group enjoy science-based activities in their leisure time. Perhaps Yr 6 are not that familiar or associate some of their activities as 'science-based'. Question 13 shows a similar trend with Yr 9 just below the mean of Yr 7. However, all of the means are less than 3 giving a negative response.

Overall, the means in theme 6 are below 3 (with the exception of Yr 9 in the Pre TOSRA Test) in both the Pre and Post TOSRA tests showing that there is not a positive attitude to pupils' leisure attitudes towards science.

Klopfer's Theme 7: Career Interest in Science

The Turner Pre TOSRA test shows that in question 7, Yrs 6 and 7 have lower means than 3 and lower than that of Yr 9, whilst all of them do have high standard deviations showing a definite spread in responses. This shows that there are a number of pupils who do have a positive interest in a career in science but also a number that do not. Again, pupils in Yr 9 are considering their careers so hence the reason perhaps for the higher mean in this year group. Question 14 shows all of the mean values in the 2's with Yr 7 having the highest mean. However, there are high standard deviations showing a spread of responses.

Career-based questions show quite low means in both questions 7 and 14 of the Turner Post TOSRA test, with the exception of Yr 9 in question 7 which has a mean of 3.02. Yr 6 pupils may not have considered their career yet but Yr 9 should have as they would be choosing their GCSEs. The high standard deviations show that there is a spread in responses from pupils and if adding on the standard deviations gives values around 3, shows that some pupils haven't over-ruled the idea of science yet and are still unsure or that some pupils want to pursue a career in science. Looking into gender issues here would be useful to see if either boys or girls are more interested in a scientific career.

Overall the means in theme 7 for the Pre and Post TOSRA tests are below 3 showing that there is not a positive attitude towards careers in science. The highest means are in Yr 9, however, which is the year group which have had to start properly considering their options for their careers. Maybe more careers in science need to be promoted in science lessons from a younger age so that pupils are more aware of what is considered 'scientific' and also those careers which are not as well known.

Other considerations

As stated throughout this analysis, it would be expected that there would be a similar distribution of responses for the same theme. This has not always been the case. This shows the wording of questions could be misunderstood or that there are many factors within a theme that need to be considered for a fuller answer.

Taking the top four means from each year group, the following shows us clearly which questions scored highly and then doing the opposite, taking the bottom four means in both the Pre and Post TOSRA Test.

Year Group	Questions with the Highest Means
6	1, 3, 4 and 10
7	1, 3, 10, 11
9	1, 5, 6 and 8

Table 4.2.7: Table showing the 4 Questions in each Year Group with the Highest Means in the Turner Pre TOSRA Test.

Both Yrs 6 and 7 have the highest means in questions 3 and 10 which both fall in theme 3. All three year groups have question 1 with a high mean giving strong evidence that pupils do know the social implications of science, but only Yr 9 has also question 8 within it (which links both questions to the same theme). Year 6 having question 4 and Year 7 having question 11 (both questions in theme 4) show some strength in evidence for attitude towards adopting a scientific attitude. Interestingly, Year 9 have the greatest difference in means and show highest means in enjoyment of science lessons and their leisure interest in science.

Year Group	Questions with the Lowest Means
6	6, 7, 12 and 14
7	6, 7, 13 and 14
9	10, 11,12 and 14

Table 4.2.8: Table showing the 4 Questions in each Year Group with the Lowest Means in the Turner Pre TOSRA Test.

Year 7 shows that the lowest means occur in two of the themes: theme 6 - leisure interest in science and theme 7 - career interest in science. Year 9 has one of its lowest means in the same theme as one of its highest means (question 12 – enjoyment of science lessons) suggesting not so strongly this is how pupils feel. Year 6 have two low means in theme 7 and then in themes 5 and 6.

Year Group	Questions with the Highest Means
6	2, 3, 5 and 10
7	3, 4, 5 and 6
9	1, 3, 5 and 8

Table 4.2.9: Table showing the 4 Questions with the Highest Means in the Turner Post TOSRA Test.

All year groups had the highest mean in question 3 – scientific inquiry (theme 3). Year 6 had both questions in this theme scoring highly. Once again, Year 9 had both questions in the theme relating to social implications of science with high means. Year 7 had no patterns in highest means.

Year Group	Questions with the Lowest Means
6	6, 7, 13 and 14
7	7, 11, 12 and 13
9	11, 12, 13 and 14

Table 4.2.10: Table showing the 4 Questions with the Lowest Means in the Turner Post TOSRA Test.

Yr 6 had questions in themes regarding leisure interest and career interest with the lowest means. Yr 7 again had no pattern with the themes with the lowest means and neither did Yr 9. However, all year groups had question 13 with a low mean, perhaps due to listening to radio articles is not perceived as 'cool' to do. Yr 7 and 9 also show poor attitudes to the material covered in science lessons. Careers in science are evident with low means in each year group.

In conclusion of these results, the top three themes with the highest pre-test means are:

- **Theme 3** – Attitude toward scientific inquiry
- **Theme 1** – Social implications of science
- **Theme 4** – Adoption of scientific attitude

In the post test, the top three themes are:

- **Theme 3** - Attitude toward scientific inquiry
- **Theme 1** – Social implications of science

- **Theme 5** – Enjoyment of science lessons

This proves that pupils do have some positive attitudes towards science, in particular towards scientific inquiry and towards the social implications of science. There is also some interest to adopting scientific attitudes and enjoying science lessons. It is apparent that there is less positive attitude towards pupils' leisure interest towards science, career interest and as to whether scientists are normal.
Theme 4 has surprising results to be here since Yr 9 have a very low mean for question 11 (1.88) hence lowering its mean in the table overall, but the other year groups show rather consistent means for both questions (3.84 and 3.64 Yr 6 and 3.48 and 3.82 Yr 7) in the mean showing a positive attitude for these two year groups.

Theme 5 in the post TOSRA test was also surprising. In question 5 all of the means were in the top 4, however, question 12 in the same theme had two of the lowest means in it so therefore the post TOSRA test would need repeating and the question would need to be reworded in order for a more accurate conclusion to be made.

In summary of this section, the results from the Turner Pre and Post TOSRA Test are:

- Klopfer Theme 1 – Pupils in all age groups display a positive attitude towards the social implications of science.
- Klopfer Theme 2 – Pupils mostly show a positive attitude towards scientists being normal (one low in the pre test for Yr 9).

- Klopfer Theme 3 – Overall pupils show a positive attitude towards scientific inquiry, however, low pre result for Yr 9.
- Klopfer Theme 4 – Pupils do not display a positive attitude towards the adoption of scientific attitude. There is variety in the results with positive attitudes in Yr 6 and 7 in the pre test and only Yr 6 in the post test.
- Klopfer Theme 5 – Pupils show a varied set of results for their enjoyment of science lessons. All of the pre test results showed a positive attitude, however, only the Yr 6 displayed a positive attitude.
- Klopfer Themes 6 and 7 – Pupils in all age groups did not display a positive attitude towards leisure interest in science or career interest in science.

<u>Pre and Post TOSRA Test Results Comparison of Each School</u>

For comparative purposes two schools were used for each year group – an independent school and a state school. In order to confirm results it is necessary to investigate the mean values and see if they are similar between year groups or different. A 0.5 difference in means is the high-lighted number in blue in the tables. This was chosen as it represented a halfway mark between two numbers in my scale of 1 -5.

Sch	Yr	Qu 1	2	3	4	5	6	7
A	6	3.61	2.95	4.18	3.86	3.16	2.11	2.48
D	6	3.93	3.02	4.42	3.82	3.68	3.00	3.02
B	7	3.88	3.33	4.37	3.66	3.60	2.46	2.85
C	7	3.63	2.89	4.14	3.21	3.02	2.27	2.98
B	9	3.83	3.11	4.30	3.66	3.00	1.85	2.62
C	9	3.61	2.84	4.16	3.55	2.66	1.93	2.68
Sch	**Yr**	**Qu 8**	**9**	**10**	**11**	**12**	**13**	**14**
A	6	2.55	3.43	3.39	3.52	2.51	2.81	1.93
D	6	3.52	3.68	4.17	3.73	2.97	3.43	2.62
B	7	3.05	3.91	3.81	4.03	3.32	2.84	2.72
C	7	3.13	3.32	3.93	3.43	2.75	2.45	2.98
B	9	3.14	3.69	3.81	3.79	2.63	2.52	2.40
C	9	2.82	3.54	4.02	3.63	2.54	2.27	2.30

Table 4.2.11: A Table showing the Mean Values for each question for the Turner Pre TOSRA Test for each school.

In the pre test, Yr 6 had differences in themes 6 and 7 (leisure interest and career interest) as well as differences in questions 5, 8 and 10. Yr 7 had some differences in questions 9, 11 and 12 and since this was only one of the questions in each theme, it could be due to understanding the question or varied attitudes. These differences could have arisen due to:

- Different teaching styles within different schools
- Different teachers and their personalities

- Social circumstances
- Influences at home for example careers of parents, television programmes they watch

There are no big differences (0.5 or above) between either school B or C for Yr 9 pupils. This suggests that attitudes within any population are set by this age and are fairly similar – if pupils are interested in science they usually are by this age as they are choosing careers and developing their personalities and individualities. Yr 6 and 7 are clearly still growing up and changing their ideas and thoughts as well as their attitudes to subjects. These pupils could be likely to like one subject one week, depending on their mood and the topic, and like another one the following week, suggesting variability.

Sch	Yr	Qu 1	2	3	4	5	6	7
A	6	3.29	3.67	4.10	2.64	3.12	1.83	1.50
D	6	3.68	3.86	3.80	3.56	4.03	2.63	1.97
B	7	3.45	4.14	3.92	2.54	3.19	1.96	1.78
C	7	3.44	3.65	4.33	2.69	3.39	2.04	2.02
B	9	3.94	4.10	3.78	2.98	3.53	2.13	1.82
C	9	3.87	4.11	4.02	3.11	3.46	2.26	1.78
Sch	**Yr**	**Qu 8**	**9**	**10**	**11**	**12**	**13**	**14**
A	6	3.10	3.67	3.74	3.02	2.74	1.98	2.55
D	6	4.03	3.61	4.00	3.73	3.29	2.15	3.02
B	7	3.41	3.83	3.54	3.64	3.10	1.77	2.50
C	7	3.26	3.70	3.72	3.33	3.17	1.98	2.87
B	9	3.72	3.81	3.50	3.95	3.02	2.11	2.62
C	9	3.59	3.74	3.96	3.70	3.19	1.85	2.54

Table 4.2.12: Mean Values responding to questions in the Turner Post TOSRA Test for each school.

There are fewer differences in the post test than in the pre test. This shows that attitudes between pupils at different schools do have slight differences in their attitudes. Year 6 have differences in two themes (theme 4 - adopting a scientific attitude and theme 5 - enjoyment of science lessons). This is different from the pre test where the main differences were in themes 6 and 7. In both themes 4 and 5, where the big differences lie in the post test, this could be due to the facilities available and teaching styles in the different schools. Questions 6 and 8 are rather different too showing different career interests depending on location and their awareness of social implications. Year 7 and Year 9 have no significant differences (0.5 or greater) at all.

In conclusion, there is, as expected, a small difference in means between schools for each question. This is most apparent in the primary school age, Yr 6. Yr 7 has some slight differences in the pre test means. Yr 9 pupils have no significant differences in either the pre or the post TOSRA test. This suggests that this age group, at any school, the pupils have generally fixed their attitudes towards science.

Bar Charts to represent the Turner Pre and Post TOSRA Test Results

Grouping data together by year group the pre and post TOSRA test can be shown using bar charts. It is visually more obvious which questions scored highly and where there are similarities/differences between the pre and post TOSRA test results.

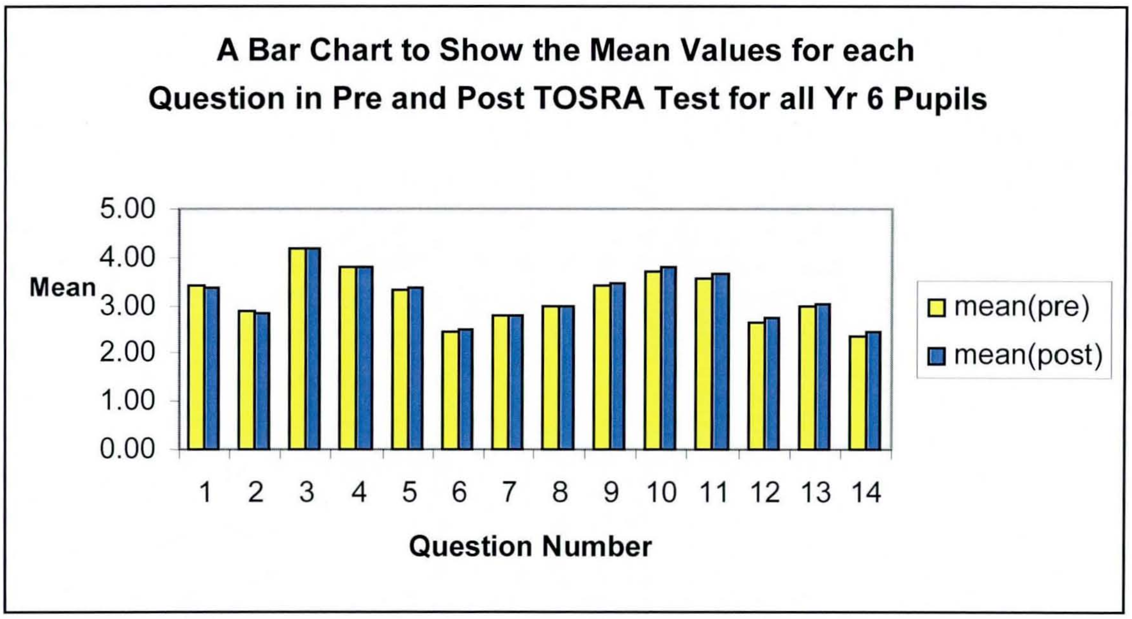


Figure 4.2.1 A Bar Chart showing Mean Values for Yr 6 Pupils for the Pre and Post TOSRA Test.

This bar chart clearly shows that there is little change in each question for the pre and post TOSRA Test and therefore that their attitudes are fixed earlier in their education. Their attitudes have not declined significantly between the pre and post TOSRA test. The most highly scoring question's mean, in both the pre and post TOSRA test, is question 3, in theme 3. The least highly scoring question's mean was number 6 (theme 6).

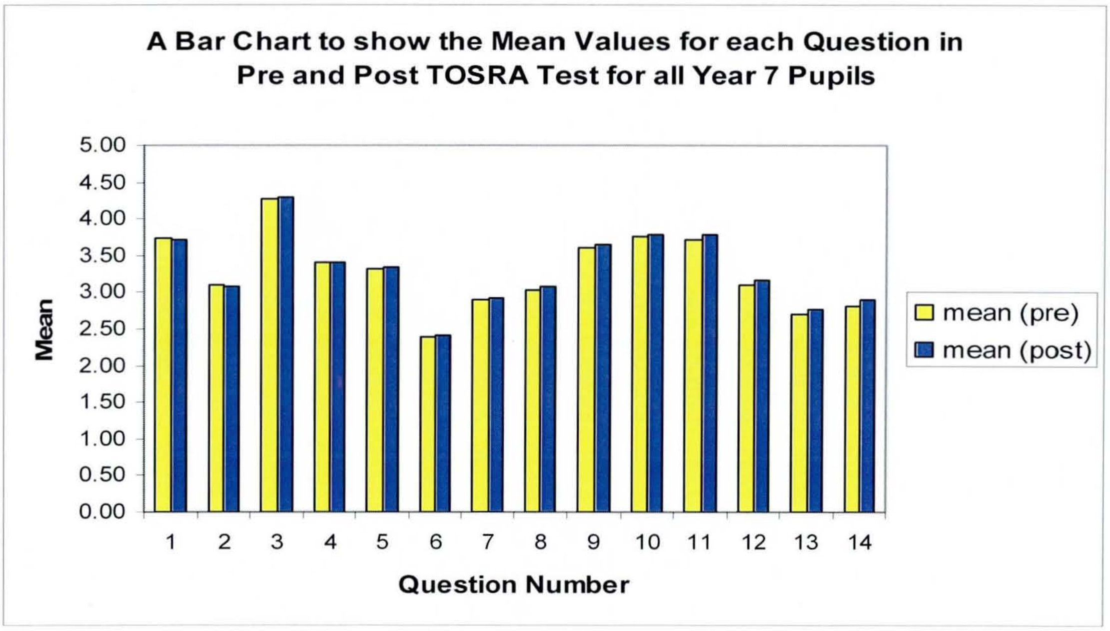


Figure 4.2.2: Bar Chart showing the Mean Values for Yr 7 Pre and Post TOSRA Test.

The bar chart showing the means gives a clear representation that question 3, in theme 3, scored positively and that question 6, in theme 6, scored negatively. The means are generally similar for the pre and post TOSRA test like the Year 6 bar chart and it shows a similar pattern.

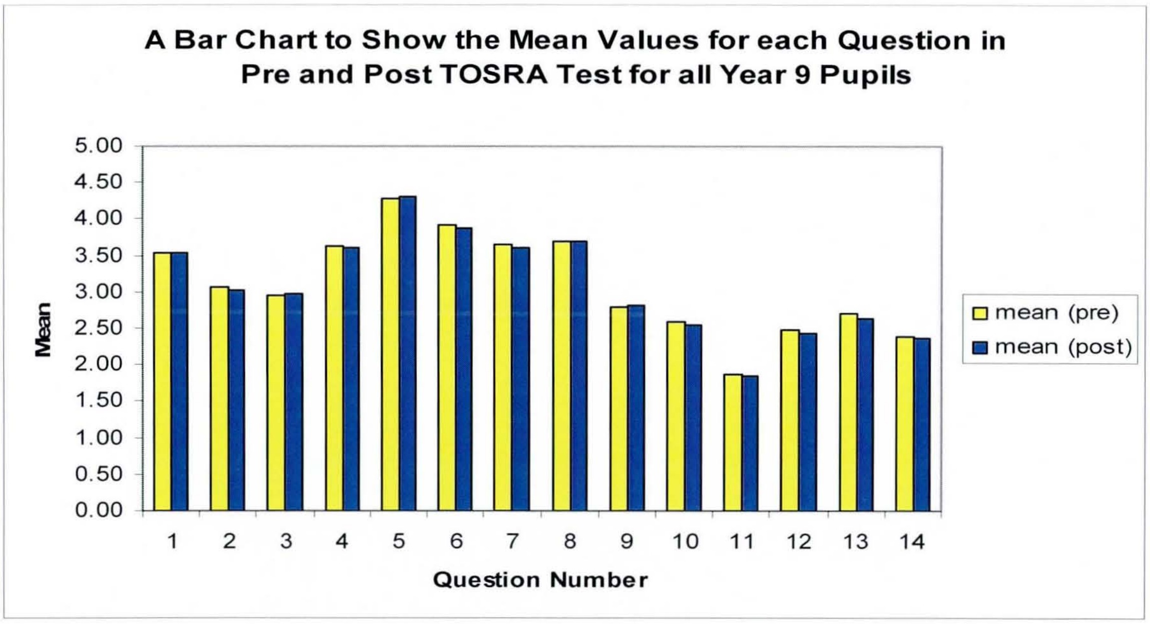


Figure 4.2.3: A Bar Chart showing the Mean Values for all Yr 9 Pupils Pre and Post TOSRA Test.

The bar chart showing the mean values clearly indicate positive attitudes towards questions 5, 6, 1 and 8, whereas question 11 is much lower in both the pre and post TOSRA test.

All of the age groups generally show no difference in pre and post TOSRA test results which are clearly observed by these bar charts.

In summary, this section has analysed the Turner Pre and Post TOSRA test in detail looking into each of Klopfer's themes using means and standard deviations, comparing age groups and schools and using bar charts to show that generally there is no change in the pre and post TOSRA test in pupils' attitudes towards science.

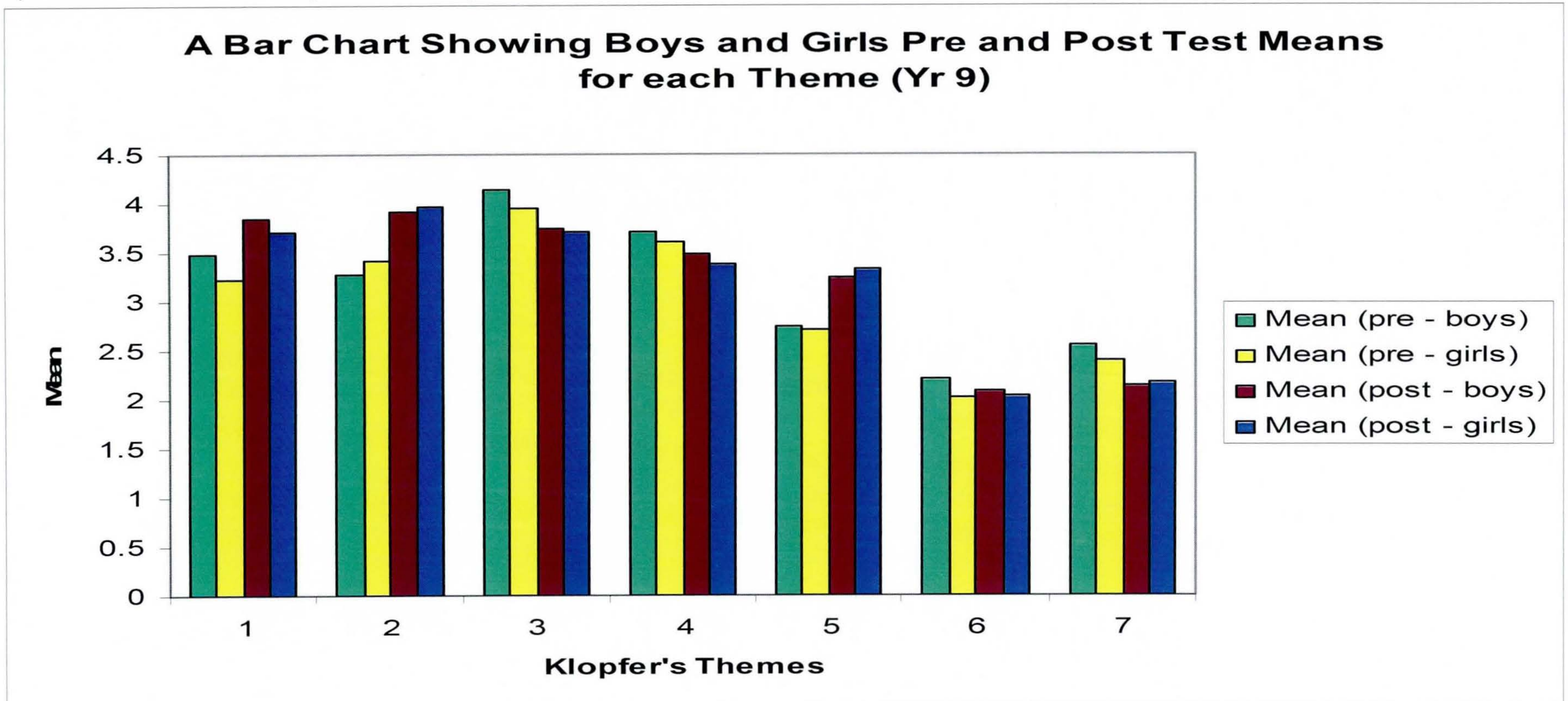


Figure 4.2.4: Gender Comparisons in the Pre and Post TOSRA Test (Yr 9).

In Yr 9, themes 1, 3, 4 and 6 show boys having higher means in both the pre and post test. Theme 2 the girls' means are higher in both pre and post test. Themes 5 and 7 see the boys having higher means in the pre test and girls having higher means in the post test. Overall in Yr 9 pupils, the boys have a more positive attitude towards science.

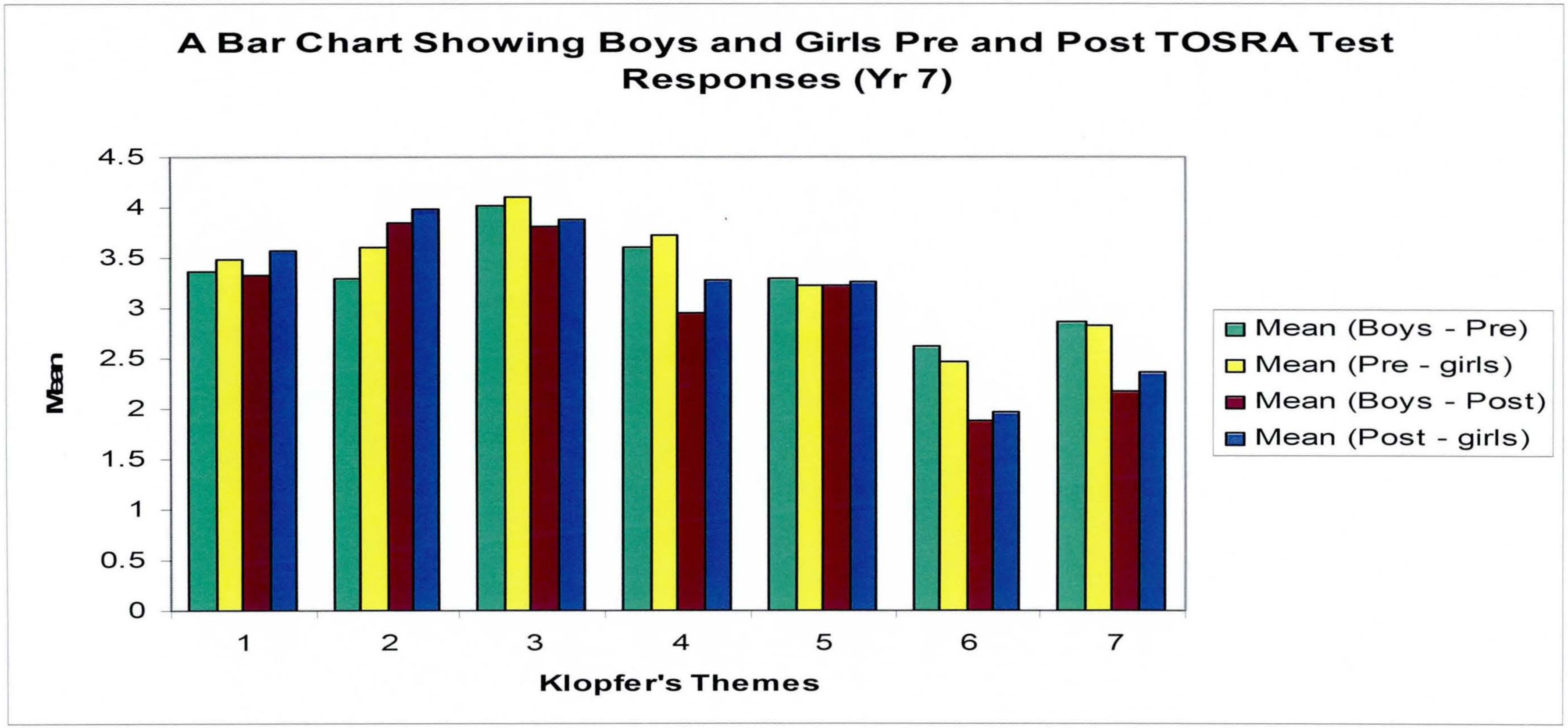


Figure 4.2.5: Gender Comparisons for the Pre and Post TOSRA Test (Yr 7).

The Yr 7 bar chart shows that girls have higher means in four of the themes both pre and post TOSRA Test. The themes were: 1, 2, 3 and 4. Themes 5, 6 and 7 observe the boys having higher means in the pre test and girls having higher means in the post test. Girls in this age group are showing a more positive attitude towards science. Influences for this could be female science teachers, parents in science-related jobs or the television/media.

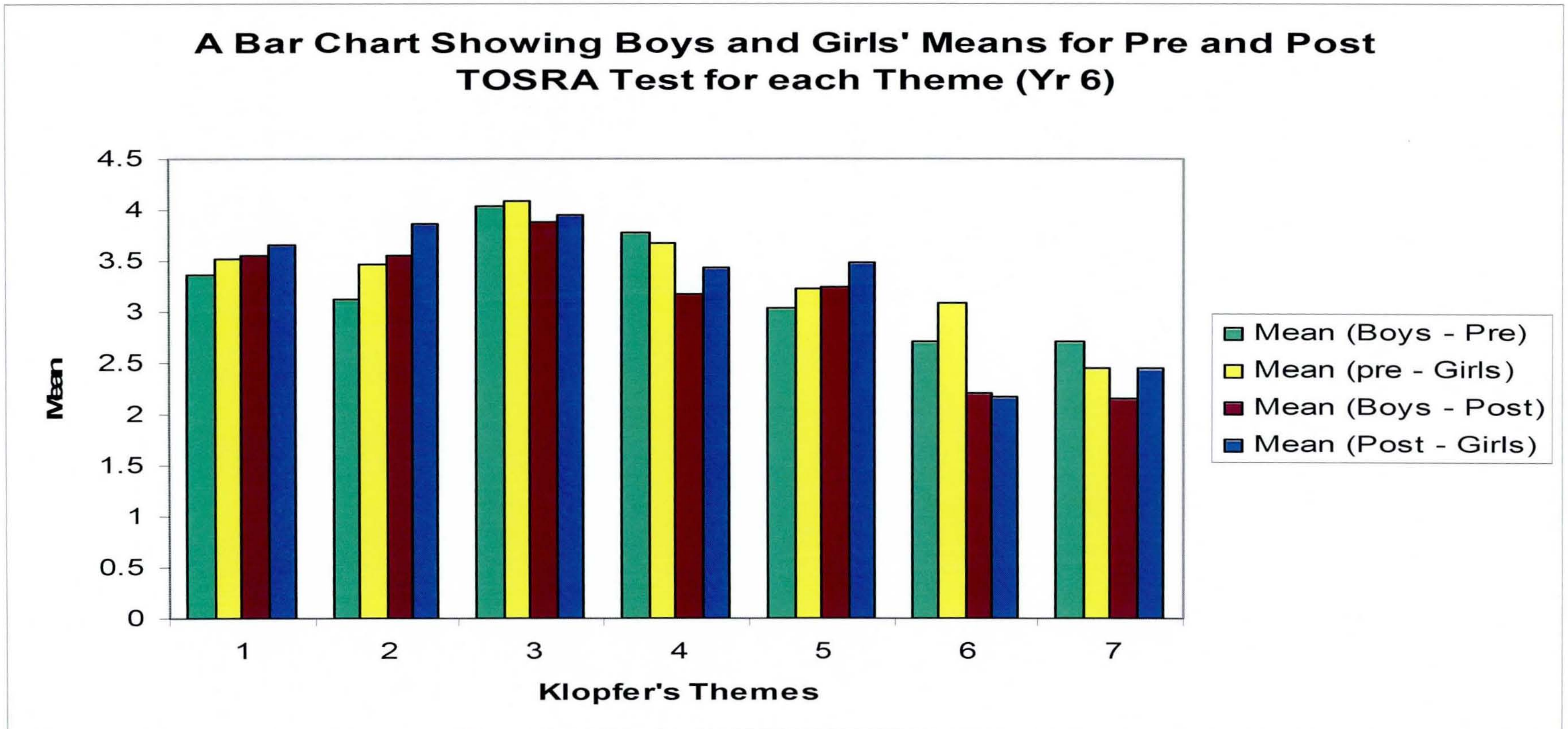


Figure 4.2.6: Gender Comparisons for Pre and Post TOSRA Test (Yr 6).

The Yr 6 pupils show a trend towards the girls showing a more positive approach to science than the boys. This is evidenced in the bar chart with four themes showing girls with the higher means in both pre and post tests. These themes are: 1, 2, 3 and 5. In themes 4 and 7, the pre test showed boys having the higher means but girls in the post test and theme 6 showed girls having a higher mean in the pre test and boys a higher mean in the post test.

Just like the Yr 7s, the girls show a more positive attitude towards science.

In conclusion, the younger age groups (Yr 6 and 7) the girls show a more positive attitude towards science whereas in Yr 9, the boys show a more positive attitude by their responses in the pre and post TOSRA test.

Research by Colley et al. (1994) found different findings. With pupils aged 11-13yrs, Physical Education and Science were preferred by boys and English and Humanities were preferred by girls.

4.3. Chi Square Analysis

Chi square test was also chosen to analyse the results because it will show what we expect to see from pre-test results against what we actually observe in the post-test (Charles, 1998). From observing the earlier results in bar chart notation it has appeared that there is no significant change in the results for the pre and post TOSRA test for any age group. Using chi square will enable confirmation, or not, of this apparent trend.

The null hypothesis, H_o, can be written as:

There is no difference between the pre and post TOSRA test results. i.e. there is no change, over time, in the pupils' attitude towards science.

Year Group	Chi Square – Theme 1	Chi Square – Theme 2	Chi Square – Theme 3	Chi Square – Theme 4	Chi Square – Theme 5	Chi Square – Theme 6	Chi Square – Theme 7
6	0.76	0.68	0.84	0.70	0.85	0.44	0.41
7	0.80	0.69	0.87	0.56	0.94	0.48	0.44
9	0.73	0.59	0.81	0.72	0.66	0.73	0.52

Table 4.3.1: Chi Square Values for each Year Group in each of Klopfer's Themes.

Having calculated chi square it would be that the null hypothesis would be accepted:

'There is no difference in attitude as measured in the pre and post test'.

To be significant at the 5% or 1% levels, chi square values would need to be 3.84 or 6.63 respectively for one degree of freedom. The chi square values calculated in table 4.3.1 show these values.

For 13 degrees of freedom, the chi square values would need to be 22.36 for 5% or 27.69 for 1% and the values obtained are well below these.

Although there is no significant difference statistically, the highest values (nearest to being significant at 5% level) are in themes 3 and 5 in Yr 7.

In conclusion, the Pre and Post TOSRA test used showed that there is no change in attitude between the timings of the two tests for all three age groups. Therefore, since using Cronbach alpha's reliability and the results were shown to be reliable, perhaps this research suggests that attitudes towards science are fixed before Yr 6 at primary school.

4.4. Yr 2 Results

In order to develop an appropriate TOSRA test, Pilot Studies were undertaken two years prior to the main study. These involved smaller numbers of pupils in just one school (B). In Yr 2 work, questionnaires with 21 questions, phrased positively were used with pupils in Yr 6, 7 and 9.

Now that the main results for the pre and post TOSRA test are analysed it will be useful to triangulate this information with the previous year's results (referred to as Yr 2) to see if there is a trend of pupils' attitudes or whether they change individually within each year group.

The order of this section will be as follows:

Yr 2 Pre and Post TOSRA Test Yr 6 – results tables, bar charts and chi square

↓

Yr 2 Pre and Post TOSRA Test Yr 7- results tables and chi square

↓

Yr 2 Pre and Post TOSRA Test Yr 9 – results tables and chi square

↓

Comparison between Yr 2 and 3 results for Pre and Post TOSRA

Figure 4.4.1: Flow diagram of the Yr 2 Work section.

Yr 2 Work Pre TOSRA Test

Qu	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Mean	3.70	3.81	4.44	3.84	3.67	2.60	2.12	3.74	3.19	3.72	3.88	2.58	3.29	2.83
S.d.	0.94	1.01	0.77	0.81	1.36	1.24	1.28	1.20	0.86	1.18	1.00	1.35	1.37	1.31

Qu	15	16	17	18	19	20	21
Mean	3.63	3.67	3.29	3.71	2.81	2.35	2.67
S.d.	1.18	1.12	1.35	0.99	1.42	1.51	1.60

Table 4.4.1: A Table showing the Pre TOSRA Test Means and Standard Deviations for Yr 6 Pupils (n=44).

Klopfer's Theme	1	2	3	4	5	6	7
Mean	3.69	3.56	3.82	3.81	3.02	2.75	2.54

Table 4.4.2: A Table showing the Means for each of Klopfer's Themes for Yr 6 Pupils.

Yr 2 Work Post TOSRA Test

Qu	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Mean	3.40	4.26	4.24	3.23	3.30	2.28	1.95	3.37	4.05	3.65	3.56	3.47	2.00	3.12
S.d.	0.78	0.88	1.00	0.95	1.06	1.08	0.97	0.95	0.75	1.19	0.91	1.18	0.95	1.18

Qu	15	16	17	18	19	20	21
Mean	3.02	3.56	3.79	3.81	3.05	2.49	3.05
S.d.	0.98	1.14	1.01	1.12	0.82	1.26	1.25

Table 4.4.3: A Table showing the Post TOSRA Means and Standard Deviations for Yr 6 Pupils (n=43).

Klopfer's Themes	1	2	3	4	5	6	7
Mean	3.26	3.96	3.89	3.53	3.27	2.26	2.71

Table 4.4.4: A Table showing the Means in each of Klopfer's Themes for Post TOSRA Test Yr 6 Pupils.

	Klopfer's Theme 1	2	3	4	5	6	7
Pre - E	2.32	2.23	2.41	2.42	1.98	1.81	1.71
Post - O	2.02	2.37	2.33	2.12	1.96	1.35	1.62
$\lvert O - E \rvert - 0.5$	-0.8	-0.36	0.58	-0.8	-0.52	-0.96	-.59
$(\lvert O - E \rvert - 0.5)^2 / E$	0.28	0.058	0.14	0.26	0.137	0.509	0.2

Table 4.4.5: Table showing how the Chi Square results for Yr 6 Pupils (Yr 2 work) were calculated.

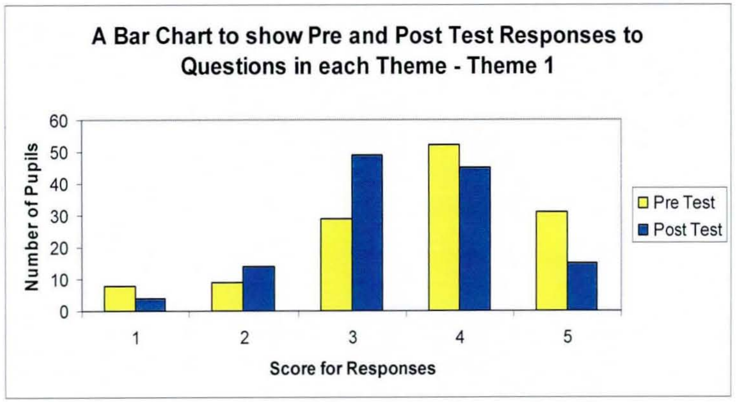


Figure 4.4.2: A Bar Chart showing Yr 6 Pupils Responses for Theme 1.

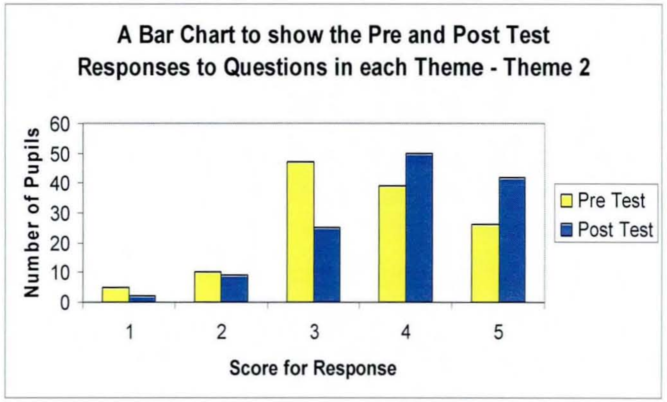


Figure 4.4.3: A Bar Chart showing Yr 6 Pupils Responses for Theme 2.

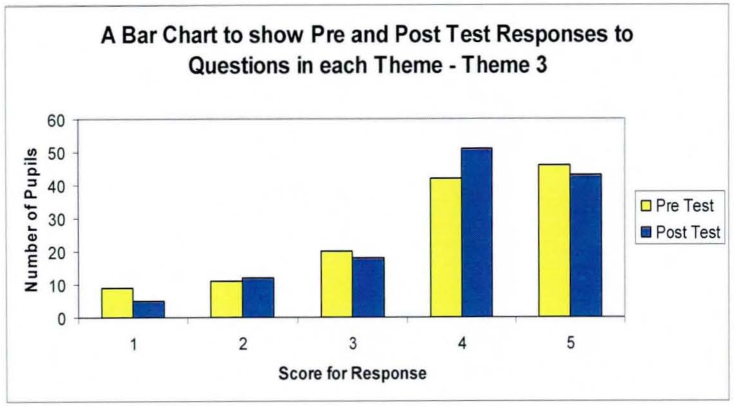


Figure 4.4.4: A Bar Chart showing Yr 6 Pupils Responses for Theme 3.

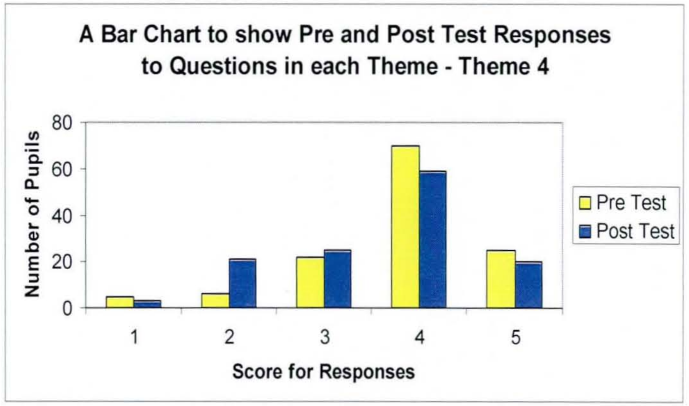


Figure 4.4.5: A Bar Chart showing Yr 6 Pupils Responses for Theme 4.

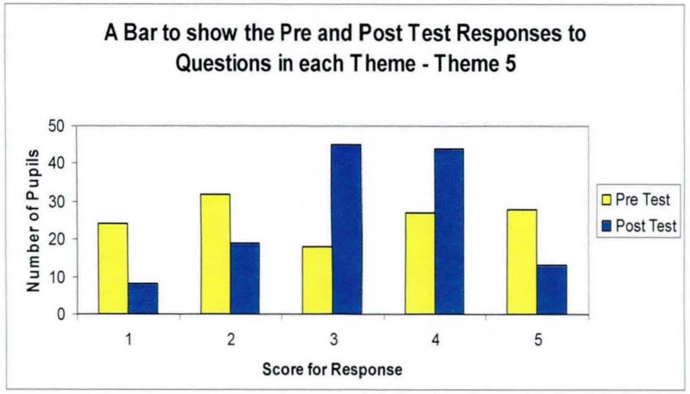


Figure 4.4.6: A Bar Chart showing Yr 6 Pupils Responses for Theme 5.

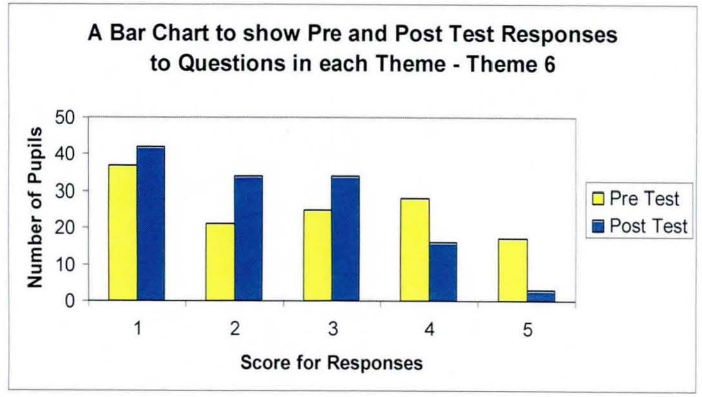


Figure 4.4.7: A Bar Chart showing Yr 6 Pupils Responses for Theme 6.

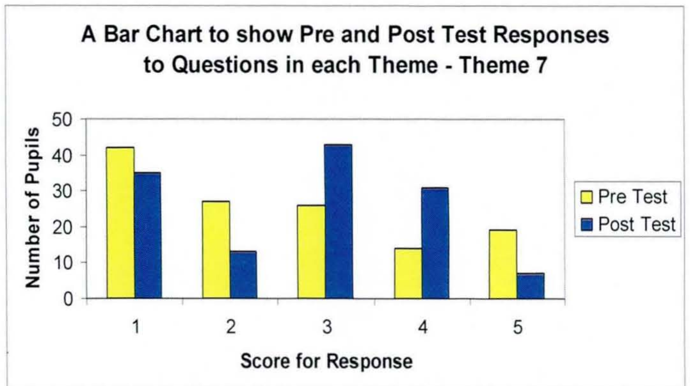


Figure 4.4.8: A Bar Chart showing Yr 6 Pupils Responses for Theme 7.

The bar charts for themes 1, 2 and 3 show higher number of pupils for scores 3, 4 or 5 showing a 'not sure' response or an agreement with the statement. Theme 4 has a definite positive response with the highest number of pupils choosing 4 so 'agree'. Themes 5, 6 and 7 show more varied results in the pre and post TOSRA test showing no conclusive evidence of pupils' attitude.

In conclusion, of the Yr 6 findings, themes 1, 3 and 4 are showing the more positive attitudes towards science. This is in both the pre and post tests, although theme 1 had more 'not sure' responses in the post test. For this age group, it is not surprising they are not sure about a career in science or perhaps enjoying science in their leisure time. This answer could be due to pupils not perceiving which activities in their free time could be classed as science-based, for example computer games.

Comparing the results with the final study results, they show high mean values in themes 3, 4 and 1 in the pre test but in the post test the highest mean values were in themes 3, 2 and 1. The conclusion for this particular age group is that they are positive in attitude towards scientific inquiry and the social implications towards science. Pupils are also quite positive at adopting scientific attitudes. The lowest mean values were also for themes 6 and 7 showing that this age group are not either engaged in scientific activities outside of school or don't understand which of the activities they pursue could be classed as scientific and that these pupils have not yet thought in depth about careers and don't realise which subjects are needed for certain jobs. This triangulation enables confidence to be drawn that these results are reliable since two different cohorts of pupils give similar trends.

The chi square values are not significant at the 5% or 1% levels for one degree of freedom and so the null hypothesis would be accepted for both years.

In conclusion for Yr 6 pupils, in both years of study themes 1 and 3 show the highest positive attitudes towards science. Themes 2 and 4 are also quite high though some changes are apparent. Themes 6 and 7 are not as high positive attitudes towards science.

Yr 2 Work Pre TOSRA Test

Qu	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Mean	3.60	4.02	4.51	3.30	3.57	2.15	2.04	3.94	3.19	4.04	3.55	2.40	2.79	2.36
S.d.	0.76	0.99	0.69	0.85	1.08	1.16	1.02	0.78	1.41	1.16	1.09	1.28	1.38	0.88

Qu	15	16	17	18	19	20	21
Mean	2.81	3.57	3.72	3.74	2.91	2.40	2.17
S.d.	0.96	1.09	1.28	0.95	1.25	1.39	1.06

Table 4.4.6: A Table showing the Means and Standard Deviations for the Pre TOSRA Test results for Yr 7 Pupils (n=45).

Klopfer's Themes	1	2	3	4	5	6	7
Mean	3.45	3.59	4.09	3.53	2.96	2.45	2.19

Table 4.4.7: A Table showing the Means for each of Klopfer's Themes for Yr 7 Pupils.

Yr 2 Work Post TOSRA Test

Qu	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Mean	3.89	4.44	4.47	2.89	3.42	2.00	2.11	3.78	4.16	3.38	3.96	3.49	1.89	2.84
S.d.	0.96	0.87	0.73	1.30	1.01	0.94	1.09	1.13	0.9	1.23	0.85	1.29	1.15	1.24

Qu	15	16	17	18	19	20	21
Mean	2.98	3.69	3.93	3.71	3.24	2.13	2.98
S.d.	1.22	1.18	0.96	1.38	1.17	1.31	1.36

Table 4.4.8: A Table showing the Means and Standard Deviations for the Post TOSRA Test results for Yr 7 Pupils (n=45).

Klopfer's Themes	1	2	3	4	5	6	7
Mean	3.55	4.10	3.93	3.52	3.38	2.01	2.64

Table 4.4.9: A Table showing the Means for each of Klopfer's Themes for Yr 7 Pupils.

	Klopfer's Theme 1	2	3	4	5	6	7
Pre - E	2.13	2.20	2.50	2.18	1.83	1.50	1.35
Post - O	2.13	2.46	2.36	2.11	2.03	1.20	1.57
$\vert O - E \vert - 0.5$	-0.50	-0.24	-0.64	-0.57	-0.30	-0.80	-0.28
$(\vert O - E \vert - 0.5)^2 / E$	0.12	0.026	0.16	0.15	0.049	0.43	0.058

Table 4.4.10: Table showing how the Chi Square results for Yr 7 Pupils (Yr 2 work) were calculated.

In the pre test, the mean values show that the most positive themes are 2, 3 and 4. Themes 5, 6 and 7 have means below 3 showing that they are negative. In the post test the mean values show that themes 1, 2 and 3 have generally positive responses showing a positive attitude. Theme 4 has also a fairly positive trend. Theme 5 has varied responses and theme 6 shows a negative response with all of the mean values for those questions (6, 13,20) having means less than 3 (2.00, 1.89, 2.13 respectively). Theme 7 shows a negative response as the means are less than 3 for each question.

In conclusion, Yr 7s are positive towards science in themes 2 and 3 in both the pre and post test. Themes 1 and 4 were also scored highly. Themes 5 and 6 show pupils don't always enjoy science lessons, although there are mixed responses, and do not pursue leisure activities involving science. These pupils, like Yr 6, may not appreciate the vast number of leisure pursuits involving science. Theme 7 responses also showed that future careers are also not known by many of this age group.

Comparing these results with the final year results, themes 3 and 4 were both scored highly in the pre test and themes and 3 in the post test. Although slight differences, the themes showing the most positive attitudes towards science in both year's research were themes 1, 3 and 4.

Once again, at the 5% or 1% levels, the chi square values in either year are below the values stating that the null hypothesis must be accepted.

Yr 2 Work Pre TOSRA Test

Qu	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Mean	4.05	4.03	4.43	3.90	3.75	2.53	2.67	4.35	3.65	4.18	3.82	2.79	3.03	3.28
s. d	0.64	0.89	0.75	0.88	0.71	1.09	1.11	0.74	1.05	0.82	0.85	1.17	1.16	0.89

Qu	15	16	17	18	19	20	21
Mean	3.69	4.23	4.26	4.46	3.56	2.54	2.97
s.d	0.89	0.78	0.68	0.72	0.97	1.17	0.87

Table 4.4.11: A Table showing the Means and Standard Deviations for the Pre TOSRA Test for Yr 9 Pupils (n=40).

Klopfer's Themes	1	2	3	4	5	6	7
Mean	4.03	3.97	4.29	4.06	3.37	2.70	2.97

Table 4.4.12: Table showing the Mean for each of Klopfer's Themes for all Yr 9 Pupils (Pre TOSRA Test).

Yr 2 Work Post TOSRA Test

Qu	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Mean	3.98	4.28	4.10	3.30	3.70	2.25	2.21	4.05	4.08	3.58	4.29	3.65	2.43	3.13
s.d.	0.8	0.85	0.84	1.07	0.82	0.98	0.83	0.71	0.66	0.86	0.52	0.86	1.04	0.88

Qu	15	16	17	18	19	20	21
Mean	3.26	3.79	3.84	4.13	3.61	2.32	3.18
s. d	0.92	0.91	0.87	0.66	0.92	1.12	0.93

Table 4.4.13: A Table showing the Means and Standard Deviations for the Post TOSRA Test for Yr 9 Pupils (n=40).

Klopfer's Themes	1	2	3	4	5	6	7
Mean	3.76	4.05	3.84	3.91	3.65	2.33	2.84

Table 4.4.14: Table showing the Means for each of Klopfer's Themes for all Yr 9 Pupils (Post TOSRA Test).

	Klopfer's Theme 1	2	3	4	5	6	7
Pre - E	**2.40**	**2.36**	**2.53**	**2.375**	**1.99**	**1.59**	**1.74**
Post - O	**2.225**	**2.39**	**2.21**	**2.26**	**2.10**	**1.34**	**1.63**
$\lvert O - E \rvert - 0.5$	**-0.675**	**-0.47**	**-0.82**	**-0.615**	**-0.39**	**-0.75**	**-0.61**
$(\lvert O - E \rvert - 0.5)^2 / E$	**0.19**	**0.093**	**0.266**	**0.16**	**0.076**	**0.35**	**0.21**

Table 4.4.15: Table showing how the Chi Square results for Yr 9 Pupils (Yr 2 work) were calculated.

These chi square values and the one obtained in the final year for Yr 9 are very low and are not significant at the 5% or 1% levels with one degree of freedom. Therefore, the null hypothesis must be accepted:

'There is no difference in attitude as measured in the pre and post test'.

In conclusion, the most positive themes, in both the pre and post TOSRA test, for Yr 9 pupils are: themes 3 and 4. Themes 1 and 2 also scored quite positively. Only themes 6 and 7 showed a less positive approach to science in this year group with mean values in both the pre and post tests less than 3.

In comparison with the final year work, in the pre test themes 1, 3 and 4 scored highly, and in this Yr 2 work themes 1, 3 and 4also scored highly. In the post test, the highest mean was in theme 1 with themes 3 and 5 also scoring quite well. In the Yr 2 work, themes 2, 3 and 4 scored the highest.

Overall with Yr 9 pupils, there are some differences between the year groups showing by this stage their decisions will vary on the individuals each year. This could be due to the slight changes in questions on the questionnaire as there are a reduced number of questions on the final year questionnaire compared with the 21 on the Yr 2 work questionnaire. The only negative attitudes are displayed in themes 6 and 7. Themes 2 and 5 show some differences. This may be expected as the attitude towards the normality of scientists could be due to home or school experiences and the enjoyment of lessons can vary from one teacher to another due to the quality of the teaching encountered.

Comparison between Results in Yr 2 and Yr 3

Klopfer's Theme	Questions	Yr 2 Mean	Yr 3 Mean	Difference
1	Scientific discoveries are doing good in the world; The government should spend more money on scientific research.	3.69	3.46	0.23
2	Scientists are about as fit and healthy and enjoy sports just as much as other people; Scientists are just as friendly as non-scientists.	3.43	3.29	0.13
3	I would rather find out why something happens by doing an experiment than by being told; Doing experiments helps me to learn just as much as finding out from teachers and books.	4.08	4.08	0.00
4	I find it interesting to hear about new ideas; In science lessons, it is good to report unexpected results as well as expected ones.	3.78	3.74	0.04
5	Science lessons are fun; Science is one of the most interesting school subjects.	3.24	3.12	0.12
6	I would like to belong to a science club to try new experiments; I enjoy watching science programs on the television.	2.95	2.89	0.06
7	I would like to work with people who make discoveries in science; I would like to work in a scientific laboratory finding out new things.	2.75	2.56	0.19

Table 4.4.16 : Table Comparing the Means for Yr 6 Pre TOSRA test for Yr 2 and 3.

The Pre TOSRA Test results for both Yr 6 year groups are all quite similar. There are no differences above 0.5 which can be evidence that the pupils in this research have fixed their attitudes before Yr 6. Interestingly, all of the means have decreased in Yr 3 work, even though there is no large difference to comment upon and each mean falls within the same whole number for example 3.43 and 3.29 (Yr 2 and 3 respectively) . This demonstrates differences within cohorts of pupils being used in research.

Klopfer's Theme	Questions	Yr 2 Mean	Yr 3 Mean	Difference
1	Laboratories are being built to be used for scientific research and this is good for society; Science helps make life better.	3.52	3.46	0.06
2	A scientist can have a normal family life; Scientists care about their working conditions.	4.16	3.71	0.45
3	I would rather find out about things by doing an experiment than asking an expert; I enjoy scientific experiments because I learn a lot from them.	4.02	3.91	0.11
4	I enjoy reading about things that challenge my existing ideas; I am curious about the world in which we live.	3.52	3.31	0.21
5	Science lessons are valuable for learning about everyday life; The material covered in science lessons is interesting.	3.18	3.36	**0.18**
6	Talking to friends about science outside of school would be interesting; Listening to science reports on the radio is really interesting.	2.39	2.18	0.21
7	I would like a career teaching science; A job as a scientist would be very exciting and interesting.	2.54	2.30	0.24

Table 4.4.17: A Table comparing the means of the questions in each Theme in Yr 2 and 3 (Post TOSRA Test Yr 6).

The differences in the means are quite similar. The only quite significant change is in theme 2. In theme 5 (highlighted in bold), the Yr 3 mean is increased giving confidence to the lessons that have been taught to the pupils have been more enjoyed by the pupils in this year. Once again, all of the other themes show that the mean in Yr 3 decreases.

Klopfer's Theme	Questions	Yr 2 Mean	Yr 3 Mean	Difference
1	Scientific discoveries are doing good in the world; The government should spend more money on scientific research.	3.38	3.42	**0.04**
2	Scientists are about as fit and healthy and enjoy sports just as much as other people; Scientists are just as friendly as non-scientists.	3.38	3.43	**0.05**
3	I would rather find out why something happens by doing an experiment than by being told; Doing experiments helps me to learn just as much as finding out from teachers and books.	4.28	4.06	0.22
4	I find it interesting to hear about new ideas; In science lessons, it is good to report unexpected results as well as expected ones.	3.52	3.65	**0.13**
5	Science lessons are fun; Science is one of the most interesting school subjects.	3.24	3.27	**0.03**
6	I would like to belong to a science club to try new experiments; I enjoy watching science programs on the television.	2.47	2.55	**0.08**
7	I would like to work with people who make discoveries in science; I would like to work in a scientific laboratory finding out new things.	2.27	2.86	**0.59**

Table 4.4.18: Table showing the Means of Pre TOSRA Test data for Yr 7 Pupils.

At the beginning of Yr 7 the pupils in both year groups seem to have similar attitudes towards science. It is interesting that all of the themes, except theme 3, have increased the mean in the Yr 3 results. The main difference is theme 7 on careers which is perhaps not an area of deep interest yet or unknown to some pupils.

Klopfer's Theme	**Questions**	**Yr 2 Mean**	**Yr 3 Mean**	**Difference**
1	Laboratories are being built to be used for scientific research and this is good for society; Science helps make life better.	3.84	3.50	0.34
2	A scientist can have a normal family life; Scientists care about their working conditions.	4.30	3.31	0.99
3	I would rather find out about things by doing an experiment than asking an expert; I enjoy scientific experiments because I learn a lot from them.	4.20	3.55	0.65
4	I enjoy reading about things that challenge my existing ideas; I am curious about the world in which we live.	3.30	2.89	0.41
5	Science lessons are valuable for learning about everyday life; The material covered in science lessons is interesting.	3.33	2.95	0.38
6	Talking to friends about science outside of school would be interesting; Listening to science reports on the radio is really interesting.	2.07	2.73	**0.66**
7	I would like a career teaching science; A job as a scientist would be very exciting and interesting.	2.48	2.61	**0.13**

Table 4. 4.19: A Table comparing the means of the questions in each Theme in Yr 2 and 3 (Post TOSRA Test Yr 7).

The Post TOSRA Test shows differences over 0.5 in themes 2, 3 and 6. This could be due to different experiences as the pupils settle into their new school. These themes are based on opinions on sensitive topics – do scientists 'fit in' or is 'science cool in leisure time'. Themes 6 and 7 are higher in the Yr 3 means than Yr 2. Different cohorts of pupils will have different overall opinions on such issues as shown in these results between the two years.

43 of the Year 6 pupils from the Yr 2 data went into the Year 7 cohort in the final year work (Yr 3). Comparing these will closer links to individual data:

Klopfer's Theme	**Questions**	**Yr 2 Mean**	**Yr 3 Mean**	**Difference**
1	Scientific discoveries are doing good in the world; The government should spend more money on scientific research.	3.69	3.42	0.27
2	Scientists are about as fit and healthy and enjoy sports just as much as other people; Scientists are just as friendly as non-scientists.	3.43	3.43	0.00
3	I would rather find out why something happens by doing an experiment than by being told; Doing experiments helps me to learn just as much as finding out from teachers and books.	4.08	4.06	0.02
4	I find it interesting to hear about new ideas; In science lessons, it is good to report unexpected results as well as expected ones.	3.78	3.65	0.13
5	Science lessons are fun; Science is one of the most interesting school subjects.	3.24	3.27	**0.03**
6	I would like to belong to a science club to try new experiments; I enjoy watching science programs on the television.	2.95	2.55	0.40
7	I would like to work with people who make discoveries in science; I would like to work in a scientific laboratory finding out new things.	2.75	2.86	**0.11**

Table 4.4.20: Table showing the Means of Pre TOSRA Test data for Yr 6 Pupils as they move into Yr 7.

Since there are other pupils in the Yr 3 cohort, it is not surprising that there is one mean value of 0.4 difference in theme 6. However, the other means are quite similar showing that the attitudes are quite stable – what some pupils felt in Yr 6, maybe carried on into Yr 7, at a new school, with new teachers, new friends and a new learning environment. Two of the themes have higher means in Yr 3 – themes 5 and

7. This perhaps supports the conclusion that attitudes are fixed at a young age, earlier than Yr 6.

Klopfer's Theme	Questions	Yr 2 Mean	Yr 3 Mean	Difference
1	Laboratories are being built to be used for scientific research and this is good for society; Science helps make life better.	3.39	3.50	**0.11**
2	A scientist can have a normal family life; Scientists care about their working conditions.	4.16	3.31	0.85
3	I would rather find out about things by doing an experiment than asking an expert; I enjoy scientific experiments because I learn a lot from them.	4.02	3.55	0.47
4	I enjoy reading about things that challenge my existing ideas; I am curious about the world in which we live.	3.52	2.89	0.63
5	Science lessons are valuable for learning about everyday life; The material covered in science lessons is interesting.	3.18	2.95	0.23
6	Talking to friends about science outside of school would be interesting; Listening to science reports on the radio is really interesting.	2.39	2.73	**0.34**
7	I would like a career teaching science; A job as a scientist would be very exciting and interesting.	2.54	2.61	**0.07**

Table 4.4.21: A Table comparing the means of the questions in each Theme as Yr 6 pupils move into Yr 7(Post TOSRA).

In the Post TOSRA test the comparisons for the Yr 6 pupils as they move into Yr 7 are similar; however, themes 2 and 4 show a greater than 0.5 difference. In Yr 3, themes 1, 6 and 7 have higher means than the previous year. Overall, the pupils have appeared to have fixed attitudes from Yr 6 to Yr 7. There are, as expected, some differences, maybe due to there being other pupils in the Yr 7 data, or some pupils who will change their attitude.

Klopfer's Theme	**Questions**	**Yr 2 Mean**	**Yr 3 Mean**	**Difference**
1	Scientific discoveries are doing good in the world; The government should spend more money on scientific research.	4.02	3.74	0.28
2	Scientists are about as fit and healthy and enjoy sports just as much as other people; Scientists are just as friendly as non-scientists.	3.94	2.96	0.98
3	I would rather find out why something happens by doing an experiment than by being told; Doing experiments helps me to learn just as much as finding out from teachers and books.	4.31	2.81	1.50
4	I find it interesting to hear about new ideas; In science lessons, it is good to report unexpected results as well as expected ones.	4.18	2.76	1.42
5	Science lessons are fun; Science is one of the most interesting school subjects.	3.66	3.34	0.32
6	I would like to belong to a science club to try new experiments; I enjoy watching science programs on the television.	2.78	3.27	**0.49**
7	I would like to work with people who make discoveries in science; I would like to work in a scientific laboratory finding out new things.	3.13	2.99	0.14

Table 4.4.22: Table showing the Means of Pre TOSRA Test data for Yr 9 Pupils.

For the Yr 9 Pre TOSRA Test comparisons the main differences of the means between the two years show huge differences for themes 2, 3 and 4 (0.98, 1.50 and 1.42 respectively). This shows that this year group can change from year to year. Theme 6 has a higher mean for Yr 3 which is encouraging to see that pupils do want to belong to science clubs and try new experiments and that they enjoy watching science programmes on the television.

Klopfer's Theme	Questions	Yr 2 Mean	Yr 3 Mean	Difference
1	Laboratories are being built to be used for scientific research and this is good for society; Science helps make life better.	4.02	3.90	0.12
2	A scientist can have a normal family life; Scientists care about their working conditions.	4.17	3.60	0.57
3	I would rather find out about things by doing an experiment than asking an expert; I enjoy scientific experiments because I learn a lot from them.	3.97	3.60	0.37
4	I enjoy reading about things that challenge my existing ideas; I am curious about the world in which we live.	3.72	2.98	0.74
5	Science lessons are valuable for learning about everyday life; The material covered in science lessons is interesting.	3.66	2.95	0.71
6	Talking to friends about science outside of school would be interesting; Listening to science reports on the radio is really interesting.	2.29	2.72	**0.43**
7	I would like a career teaching science; A job as a scientist would be very exciting and interesting.	2.67	2.81	**0.14**

Table 4.4.23: A Table comparing the means of the questions in each Theme for Yr 9 Pupils (Post TOSRA).

Between the years results show that themes 2, 4 and 5 have differences over 0.5. Themes 2 and 4 also showed large differences in the pre test so perhaps concludes that these two year groups have different attitudes to these themes. Themes 6 and 7 have higher means in Yr 3 work than Yr 2.

In conclusion of the pre and post TOSRA test data obtained for all three year groups over two years, the most positive themes have been those related to social implications of science, normality of scientists, attitude towards scientific inquiry and adopting a scientific attitude. In contrast the results have shown negative attitudes towards leisure interest and career interest. Theme 5 shows odd patterns and depends on each year group.

Triangulation was used to strengthen the outcomes of the results. In each year group, in both years research was undertaken, the means of the results were generally similar in the pre and post TOSRA tests for the same themes. Therefore, the conclusions can be made with some degree of confidence.

Enjoyment of science lessons had some varied results in Yr 2 so further research was undertaken into which subjects pupils liked and what things they liked to do in lessons. This was achieved in a ranking of subjects grouped as core subjects, practical subjects and mixed subjects and pupils ticking which activities they enjoyed participating in during their science lessons. This is analysed in section 4.5.

4.5. Main TOSRA Test (Yr 3) Analysis of Ranking Subjects

Pupils' Favourite School Subjects – Core Subjects

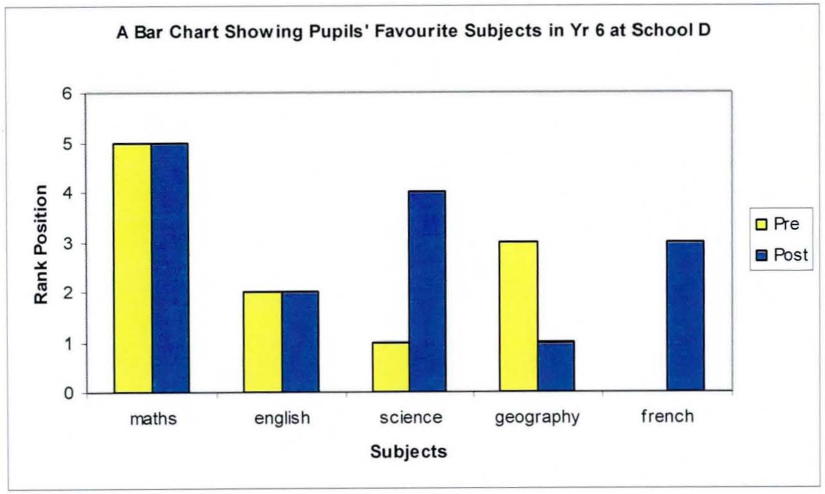


Figure 4.5.1: Favourite Subjects for Yr 6 Pupils (school D).

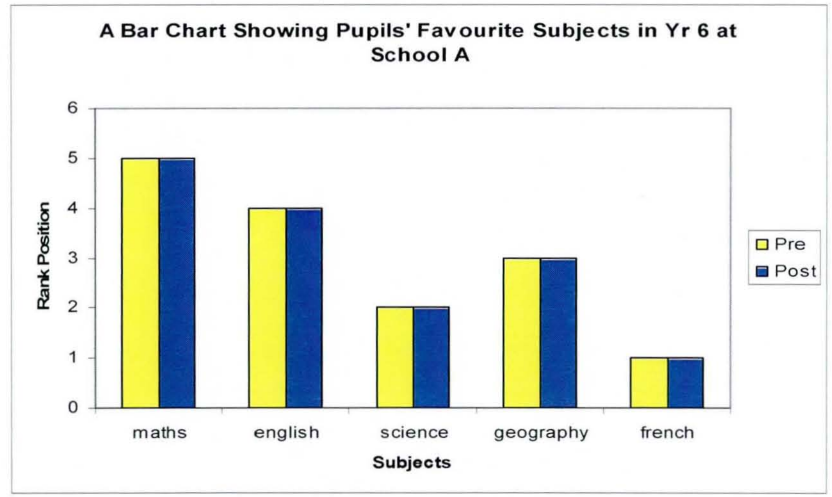


Figure 4.5.2: Favourite Subjects for Yr 6 Pupils (school A).

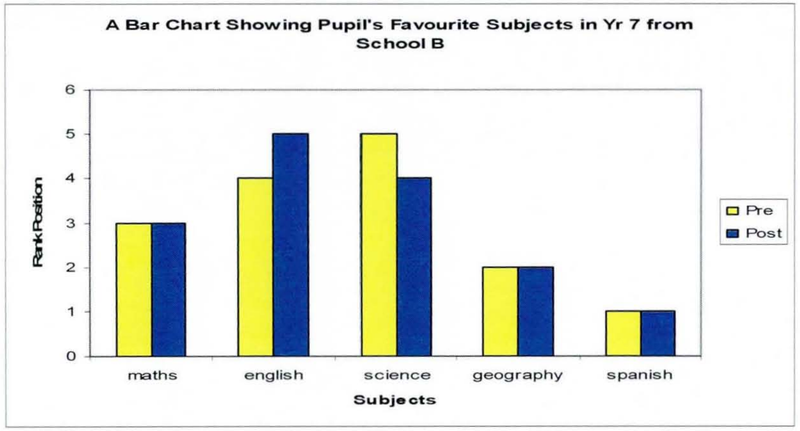


Figure 4.5.3: Favourite Subjects for Yr 7 Pupils (school B).

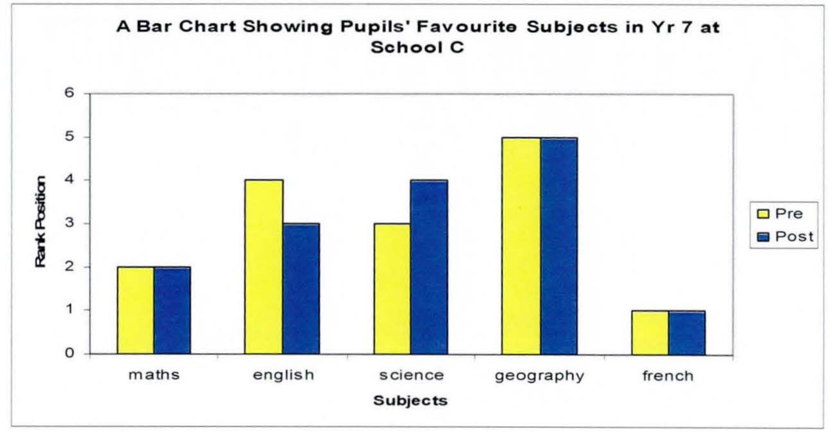


Figure 4.5.4: Favourite Subjects for Yr 7 Pupils (school C).

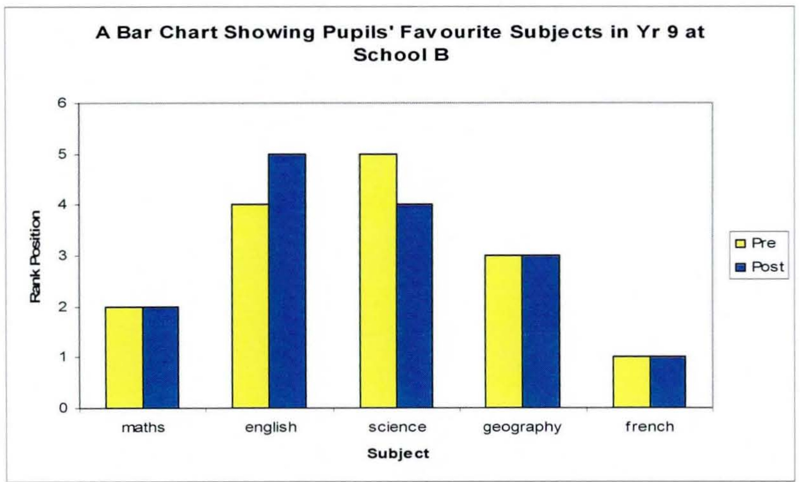


Figure 4.5.5: Favourite Subjects for Yr 9 Pupils (school B).

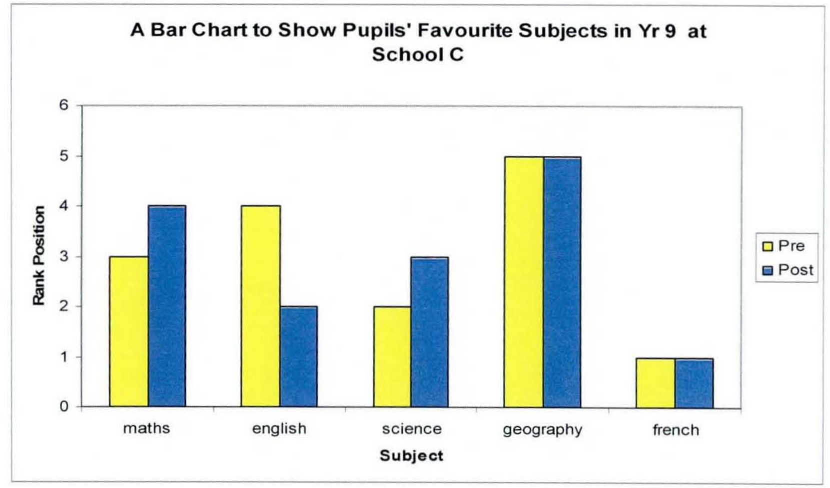
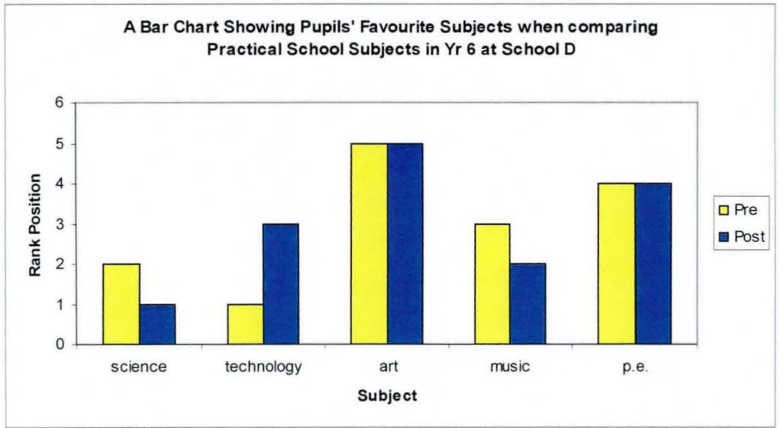


Figure 4.5.6: Favourite Subjects for Yr 9 Pupils (school C).

These bar charts show that the favourite subjects depend on the school, perhaps on the teacher or the pupil's interest at the time. French, however, was the least favourite in all schools, except school D where it was a new subject in Yr 6 and the pupils showed they enjoyed it. Science was quite popular with Yr 7 pupils. Yrs 6 and 9 showed differences in pre and post test for the liking of science compared with the other core subjects. However, school A ranked science in the same position in both the pre and post test

Pupils' Favourite Subjects – Practical



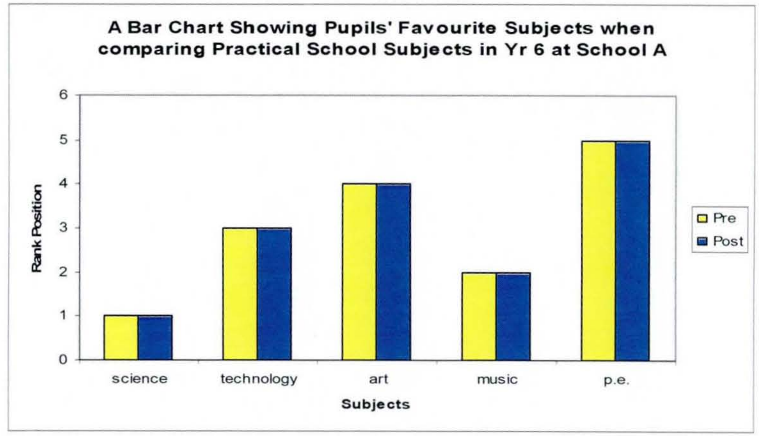


Figure 4.5.7: Favourite Subjects for Pupils in Yr 6 (school D). **Figure 4.5.8: Favourite Subjects for Pupils in Yr 6 (school A).**

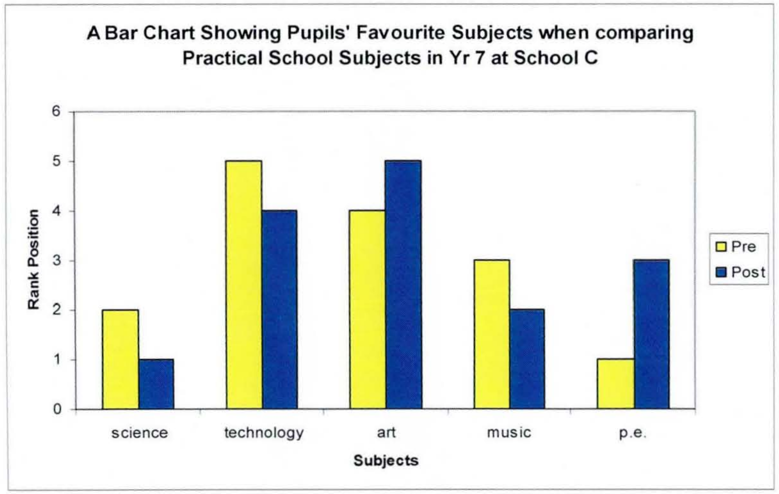


Figure 4.5.9: Favourite Subjects for Pupils in Yr 7 (school C).

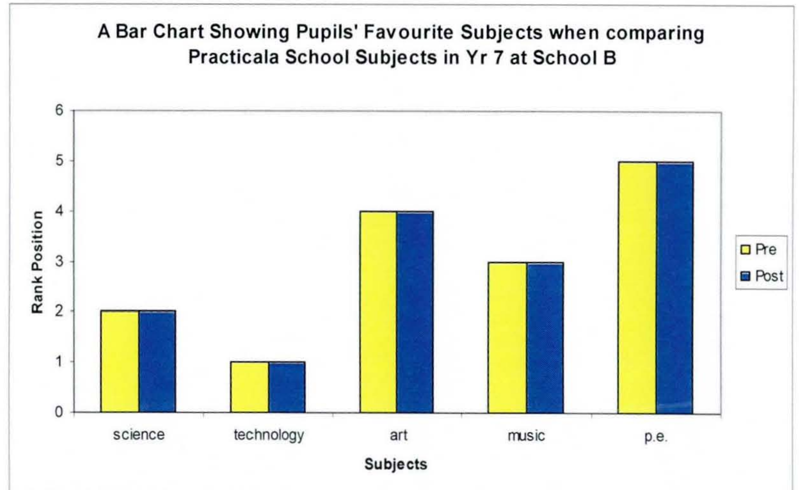
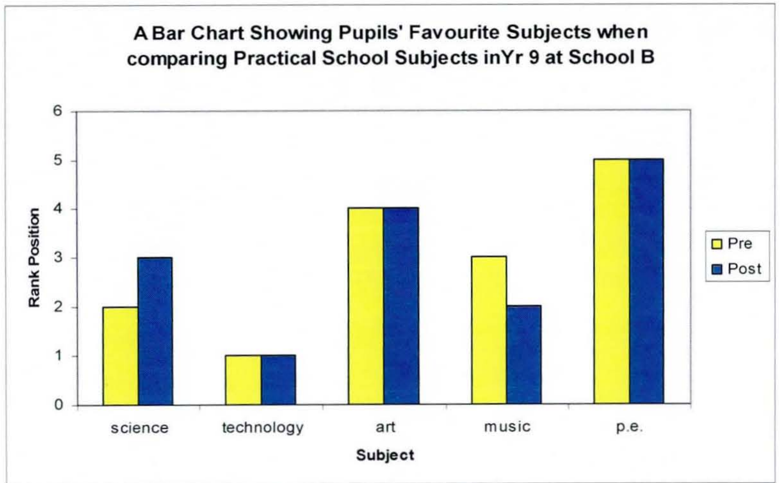


Figure 4.5.10: Favourite Subjects for Pupils in Yr 7 (school B).



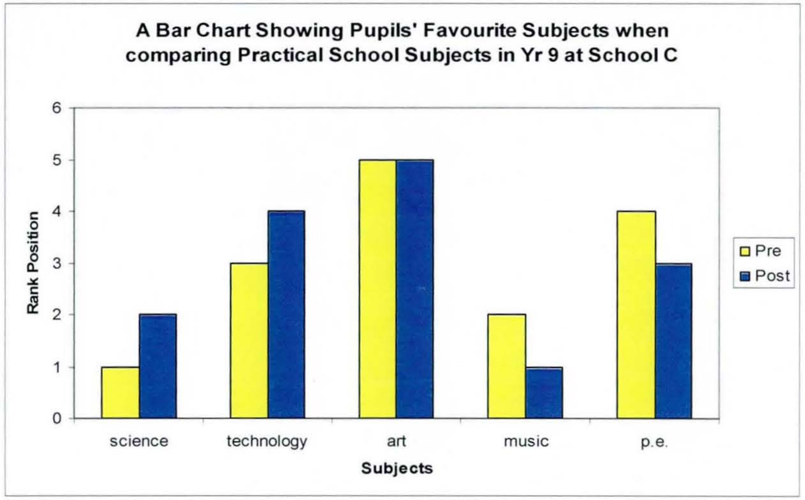


Figure 4.5.11: Favourite Subjects for Pupils in Yr 9 (school B).

Figure 4.5.12: Favourite Subjects for Pupils in Yr 9 (school C).

In the core subjects, Yr 9's favourite are different at the two different schools – in school B, English and Science are rated highly whereas in school C, Geography is enjoyed. Yr 7 also has a mixture of favourites: School B enjoyed Science and English and school C Geography. The Yr 6's, both schools' favourite subjects were Maths and English. French did not appear to be enjoyed. The numeracy and literacy hours take up much of the timetable at primary school and therefore it is good to see that the pupils enjoy them. As in all cases, the teachers they have this particular year of research may affect the results.

Comparing practical subjects, the pupils favourite in all 6 schools was Art and in 5 out of 6 schools was P.E. Technology also featured in two of the schools. Music and Science had mixed responses. The subjects with less writing, P.E. and Art, received the highest rankings. Yr 7 pupils had the most varied liking of practical subjects. This could be due to the mixture of practical and written work or practical and higher-level thinking that is required within the overall nature of the subject. Technology and science both have demanding concepts for pupils to learn and understand as well as practical components. Perhaps the timing of the questionnaires given reflects what was being taught at that particular time. Researching this on a more regular basis could show an interesting pattern relating to topic and enjoyment.

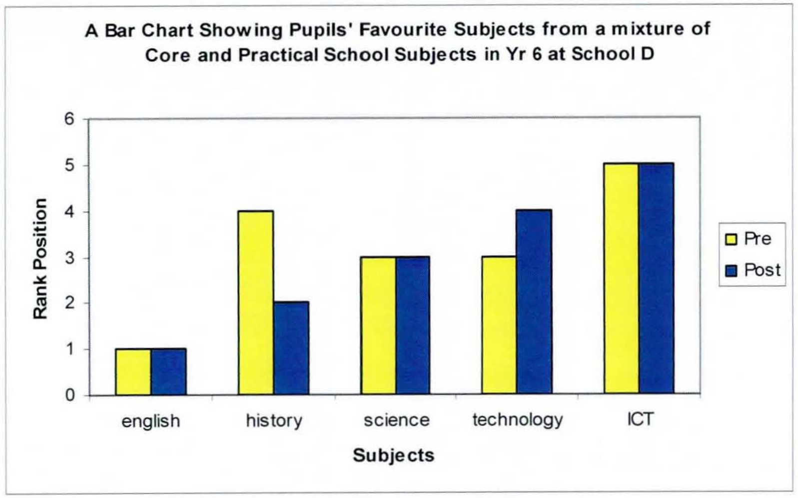


Figure 4.5.13: Favourite Subjects for Pupils in Yr 6 (school D).

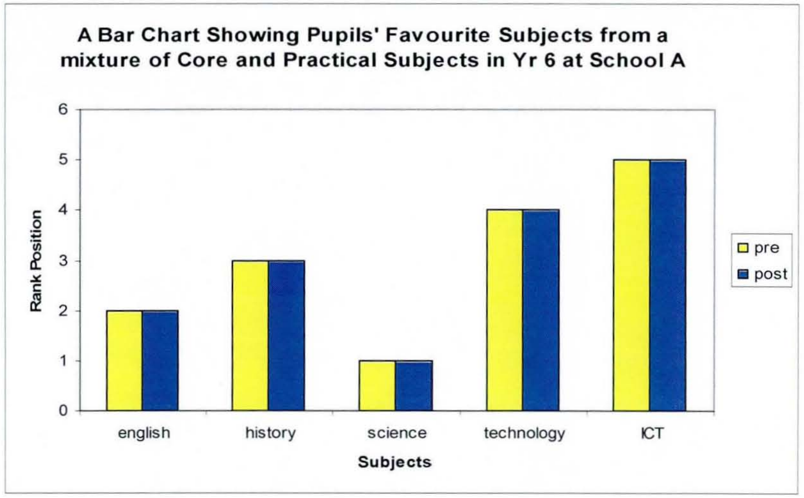


Figure 4.5.14: Favourite Subjects for Pupils in Yr 6 (school A).

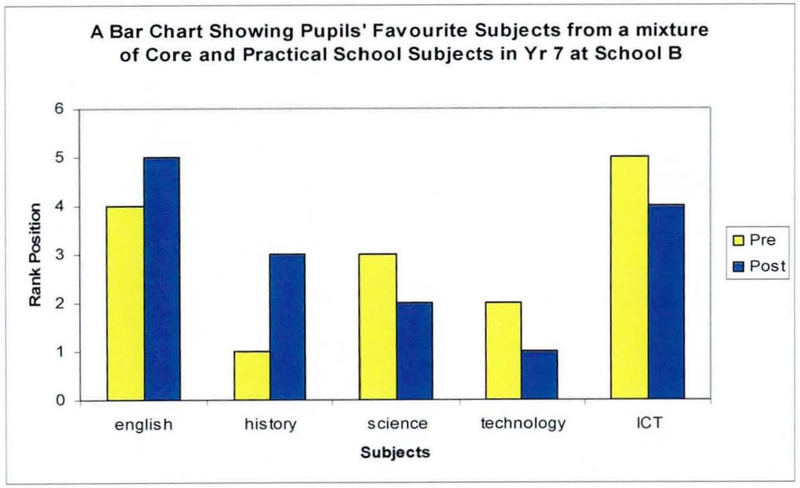


Figure 4.5.15: Favourite Subjects for Pupils in Yr 7 (school B).

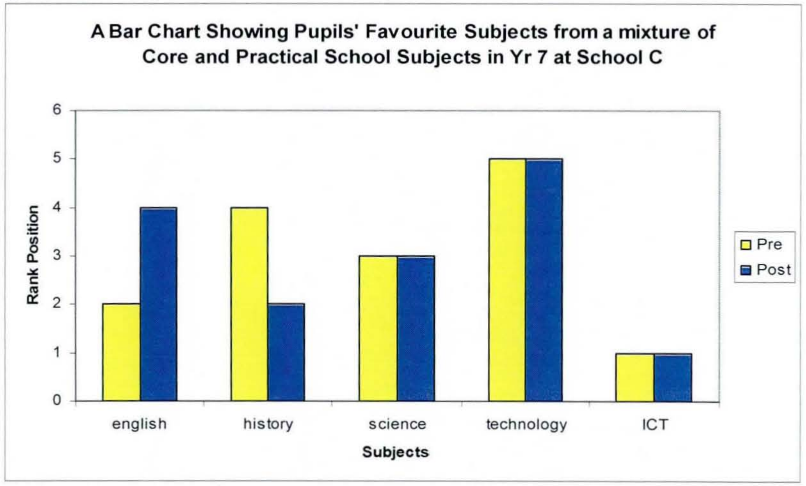


Figure 4.5.16: Favourite Subjects for Pupils in Yr 7 (school C).

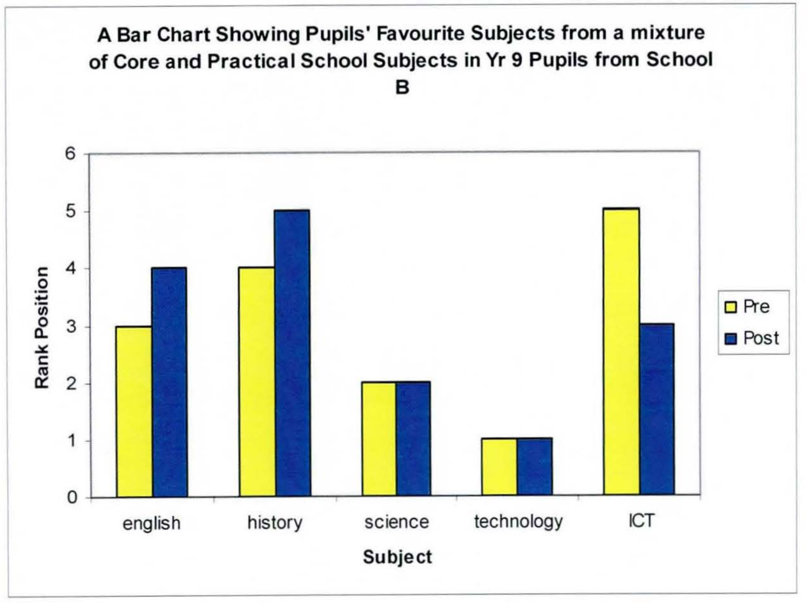


Figure 4.5.17: Favourite Subjects for Pupils in Yr 9 (school B).

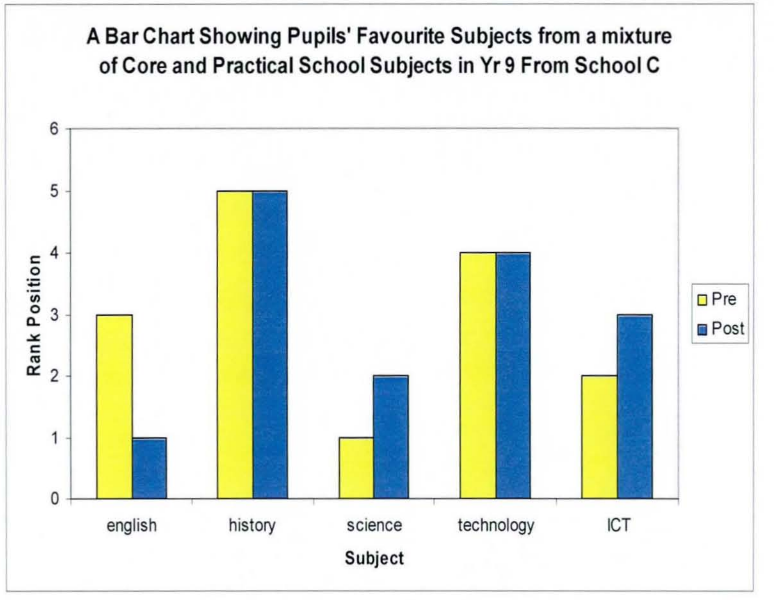


Figure 4.5.18: Favourite Subjects for Pupils in Yr 9 (school C).

When asking pupils about their favourite subjects when they are presented with practical and core subjects the results show that the common 'practical' subject is ICT and the common 'core' subject is history. In Yr 9 school B had favourites of ICT and history; School C had favourites of history and technology. In Yr 7, schools C had favourites of technology, English and history and school B had favourites of ICT and English. The Yr 6 pupils ranked ICT and Technology as favourites and additionally, school D ranked history as a favourite. School facilities will possibly have an effect on whether pupils enjoy a practical subject or not.

Since science was not a favourite subject when mixed with other core or practical subjects, the next question investigated which of the sciences they liked the most. In three schools the pattern was chemistry- biology-physics. Both Yr 6 schools ranked them in this order and this was interesting regarding the limited experiments they would do at this age. Yr 7 had chemistry at the top, but sharing with biology in school B. School B (Yr 9) ranked biology first.

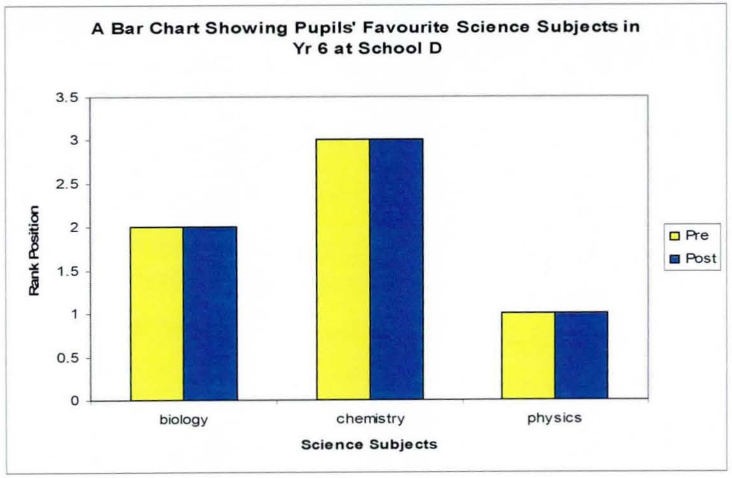


Figure 4.5.19: Favourite Science for Yr 6 Pupils (school D).

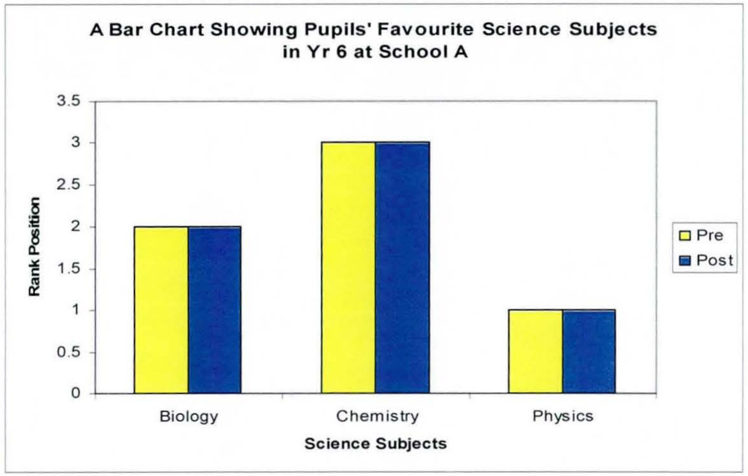


Figure 4.5.20: Favourite Science for Yr 6 Pupils (school A).

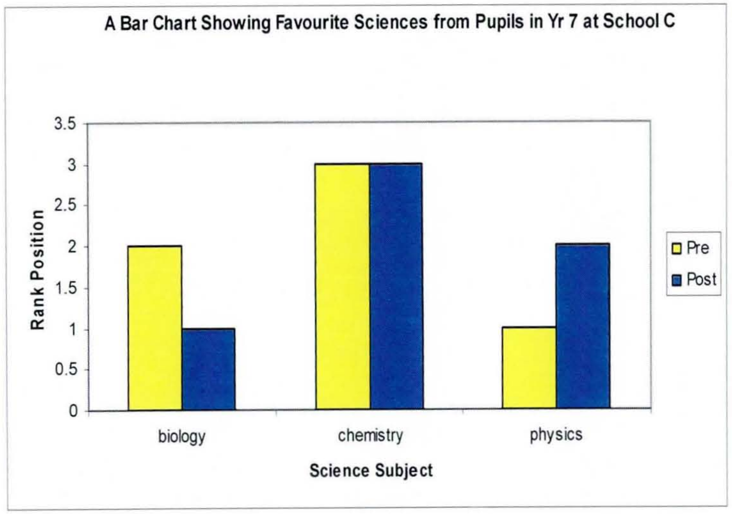


Figure 4.5.21: Favourite Science for Yr 7 Pupils (school C).

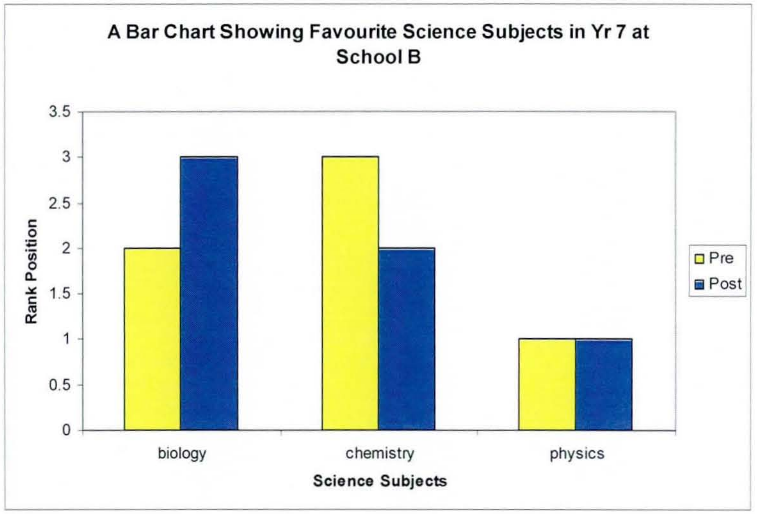


Figure 4.5.22: Favourite Science for Yr 7 Pupils (school B).

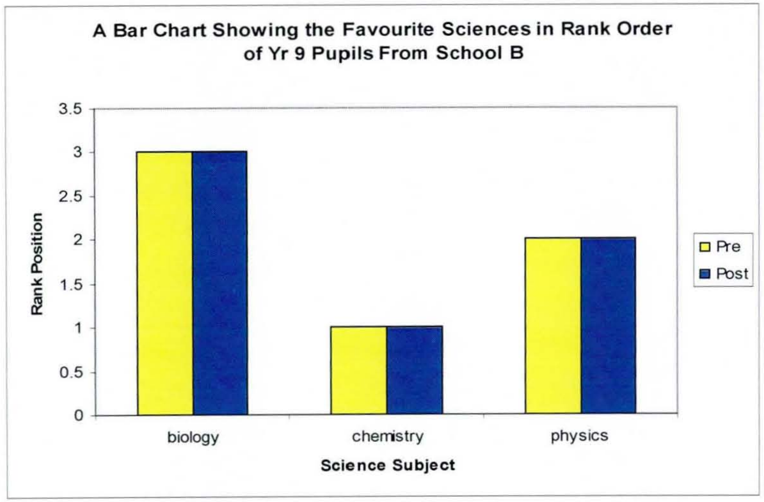


Figure 4.5.23: Favourite Science for Yr 9 Pupils (school B).

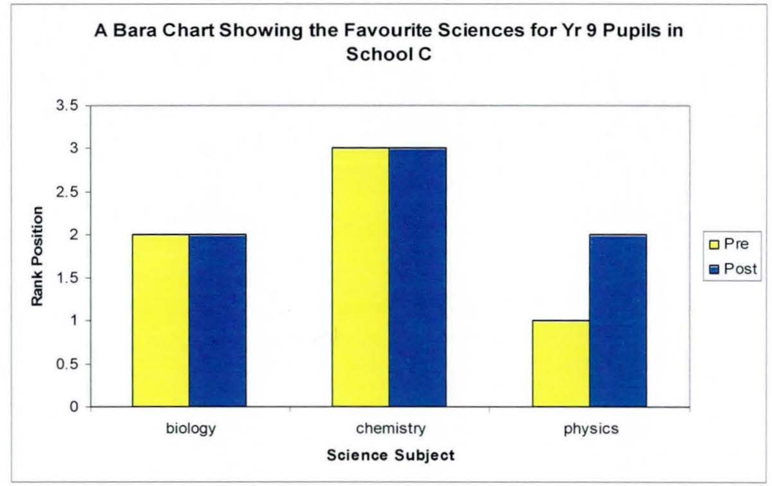


Figure 4.5.24: Favourite Science for Yr 9 Pupils (school C).

Reasons why pupils like lessons showed all three age groups saying if it was 'interesting' and if they 'like the teacher'. The Yr 6 and 7 pupils also really liked lessons if they went on the computers or had field trips. Yr 9 pupils and Yr 7 also liked a lesson if they were good at it. Yr 9 also enjoyed lessons if they found them easy. This shows that pupils are not keen on having to think for themselves, use their imagination and perhaps because this is often integrated into practicals, especially in science, it is not liked as much as expected. Videos are commonly 'old' and are therefore not as appealing to pupils as teachers might expect. One reason pupils may enjoy videos is that they are perhaps perceived as less demanding classroom activities. However, incorporating tasks whilst watching videos enhances the learning quality of the task but from a pupil's perspective may make them less enjoyable.

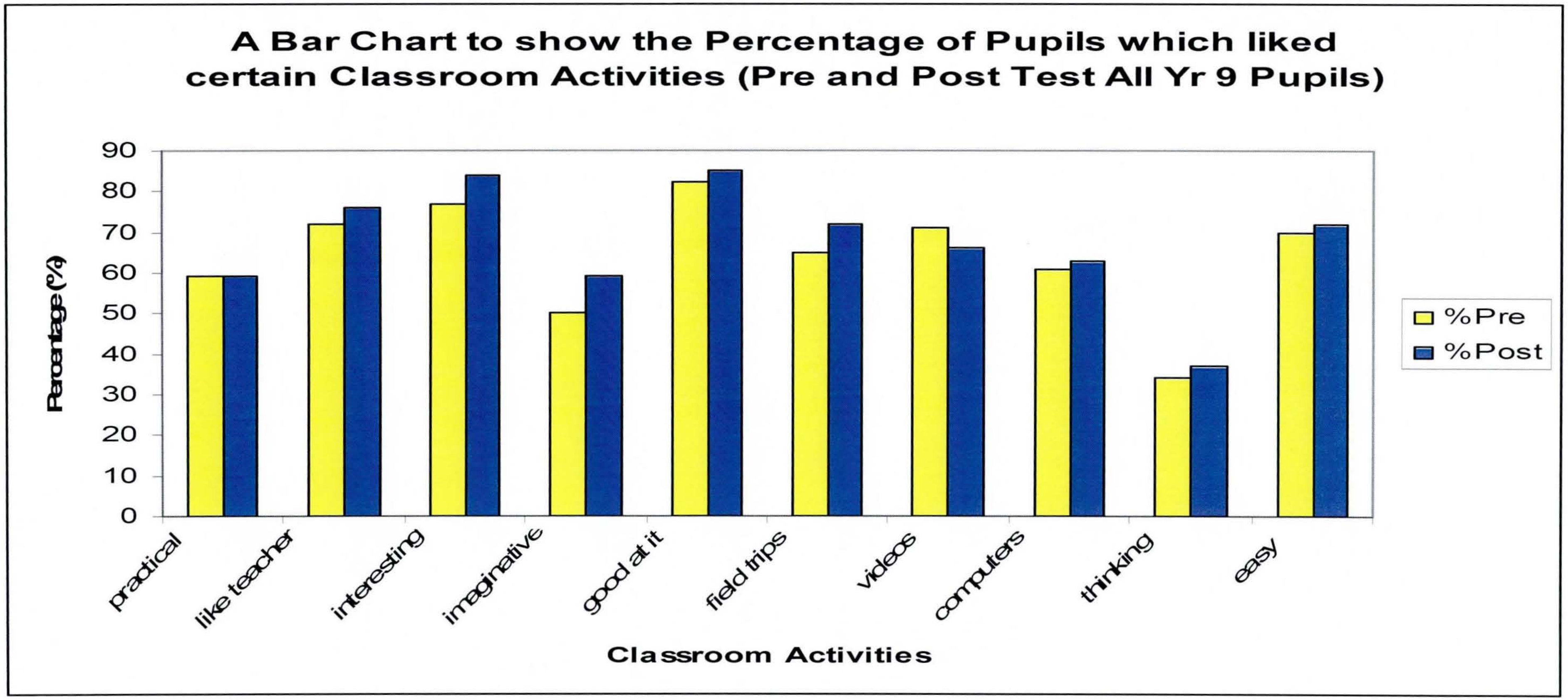


Figure 4.5.25: Pupils' Favourite Classroom Activities (Yr 9).

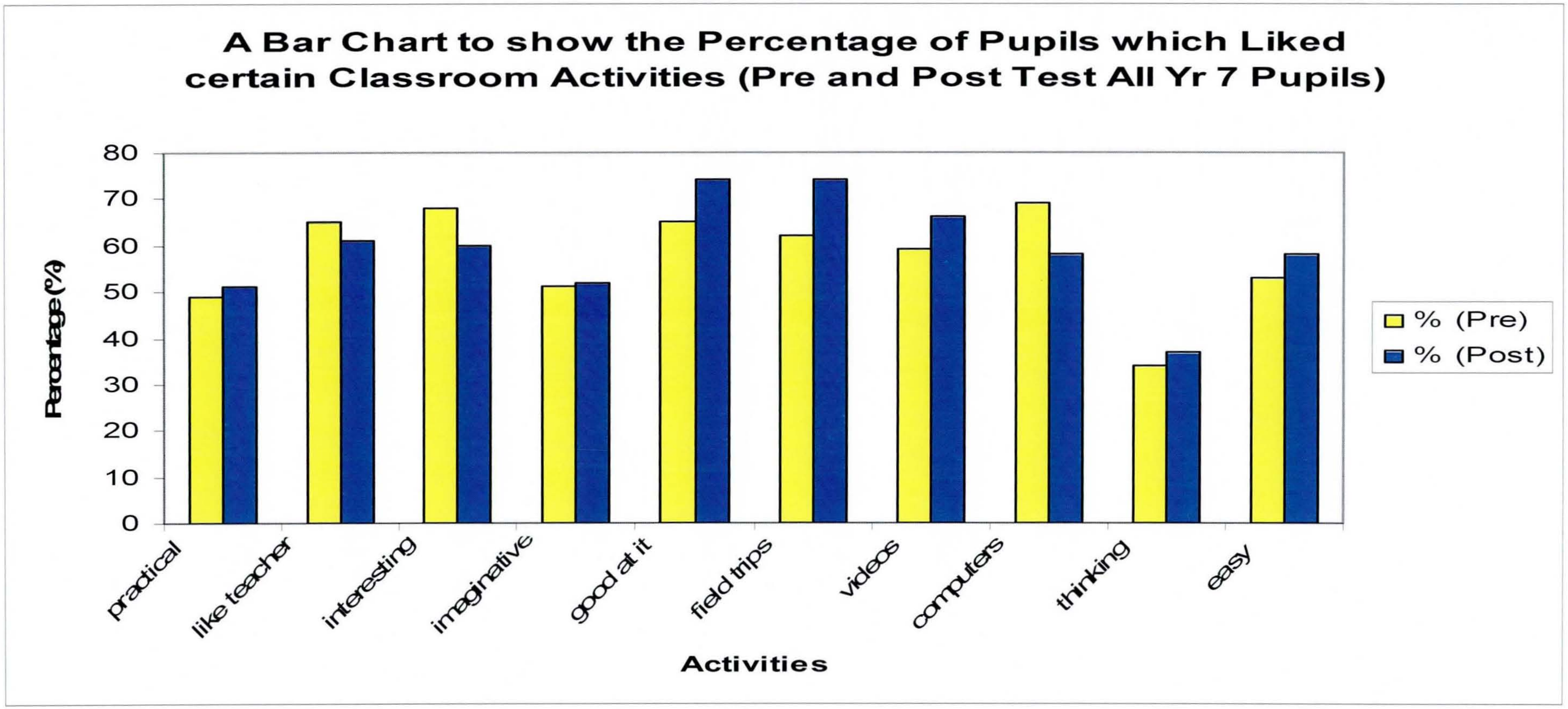


Figure 4.5.26: Pupils' Favourite Classroom Activities (Yr 7).

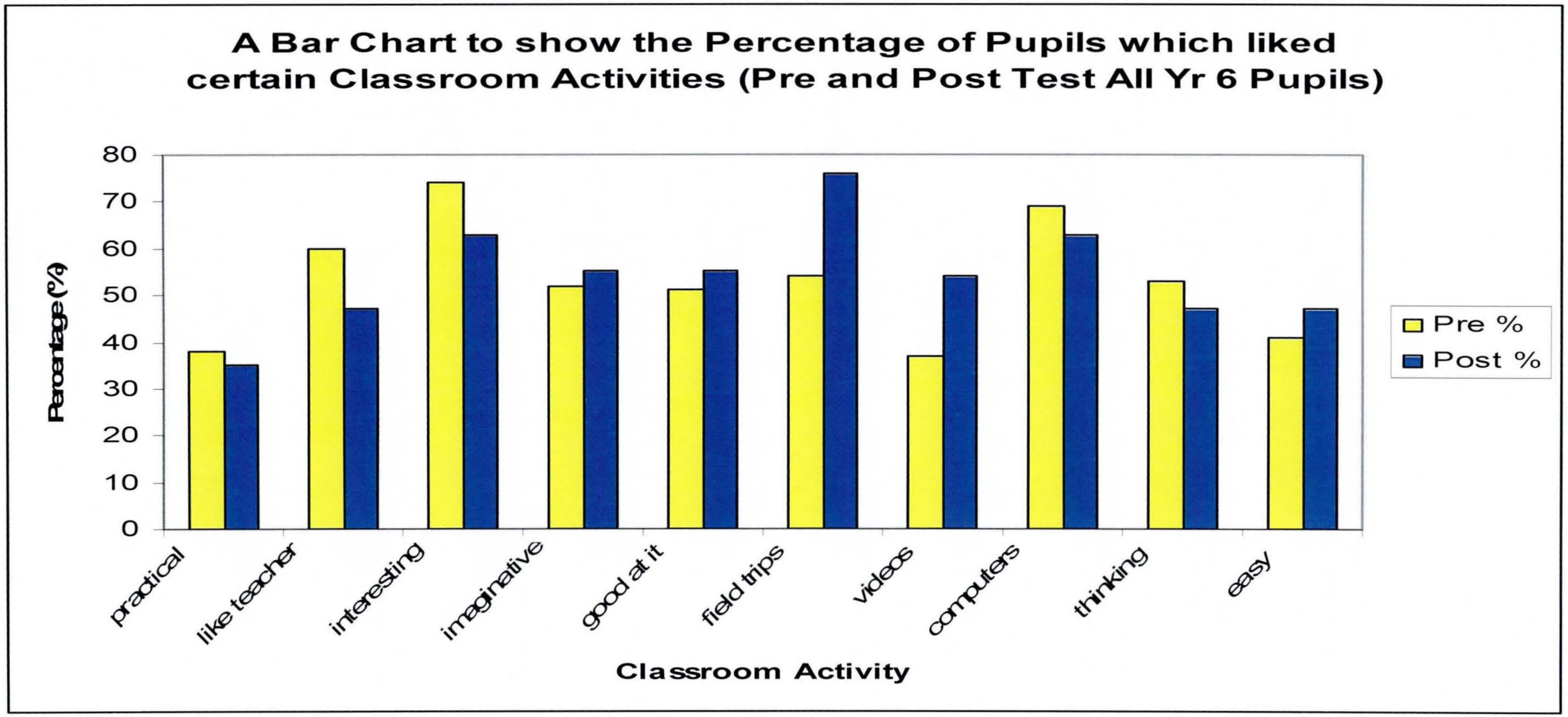


Figure 4.5.27: Pupils' Favourite Classroom Activities (Yr 6).

Teachers of science can make use of this information regarding what activities pupils like in lessons in order to try and improve their attitudes towards science at school. Using a variety of teaching methods, and by increasing pupils' awareness of science in their everyday lives and career opportunities in science, may by beneficial.

In conclusion, this section has analysed pupils' ranking of their favourite school subjects when given a mixture of practical or core subjects and the sciences and pupils have enlightened teachers as to which are their favourite classroom activities.

4.6. Results of the Pilot Study

Case Study Results

Interviews (Questions in Appendix)

The main points from the interviews with the case study are summarised as follows:

Interview 1 – January 2003

- She has particularly enjoyed experiments in lessons and demonstrations by the teacher.
- She has enjoyed studying the topics that interested her and outside of the classroom has watched television programmes based on science and following the teacher talking about the wide use of halogens in the home she remarked about having some in her shampoo (this was not mentioned in the interview; taken from the lesson).
- She felt that there was never a bad chemistry lesson and enjoyed the atmosphere as her friend was there also. She does not always look forward to biology due to the unpredictable mood of the teacher.

Interview 2 March 2003

- This term she has particularly enjoyed studying atoms and ions, balancing equations (she asked for extra practice on this even though we were not specifically doing them) and has enjoyed any experiment. The case study feels that she understands it all when it clicks into place.
- The extraction of metals topic was disliked as she found it boring and also didn't enjoy learning about covalent bonding.
- The teaching activities that the case study could remember well were: the experiment on bonding, the electrolysis role-play and she disliked, but

remembered, the overhead transparencies and rusting experiment which were both boring, the latter because she had done it before.

- In her approach to chemistry lessons, she has not felt as positive as the previous term. Last term a lot of her enjoyment came from her being surprised at how well she understood the work. This term it has been harder and she has found that she has understood less.
- Outside of school she has watched wildlife programmes on television but has not participated specifically in scientific activities.
- In her other comments about chemistry this term, the case study said that she has found it harder this term with having a PGCE teacher and she has not understood the work as much and she has been 'put off' science a bit.

Interview 3 – July 2003

- This term she has felt more positive again about chemistry lessons. It has helped that the original teacher is teaching again. She did comment that one frustrating part of having a student teacher was that there was no continuity in her teaching due to absence.
- Her examination result was very good and she was very impressed with herself (78%). She still felt that she could have done even better in her examination as she had muddled up ΔH and the half equations.
- The coursework component undertaken for the latter part of the term she has found much easier than expected! Her biology examination result was also very good (81%). She has enjoyed biology this term as the topics have been human based and she has found this interesting.

- In preparation for her examination, the case study read some science magazines and went on the GCSE bitesize website to aid her revision.
- Next year, she has decided that she wants at least a B grade in both biology and chemistry GCSEs (A's preferably!). She is surprised that she is better in subjects that she thinks she is not very good at but this causes her to worry and this motivates her to work hard to understand them.
- She definitely intends to study language A levels and have a career someway related to them. She picks them up easily and enjoys being able to use them on holiday (ie. She sees the relevance of studying them).

Diary: (January – March) 2003

Some general patterns from her diary show that:

1. The case study likes visual learning experiences such as demonstrations and experiments;
2. She likes teaching activities that are different e.g. games;
3. She likes to use her knowledge gained outside of the classroom (e.g. with her languages);
4. She likes learning methods to show her how to remember things e.g. mnemonics;
5. She likes repetition in teaching to aid her learning.

Diary: Summer Term (April – July) 2003

Some general patterns from her diary show that:

1. She finally grasped bond energies but doesn't see the point in them, particularly since they have not done organic chemistry yet (Which is where

she will mostly come across them);

2. She understood alloys well and used a mnemonic, OILRIG to help her remember redox;
3. It was interesting in biology to dissect an eye;
4. The flashcards she made in lessons for revision were useful;
5. The mid-term tests were good because they helped her to identify where she needed help or where she needed to do some extra work to fully understand;
6. She has found the chemistry coursework alright and it has helped that she has already done biology coursework.

<u>Conclusion: Interviews</u>

Her success this year has been based on her enjoying the lessons and even though this appears to be because of the social aspect it has had a positive effect on her learning. Teachers can use this and incorporate more group work into their lessons. She is confident to ask for help and keen to understand the work and therefore is confident to ask questions until she understands a concept. The atmosphere within the lesson gives her a positive attitude to come to the lesson.

For the first interview it was difficult on both parts. It was hard to extract the information; it was difficult for her to know how to answer. However, throughout the three interviews she became more aware of the chemistry-type questions and lesson-questions and having kept a diary for 6 months, she was more focussed on what we have done and what she has enjoyed. It was learnt in the first interview that some questions which need exact answers need to be specific, however, others need to be open for interpretation so that a wider appreciation from the interviewee is gained.

It was good to hear that she feels so positive towards chemistry lessons and it being due to the atmosphere is a consideration to a positive attitude towards a lesson. However, this could be due to her taking part in this research. It is obviously a suitable learning environment for her. Variety in lessons will keep her challenged and motivated and therefore having a positive attitude.

It doesn't however help with a more general view. If pupils are not with their friends, does it mean that they will not enjoy a subject and therefore display a negative attitude towards the lessons. How can a teacher overcome this? Perhaps the use of group work that was used in the study by Matthews et al. (2002), should be used so that all pupils get to know one another in their class and therefore the atmosphere will be enjoyed by all, however, this doesn't suit all teachers.

It is interesting how she would say she has no interest in science outside the classroom yet she enjoys watching wildlife programmes. Her 'hate' directed towards biology is rather surprising and shows the effect of the teacher on the attitude of the pupil towards a lesson. All teachers are different however and therefore one pupil will always have a preference as to who they prefer to be taught by. The case study appeared to like consistency in her teaching and has therefore reacted negatively toward a student teacher. Many pupils find change within the school year difficult to deal with as pupils get used to a teacher's style.

It was more difficult writing down the comments than when having the interview recorded; the flow and ease of conversation and 'going off on a tangent' did not occur in the final two interviews. This illustrates the importance of checking equipment beforehand. This is an additional limitation of using recordings.

It is disturbing that her enthusiasm has somewhat dropped and this could be linked to the level of difficulty, the topics being covered (metal extraction) or the change in teacher. She was much happier when the original teacher returned and a good examination result boosted her confidence. This shows how positive results in assessments play an important role in a pupil's enjoyment and attitude towards a subject.

In terms of coursework, she found the chemistry one easy as she had done a similar one in biology. This stresses the importance of doing practice pieces of coursework earlier down the school so that pupils do not dread the coursework component. One would expect pupils to enjoy them due to the practical element involved; however, pupils are wary of thinking for themselves and want help so they obtain the 'right' answer. The case study has highlighted the need for pupils to see the relevance of what they are studying and therefore from a teaching perspective the teacher needs to explain why they are studying a particular topic.

Diary Conclusion

Having a diary has helped the participant to focus on certain aspects of school life. As time has gone on, she has found it easier to answer the questions and she has thought about them more in the week so therefore can answer them in more detail. This does have a negative impact on the accuracy of the research since she may be enjoying chemistry more due to the attention that she is receiving that other pupils are not. The responses link to the interview answers and therefore firm conclusions can be drawn. The main ones are:

- When she has been concentrating she has understood the work;
- She gets frustrated if she doesn't grasp a concept straight away;
- She could remember practicals, demonstrations and videos from the lessons as well as note taking;
- She remembers demonstrations from lessons and activities that she found enjoyable (teachers need to be dramatic!);
- Understood things very well if they were topics previously studied;
- Found things that she would use in her everyday life useful but other parts not (only use is her GCSE examination!).

These highlight the need for pupils to be concentrating and being awake at school if they are to learn and get as much as they can from lessons. Many pupils, like the participant, the author has observed in lessons, get frustrated if they do not grasp the topic immediately. This has been particularly apparent in brighter pupils who have been used to understanding topics quickly.

It is important that pupils can remember demonstrations (if not it would be pointless). These should be interesting to pupils as they are experiments that only the teacher can do so perhaps it should inspire pupils since, if they progress, that is what they could do.

Repetition and linking work to that that has been previously studied allows pupils to know where they are starting from and any misunderstandings can be sorted out at the start of the topic. Brainstorming new topics can be a useful way to start a lesson; it awakens the pupil to previous work and it alerts the teacher to any misconceptions or gaps in their knowledge.

Making science relevant to every day life is extremely important; if pupils know why they need to know something or an interesting, relevant point, they are likely to enjoy it and therefore think quite positively about it.

In conclusion, the case study helped the plan by confirming some key reasons why pupils may like lessons, for example being with their friends, consistency in the teaching received, variety of teaching activities. Some interesting points were raised such as lacking confidence in writing about practicals and thinking about the results and also not associating some pastimes as scientific. This shows that how this question is worded is important to achieve the same understanding between the researcher and participant.

Pilot Study – TOSRA Test Results tables of means in each theme

Klopfer's Theme	Pre TOSRA Test - Mean	Post TOSRA Test - Mean
1	3.34	3.22
2	3.23	3.20
3	4.29	4.24
4	3.42	3.02
5	3.31	3.09
6	2.75	2.10
7	3.02	2.39

Table 4.6.1: Yr 7 Pilot Study Results for Pre and Post TOSRA Test (n=21).

Klopfer's Themes	Girls – Pre TOSRA Test Mean Value	Boys – Pre TOSRA Test Mean Value	Girls – Post TOSRA Test Mean Value	Boys – Post TOSRA Test Mean Value
1	3.54	3.24	3.83	2.91
2	3.54	3.07	3.86	2.87
3	4.23	4.31	4.40	4.16
4	3.77	3.24	3.51	2.77
5	3.49	3.23	3.74	2.76
6	3.06	2.64	3.03	1.74
7	3.46	2.80	3.03	2.07

Table 4.6.2: Yr 7 Girls (n=7) and Boys (n=14) Mean Values for Pre and Post Pilot Study TOSRA Test.

The results are for a mixed gender class of 21 Yr 7 pupils. The results from the questionnaires show that for each theme the mean is lower in the post test for all of the themes than the pre test. Chi square calculations showed that the significance in pre and post TOSRA test values is a probability of 0.95. Although themes 4, 6 and 7 in the post test appear to be lower values than the pre test, the difference is not significantly different.

From analysing the seven girls in the sample themes 1, 2, 3 and 5 show a higher mean in the post test results. However, chi square reveals that the significant difference between the pre and post test for the girls in Yr 7 is 0.61 and with six degrees of freedom the probability is 0.995, hence the null hypothesis cannot be rejected.

Compared with the boys, the girls have higher mean values in both the pre and post TOSRA test in themes 1, 2, 4, 5, 6 and 7. In themes 1, 2, 4, 5, 6 and 7 the boys have a mean less than three for the post test demonstrating a negative attitude. Theme 3 has the boys with a higher pre test mean but the girls are higher again in the post test. However, this is a small sample and therefore cannot be deemed reliable. These results could be very different in another school.

Analysing the Yr 7 data for just the boys, all of the post test means are lower than the pre test. Chi square is 2.27 and this shows the probability of 0.9.

Klopfer's Themes	Pre TOSRA Test – Mean Value	Post TOSRA Test – Mean Value
1	3.49	3.61
2	3.71	4.07
3	3.90	3.53
4	3.70	3.25
5	2.87	3.31
6	2.43	2.16
7	3.10	2.74

Table 4.6.3: Pilot Study Results for Yr 9 Pre and Post TOSRA Test Mean Values (n= 20).

Klopfer's Themes	Girls – Pre TOSRA Test Mean Values	Boys – Pre TOSRA Test Mean Values	Girls – Post TOSRA Test Mean Values	Boys – Post TOSRA Test Mean Values
1	3.62	3.38	3.67	3.56
2	3.93	3.53	4.20	3.96
3	3.96	3.85	3.07	3.91
4	3.78	3.64	3.33	3.18
5	3.24	2.56	3.49	3.16
6	2.58	2.31	2.44	1.93
7	3.20	3.02	2.80	2.69

Table 4.6.4: Yr 9 Girls and Boys Mean Values for Pre and Post TOSRA Test in the Pilot Study (girls n=9; boys n=11).

For the group of 20 Yr 9 pupils the results show that themes 1, 2 and 5 are higher in the post test. The result of chi square shows that the probability is 0.99, hence the null hypothesis cannot be rejected.

The highest value means are in themes 2 (post test - 4.07) and 3 (pre test - 3.90). Means less than three, showing a negative attitude are in theme 6 in both the pre and post test but only in the pre test for theme 5 and only the post test for theme 7.

The results of the nine girls in the sample show that the post test results are higher in themes 1,2 and 5. Chi square is 1.228 and this probability is 0.975.

For the eleven boys in Yr 9, the results show that the post test results are higher in themes 1, 2, 3 and 5. The chi square value is 0.9053 and this probability is 0.99.

Klopfer's Themes	Post TOSRA Test – Mean	Turner Post TOSRA - Mean
1	3.22	2.97
2	3.20	3.09
3	4.24	3.14
4	3.02	2.90
5	3.09	2.72
6	2.10	2.01
7	2.39	2.60

Table 4.6.5: Yr 7 Ledbetter and Nix Post TOSRA Test Mean Values compared with Turner, Post TOSRA Test Mean Values (n=21).

These results show that the means for the Post TOSRA Test Turner questionnaire are all lower than the Ledbetter and Nix (2002) means except for Theme 7. However, this could be the case: the pupils' attitudes are in fact less than apparent due to lack of understanding the question. Pell and Jarvis (2001) took care to avoid using any reversed items so that the questions were more accessible to the youngest pupils. In this research, Yr 6, are the youngest age group used from primary school and the small group interview, following the Pilot study, also echoed that the questions were easier to read and interpret when written positively phrased.

4.7. Final Year Work with Primary Yr 2 Pupils

Having obtained results from Years 6, 7 and 9 for the 'pupil-friendly' TOSRA test, since an obvious decline was not evident and it appeared that attitudes had been instilled before this age group, it was decided that moving down a Key Stage would be useful to investigate if their attitudes were determined by that age. Pell and Jarvis (2001) report that girls and boys decline in positive attitude towards science appears towards the end of primary years so this was investigated. Piburn and Baker (1993) report that the results of the National Assessment showed decline in attitude towards science and interestingly that the most positive attitudes were held by 9 year olds (1977, 1982 and 1986). This could be an age group to research and compare if that statement is still true nearly thirty years later.

Research methods were investigated but were not suitable for this age group, e.g. completing questionnaires, diaries, role-play and therefore a different method was needed to be designed based on questionnaires but being accessible to young children. Mortimore et al. (1988) used a smiley face scale for Yr 3 pupils investigating children's attitudes to different aspects of school life. This was a five point scale based on the smiley faces being very happy to very sad. A similar method could be used with Yr 2.

The age group chosen are able to communicate quite well and although wouldn't be able to answer the questionnaire alone, a simple word-card game was designed based on each question theme in the questionnaire. This idea arose from reading and speaking to primary classroom teachers and asking what skills Year 2 pupils have and what kind of information would be accessible to the researcher. The word cards had pictures on so if the pupils couldn't read the words or know what they meant after having them read out to them, that a picture might be most helpful (see Appendix 11 for examples used). The level of ability would differ so hence a choice of 'not sure' was put in so that if pupils didn't understand, they didn't have to make a firm wrong choice. Since experts in the field (primary teachers) were asked about the task this gives the activity some validity.

A pilot study was carried out to see if the questions would be understood by this age group, if the tasks were simple enough, how long the activity would take and how many groups could carry it out at one time. It did show that giving a tick-box 'after-school activity' sheet was very hard for them so it was easier for the sheet to be read out and for the researcher to tick the boxes. Working with one pair at a time seemed the most supportive and simplest way of working for both the pupils and the researcher. The pupils enjoyed the activity and could, if not read the cards, understand what was being said by the pictures so it was pitched at a suitable level for this age group. Each pair (and this was chosen so that each pupil had support from each other when faced with a stranger) took approximately fifteen minutes to complete the task.

The six schools that participated in the research (excluding the Pilot Results which were smaller in number) have all received their own individual school results. Each school was responsible for selecting a range of ability pupils and either girl or boy. Results for each school were analysed according to gender but not for the overall results. Pupils participated in pairs so that they would feel more comfortable talking to a 'stranger' and also so that brighter pupils were able to help less able pupils. In order to gain the pupils' confidence the test commenced with a brief explanation of who the researcher was and reassuring the pupils that they were not being testing in anyway. The rules for the test were explained - for the pair responses both of the pupils needed to agree for a smiley face 'yes' or a sad face 'no' or if they couldn't decide, did not know or did not agree, then the not sure face was to be used. This type of smiley face scale was used by Mortimore et al. (1988). They used a five-point scale, however, just a three point scale will be used in this study. The conversation started with the question about which jobs needed some knowledge of science and a vet was selected first so that the pupils could be asked if the pupils had any pets and have a chat with them about them. This proved successful and helped the pupils to enjoy being a part of the research and to feel at ease with the researcher. Some of the teachers invited the researcher into the classroom so that the pupils felt she was part of the lesson and in all cases, the pupils and the researcher sat in the corner at their own table.

The seven questions asked were (one in each of Klopfer's themes as before):

1. Which jobs do you think need you to have some knowledge of science for you to be able to do them?
2. What do you think Scientists are like as people?
3. What things do you think you need to do in a science lesson to be like a scientist?
4. Which of the following everyday objects do you think were made/developed by scientists?
5. Which of the following activities do you enjoy in science lessons?

6 Which of the following activities do you do after school?

7 What do you want to be when you grow-up?

The choices the pupils had are shown in the bar charts following and the pupils, together, chose which face was appropriate to their response. My comments on the result will focus on the highest number of pairs of pupils for smiley face (positive) responses.

The overall results are as follows:

Question 1

Of the option given, the most likely to be jobs requiring some knowledge of science are:

- Dentist
- Nurse
- Doctor
- Paramedic

The pupils' responses did show that the jobs that needed science were a dentist, nurse, doctor, paramedic and florist. However, a policeman and fireman also scored quite highly which do require some knowledge in certain fields. One anomalous result that stands out is that the pupils think typists need some knowledge of science. One of the teachers suggested that this was because one typist types up the science notes. Pupils were sure that bankers did not need any knowledge of science. Pupils were not sure about lawyers, maybe because they did not understand what they do as a job. Perhaps many of their decisions came from knowing what their parents' occupation were and what they needed to know to carry them out.

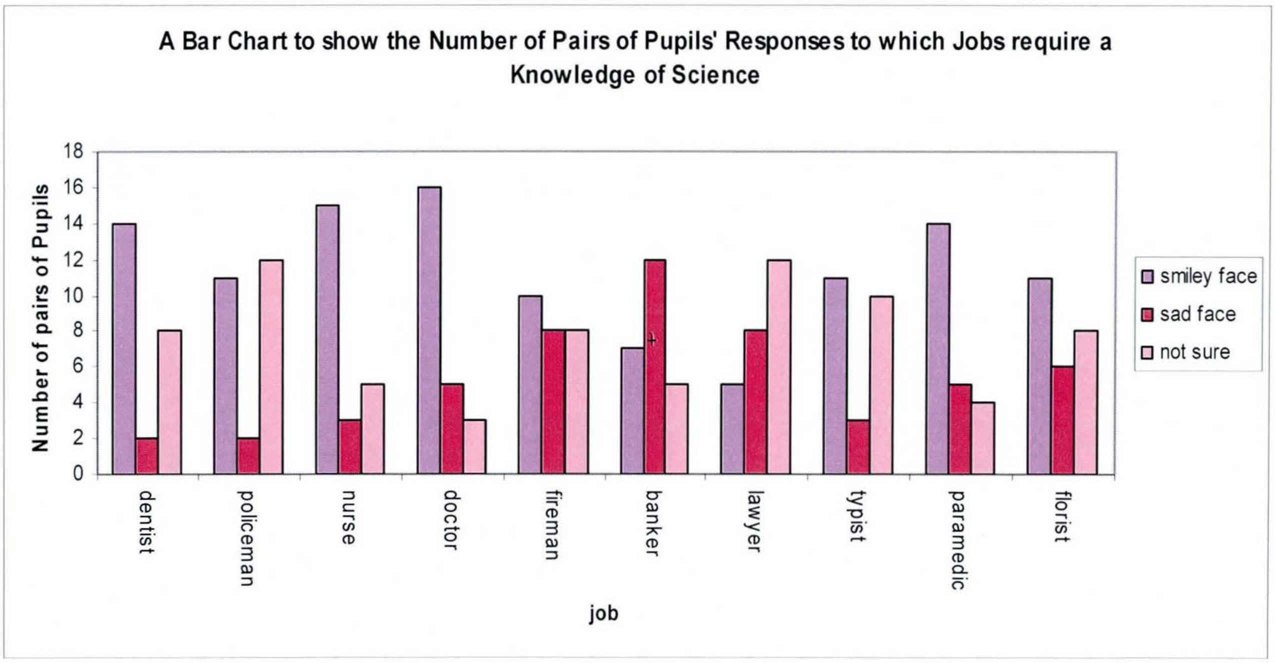


Figure 4.7.1: Yr 2 Activity – Bar Chart to show which Jobs require Knowledge of Science.

Question 2

This question was testing the stereotypes of scientists. The top responses from pupils regarding what scientists are like were:

- Likes to read
- Wears a white coat
- Smiles a lot
- Very quiet

These responses show that for some the stereotypes are there but not for all pupils. Smiling was a response that was not expected and would be an interesting question to expand upon. There were some interesting discussions with many of the pairs of pupils about whether scientists have grey hair, glasses or a beard and the pupils that were more able discussed that some scientists would and it might depend on their age. The pupils did put a lot of thought into these responses. Pupils responded 'not sure' to the cards of do scientists have grey hair, wear glasses, are married or have pets at home. Some pupils in the pair were strong to say 'Of course they will be married or have pets' others really did not know what to think about these things. Pupils responded 'no' to playing sports, watching television and having a beard so perhaps showing some thought of scientists being excluded or introvert.

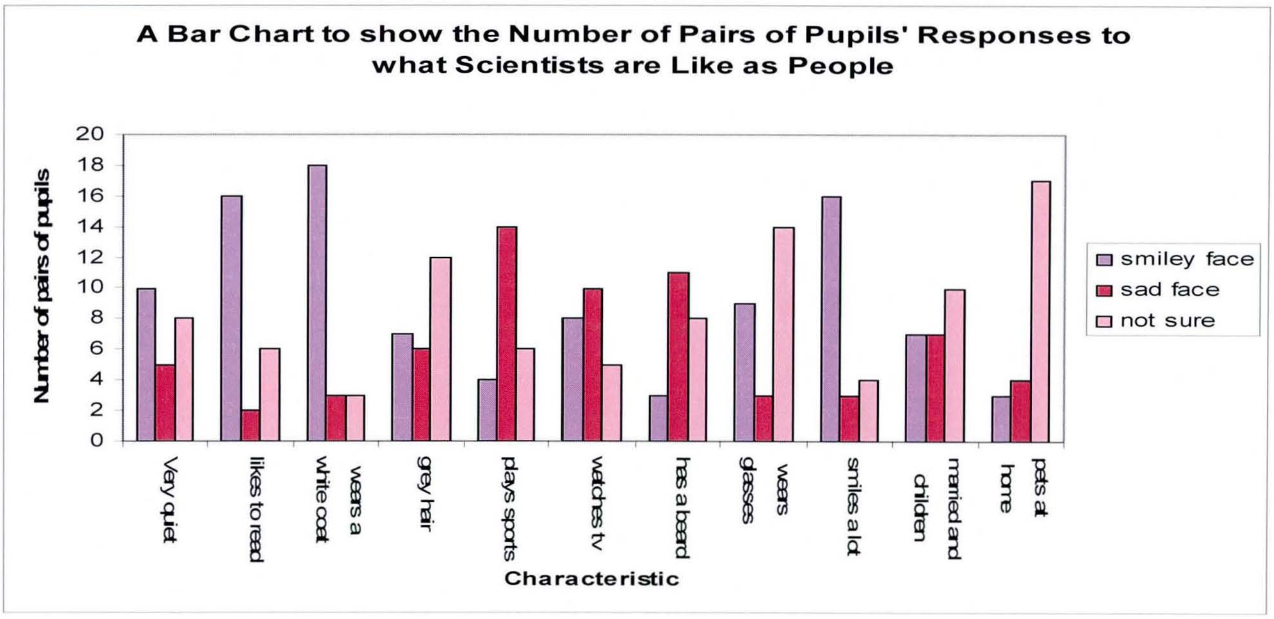


Figure 4.7.2: Yr 2 Activity – Bar Chart showing what the Pupils' think Scientists are like.

Question 3

Pupils gave good responses to this question and the most common things to do in science lessons to be 'like a scientist' were:

- Repeat an experiment
- Ask questions
- Read books
- Try a new experiment

Working with friends and going on the internet also scored quite highly overall. Their responses were rather mature to this question and did show that even though their science experiments are quite basic, they understand what they need to do and why. This question did provoke discussions such as scientists would not watch the television as it needs to be more up to date and the pupils were unsure whether scientists would work alone or in groups.

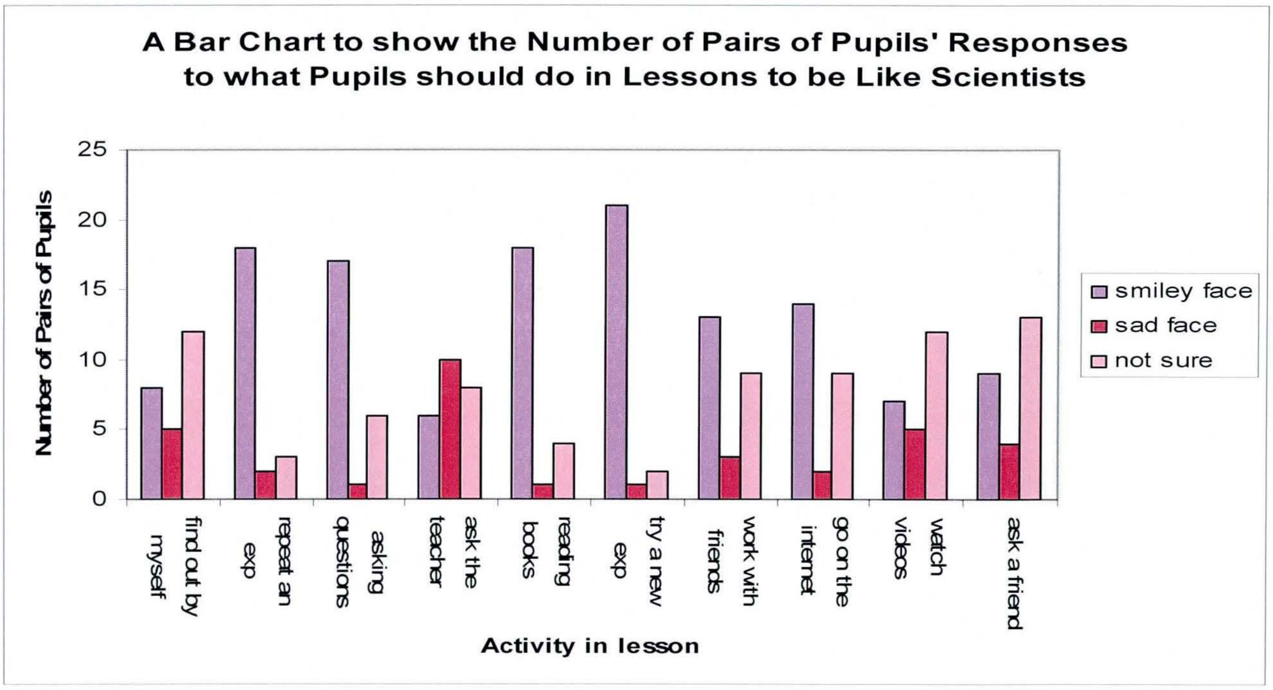


Figure 4.7.3: Yr 2 Activity – Bar Chart showing what Pupils think you should do in Science lessons to be like Scientists.

Question 4

Deciding what was made by scientists proved a difficult question but it could be argued that all of the objects somewhere had been made by scientists! Definite 'no's that the pupils said were houses, schools, soap, toaster, washing machine and shoes. Pupils did choose the expected word cards from the choice as items that had been made by scientists:

- Computers
- Cars
- Medicines

- Mobile phones

This question does show that even young children have an appreciation of what scientists can make.

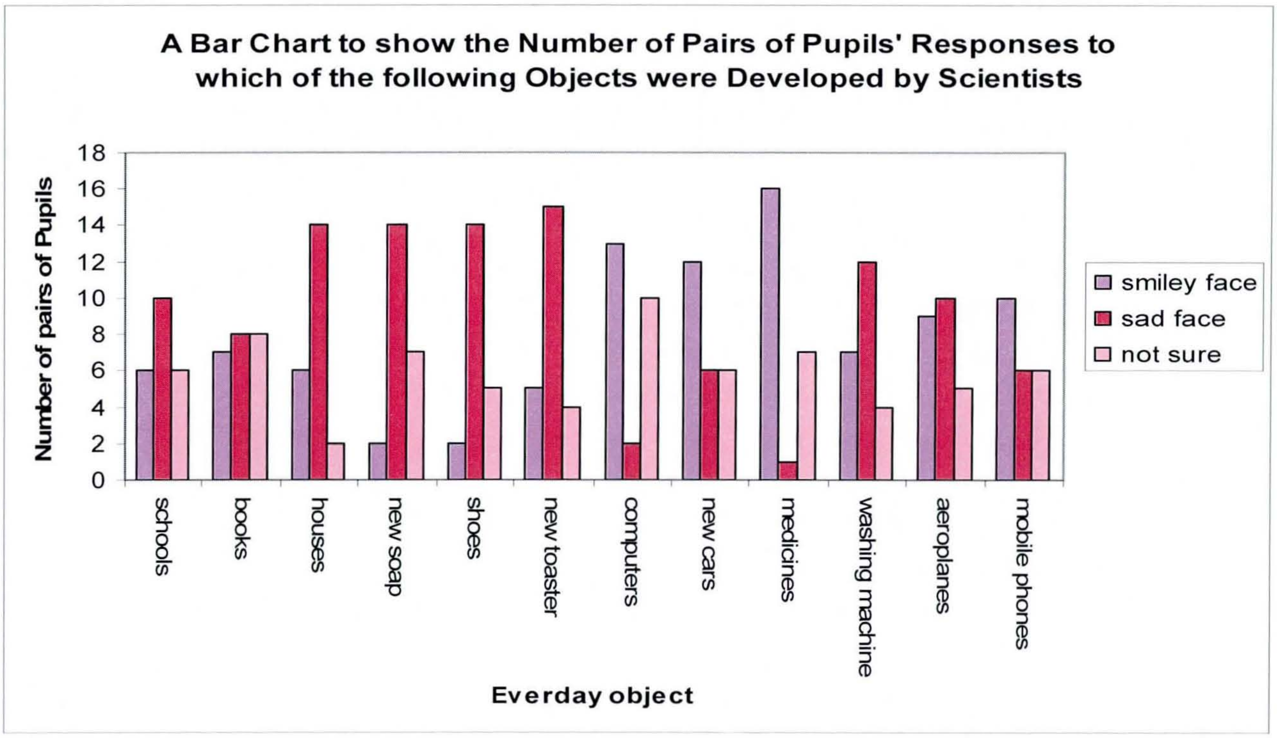


Figure 4.7.4: Yr 2 Activity – Bar Chart showing what Pupils think are made by Scientists.

Question 5

Most pupils were enthusiastic about their science lessons and appeared to like lots of different activities. The favourite activities were:

- Computers
- Group work
- Making things
- Experiments

Also scoring quite highly as positives:

- Watching videos

- Field trips/museums
- Writing up experiments
- Writing stories
- Drawing diagrams
- Poster

Activities that did not get smiley faces as much were having discussions or writing poems. These results are similar to those of Pollard et al. (1994) who researched why children liked certain school activities. In their findings they liked activities that were interesting, fun, gave them success whilst they disliked activities which made them bored, that they found difficult, involved sitting down, listening or writing.

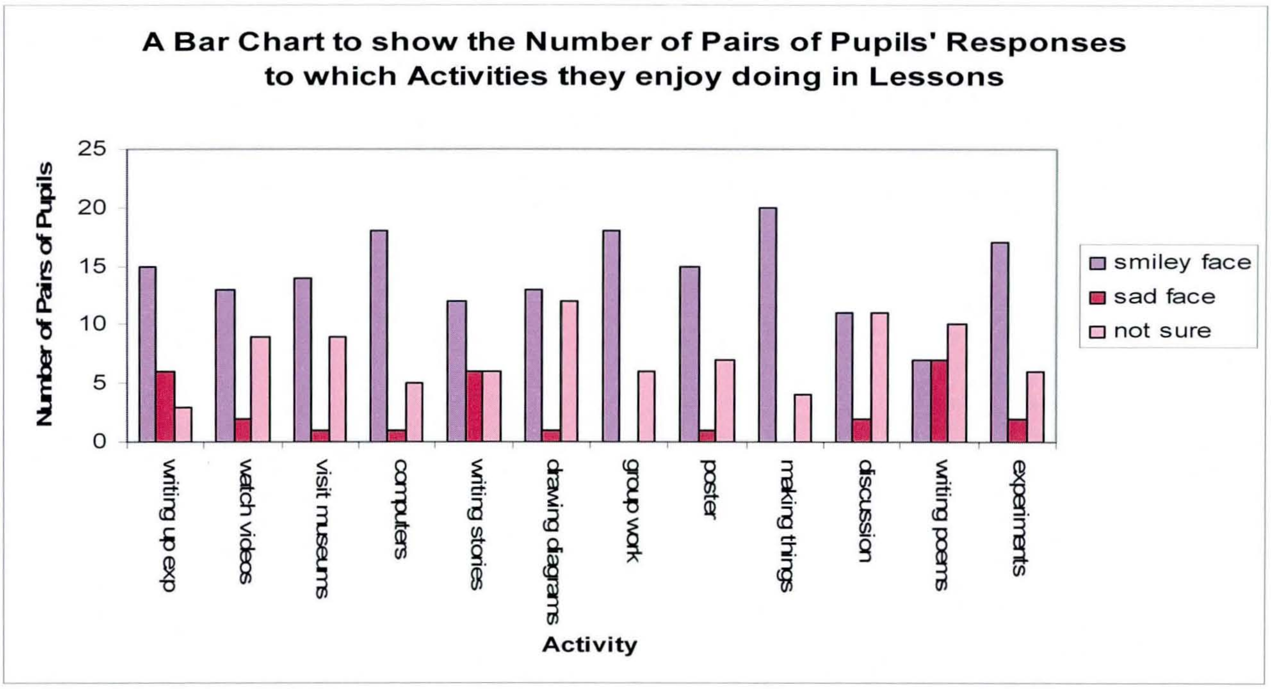


Figure 4.7.5: Yr 2 Activity – Bar Chart to show which Activities Pupils like to do in Lessons.

Question 6

After school the pupils were very busy with a variety of activities! The common activities that pupils participate in were:

- Watch television

- Play with friends
- Play computer games

Playing sports, drawing and playing a musical instrument also scored quite highly. In discussions with the pupils about other activities, the following were mentioned:

- Attending Beavers/Brownies
- Reading with member of family
- Getting changed/dressing up

A favourite television programme appeared to be Sponge Bob. Brainiac was also mentioned.

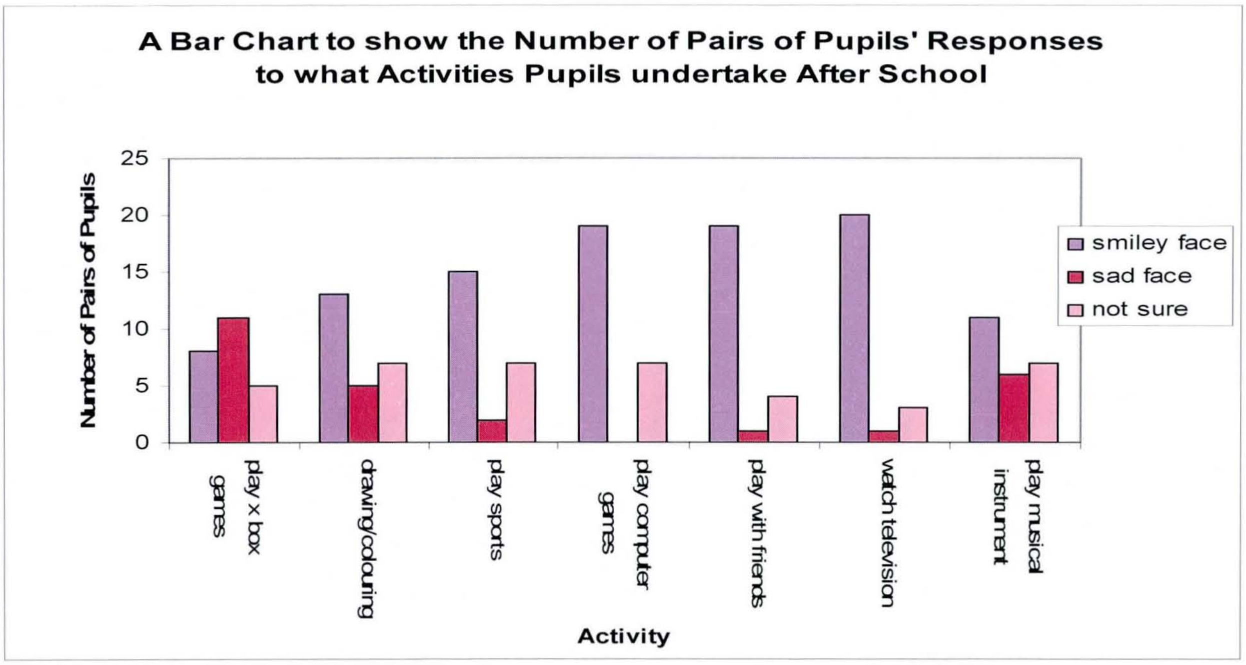


Figure 4.7.6: Yr 2 Activity – Bar Chart showing what Activities Pupils Participate in after School.

Question 7

What pupils want to be when they grow-up caused the most disagreement in the pairs so many had to say 'not sure'. Other option choices that were discussed which were not in the given choice were astronomer or footballer. Pupils were generally 'not sure' about their future and warmed towards jobs they had seen or were a bit more familiar with such as:

- Actor
- Vet
- Policeman
- School teacher
- Hair dresser

The most common response overall was 'no' and this was particularly for the following:

- Air pilot/air hostess
- Doctor
- Builder
- Taxi/bus driver
- Fireman
- Gardener
- Nurse
- Lawyer
- Dentist
- Typist
- Mechanic

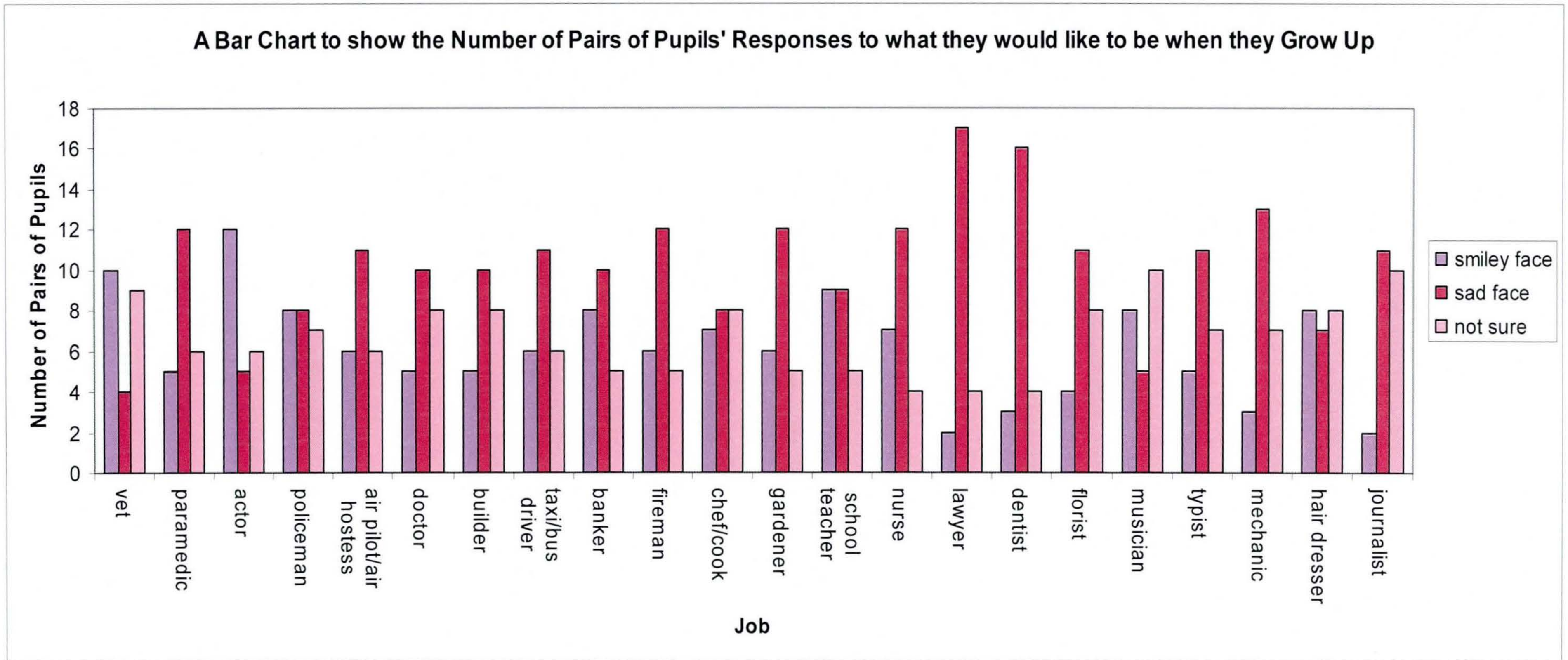


Figure 4.7.7: Yr 2 Activity – Bar Chart showing what Pupils want to be when they Grow Up.

In conclusion, there appeared to be a great deal of enthusiasm for science in the pupils and as teachers, there are useful hints as to which activities in lessons pupils need to do to be like scientists and of what pupils enjoy. Their awareness, of what scientists do and are like, is good and this may have been portrayed through the media, magazines, family or school. One also has to be aware that not all pupils would fully understand what was meant by 'science' even though it was explained to them by their teacher as to what they had done this year such as materials, planets or animals. Also, if a pair disagreed they were told to choose 'not sure' which would be incorrect and some pupils will have just agreed with their partner. Therefore some of the responses must be taken with caution as they may not be a true reflection of what the pupils actually felt.

From this research, there were still some questions to be answered, for example, how did the pupils know that doctors and nurses would need some scientific knowledge, how do they know that scientists wear white coats? One could hypothesise that the answers lie in their parents, friends, television and school but nothing certain. In order to triangulate my findings, a group discussion was held with some pupils in this age group to confirm the findings. The discussion took place with both Yr 2 and 3 pupils.

Group Discussion

Pupils' views on how they know that doctors, dentists, nurses and paramedics need some knowledge of science were:

- Been to visit them e.g. dentist, doctor, nurse;
- One of their mums is a doctor/one of their mum's friends is a doctor;

- Watch Brainiac on television (very popular);
- Read books about Science which had mentioned doctors and nurses.

Their views on how they know that scientists wear white coats, like to read, are quiet and smile are:

- White coat – drawn them like this in science lessons, seen pictures of them in them, done a jigsaw with a picture on it, they think if they are doing experiments they might get messy and wouldn't want to spoil their clothes, when been to Drs or dentist the people there have worn white coats;
- Like to read – so they know what experiment to do, learn something like they do from books, might have an experiment in their book that they want to do;
- Quiet – when they are concentrating they need to be quiet, if someone can help them then they might have to talk to them, they might talk when they go and get something;
- Smile – when they get experiments correct they might get excited.

Pupils' comments on how they know in science lessons to repeat experiments, ask questions, read books and try new experiments were:

- Repeat – see if the experiment still works, try a medicine more than once and then try it again before you try and use it;
- Ask questions – if you don't know something, you ask someone, this could be for safety so you don't blow things up;
- Read books – you become clever if you read, they are used to it;
- Try new experiments – learn more, become more scientific.

Pupils' responses on how they know certain things are made by scientists:

- Information from the television;
- Scientists are clever and these things are complicated so they must have made them.

All of this research leads to a conclusion based on experiences in their everyday life from a very young age, maybe from birth with children being shown pictures, experience of hospitals/doctors/nurses/dentists, children are shown books and encouraged to read and children enjoy watching the television. If pupils know so much from a young age, this needs to be nurtured and encouraged as they grow up. Writers, television producers can take advice from this research in knowing that they provide for this age group a lot of encouraging and positive things about science but they need to be continued in an exciting and 'cool' way for all ages, especially at both primary and secondary school level.

In agreement with the research undertaken in the final year work, in Yrs 6, 7 and 9, the most common themes with 'correct' responses relating to science were themes 1, 3 and 4 (obvious chosen). Theme 2 showed that pupils do not have such a stereotypical view as perhaps thought – not a convincing 'yes' for a beard, glasses, grey hair but pupils were not sure if scientists would have pets or not. Pupils did think they would wear lab coats. The enjoyment of specific activities in lessons, at this young age, was making things and experiments. From a teacher's view point, their skill in primary school is to maintain the enthusiasm in pupils and to promote science in everyday life and leisure time. Just like the older pupils, Yr 2 pupils were unsure of careers based in science but in terms of leisure time involving science, many pupils loved to play computer games which could be considered scientific.

4.8. Final Year Work Yr 6-7 Transition

The transition from primary to secondary school is one that has been renowned for a dip in progress for pupils (Ryan, 2002). In order to investigate this part of the dip in attitude, research was undertaken with pupils as they joined secondary school.

The research undertaken was in the form of a questionnaire (8 questions) and a small group interview (8 volunteers from the forms) at the end of the first term. The aim was to investigate what pupils liked/disliked at secondary school. The questionnaires gave a general insight to why pupils like/dislike certain subjects and what moments have been memorable/not enjoyable this term. The small group interview helped to get more detail on these questions and to clarify any uncertainties that the researcher had.

Many of the questions have more responses than others this is due to not all pupils giving a response to a question and some pupils gave more than one response. Some responses have been abbreviated or slotted into a category which means the same. Further analysis into which boys/girls answered could be undertaken, particularly where liking/disliking of subjects is present.

Before considering the Yr 7s after transition, the researcher observed some science lessons in Yr 6, two years running, of similar material, so that comparison could be made as the researcher observed the different pupils and their responses.

The key points from the lesson observations about Yr 6's and their learning were the following:

- When writing up practicals, one new part introduced each time, for example, prediction or conclusion;
- Pupils were enthusiastic in the lessons, enjoyed the practical and asked a lot of questions;
- Linking of maths and science was apparent with the graph work;
- Pupils were extended by being asked to write predictions and to think about the practical in different ways;
- Pupils have been used to writing up practicals at primary school including evaluating what they have done;
- Pupils have a lot of general knowledge on science and are inquisitive – discussion time is valuable;
- Good pace of lesson with a high expectation of how much would be done (pupils wrote one and a half sides of A4 paper in 30mins);
- Pupils need constant encouragement and are used to regular feedback.

This enabled the researcher to compare how secondary school science is taught and how primary science is taught. Although there are many similarities, such as a special science room, different teacher, there are many differences also, especially in expectation during practical write-ups and the length of time spent on one part of the activity.

Transition Data

Since the pupils are at a new school the pupils were asked, at the end of their first term, to choose their favourite subject (which was Games) and their top 5 favourite subjects. The results were (n=110):

1 Games
2 English
3 Art
4 Drama
5 ICT

The pupils were also asked to choose their least favourite subject (Religious Studies) and their top 5 least favourite subjects. The results were:

1 Religious Studies
2 Spanish
3 Mathematics
4 Geography
5 Design Technology

At the end of the academic year, the pupils were asked the same questions again. Games was still definitely the favourite subject, however, in the top 5, Biology was in 5th place instead of ICT. Religious Studies was still the least favourite subject but there were some changes in the top 5 least favourite:

1 Religious Studies

2 Spanish

3 Mathematics

4 Physics

5 Chemistry

In the questions regarding subjects it is not surprising that answers why pupils like certain subjects are because of the nature of the subject, they are good at it, they enjoy it or the practical nature where applicable. However, there are some other less obvious answers for example, 'the teacher not understanding my needs', 'I'm dyslexic' and 'no one picks me'.

New subjects to pupils are different due to different pupils' perceptions of the term 'new'. Science was obviously studied at primary school but at this school it is studied as three separate sciences and many pupils noted this. However, some only named chemistry and physics or biology and chemistry, perhaps relating to how much of the other or of these they had actually done in their primary school. Often biology is most studied at primary school as there are more practicals for it so perhaps pupils don't see it as being new. Spanish, being the language learnt in Yr 7, was new to many pupils as they may not have studied one at all at primary school. P.S.H.E. (Personal, Social and Health Education) was also a 'new' subject which they wouldn't have had separately or given a name. Other subjects that pupils commented on were: design and technology, drama, music, games, R.S., history and geography. Different primary school undertake different themes so some of these subjects were maybe not taught on a weekly basis or made clear to the pupils what they were studying in terms of the curriculum.

There are a variety of positive comments about memorable moments in the term. Many of these relate to pupils' friends that they have made and also to sports matches – the first match, being in the 'A' team and scoring in matches. On the other hand, many of the pupils' 'worst' moments were about not being picked for a team, falling out with friends/bullying or receiving some kind of punishment. An insightful list was produced from the comments that were given – some you'd expect and other refreshing thoughts! (See Appendix 12 for full table of reasons).

In the other comments about the school, some were very positive comments about how much they like it and their friends and teachers and others were making negative comments that they obviously could not make anywhere else on the questionnaire. The answers given were how they interpreted the question and so again a variety of useful and interesting comments were given. Two of the best moments given were related to science: lighting a Bunsen burner and watching a duck hatch. Also, two worst moments were related to science: change of physics teacher and failing chemistry.

Subject	**Reasons for Liking It**
Biology	Good experiments, like it, like animals, interesting, mum's a GP, fun, easy, good at it
Chemistry	Like practicals, fun, different, interesting, like the teacher, good at it
Physics	Fun, easy, like the teacher, like to find things out, interesting, like the style of lesson, different activities

Table 4.8.1: Reasons for liking Science Subjects at School.

Subject	Reasons for Disliking It
Biology	Difficult, boring, not challenging enough, hard to concentrate, do not like the topics, do not like the teacher, write a lot, teacher talks too much, do not enjoy it
Chemistry	Write too much, too many words to learn, not very good at it, hard homework, complicated experiments, room smells, hard, uninteresting, boring, do not like the teacher, too many sheets
Physics	Write too much, difficult, hardly do any practicals, boring, not very good at it, do not enjoy it, hard homework, do not understand it, hard to remember everything, maths is a bit hard, I am not scientific

Table 4.8.2: Reasons for Disliking Science at School.

In conclusion, it can be seen that in lessons, pupils like to do practicals, enjoy what they are doing and see the relevance of it, to be stretched and to be challenged. This is useful information to Yr 7 teachers and bearing in mind the culture they have come from in primary school – just one teacher for nearly all their school day and lots of different activities – should help pupils to overcome some of the negative comments like 'boring' and 'uninteresting' in their planning. It is useful to see which subjects are perceived as 'new' to pupils and perhaps these can be introduced on 'taster days' or at the end of primary school to help the transition. General comments about the school enforce the importance of positive rewards such as stars, playing for school teams and examination performance and also highlight that the punishment system is respected and not enjoyed by pupils e.g. 'yellow papers' and detentions.

The overall positive feedback from the pupils shows that the school is a happy and friendly place and that there are enjoyable experiences for most pupils to help the transition. An assumption can be made based on the evidence that pupils felt happy at their secondary school that the transition was not a factor in their attitudes towards science.

4.9. Final Year Work - Teacher Questionnaire Findings

Having considered the pupils throughout the research and their attitudes towards science, since these attitudes are set at a young age, in primary school, who has the most influence over these pupils? Their parents? The media? Their primary school teachers?

Teachers were one of these areas that could be researched so a number of schools were sent a questionnaire for their teachers to complete. This requested information regarding what subject they were trained in, which subjects do they enjoy/not enjoy teaching and reasons? Questionnaire in Appendix 6). Only a small number of schools (6 in total) took part in the research but some interesting patterns were found.

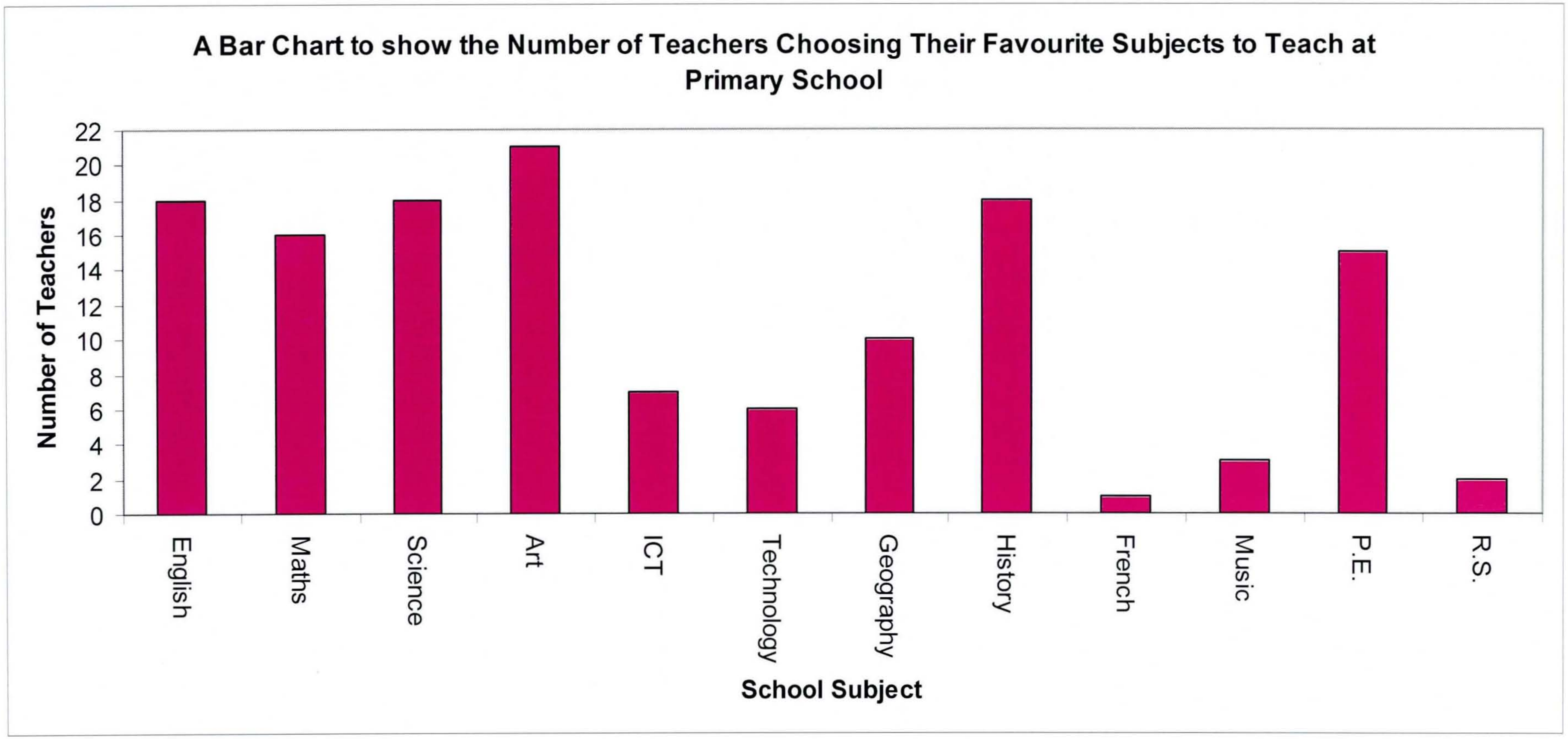


Figure 4.9.1: Bar Chart showing the number of teachers choosing their favourite subjects to teach (n=38).

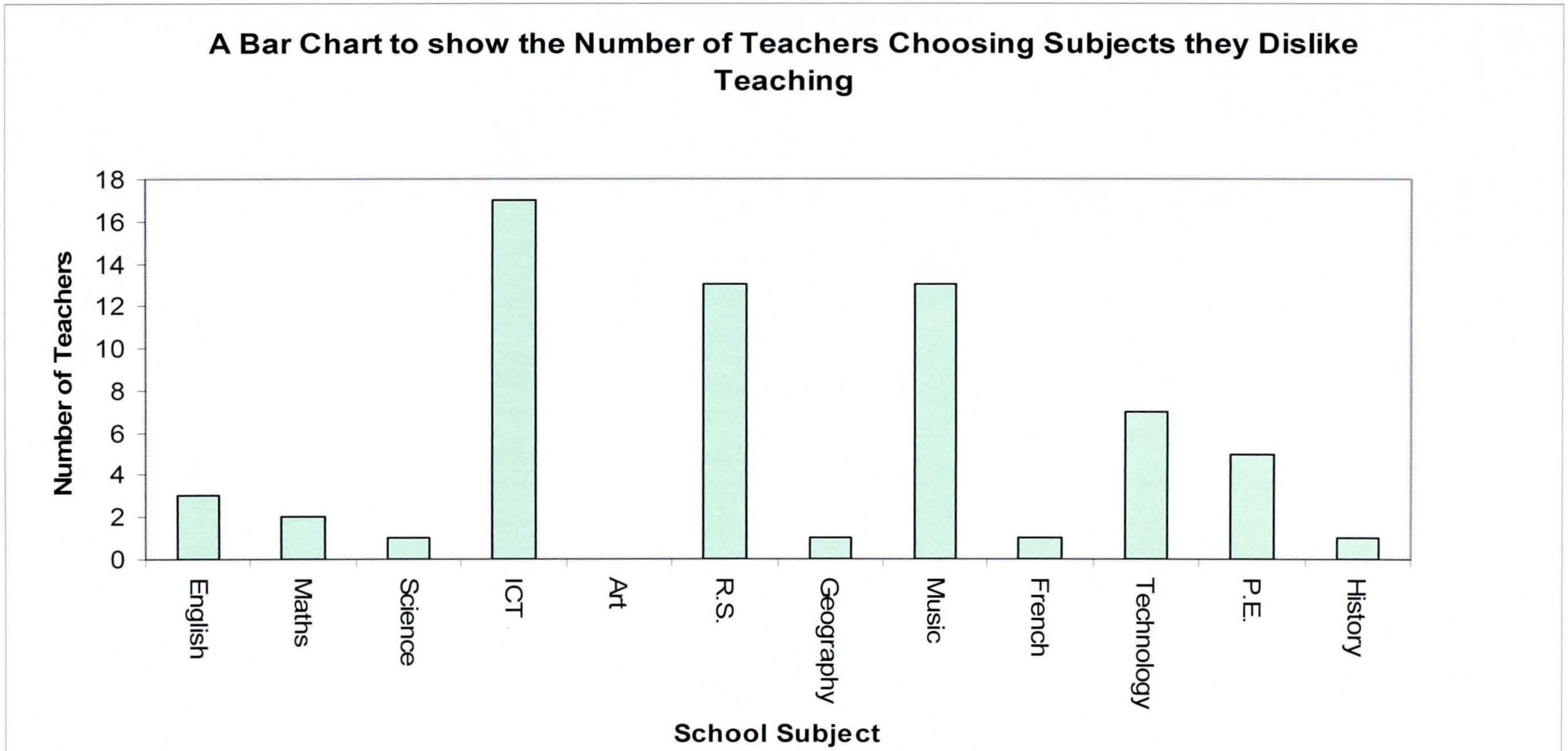


Figure 4.9.2: Bar Chart showing the subjects that teachers dislike teaching (n=38).

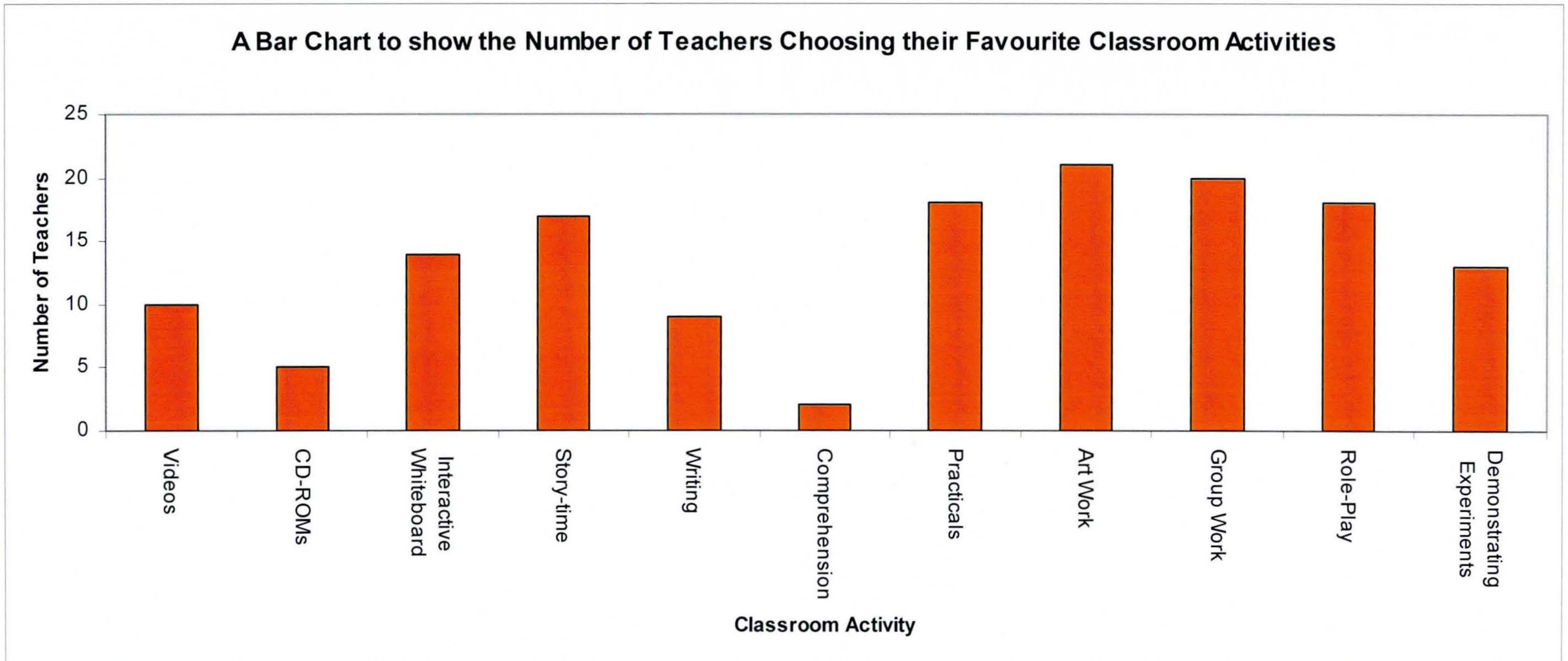


Figure 4.9.3: Bar Chart showing teachers' favourite classroom activities (n=38).

From these bar charts, the following can be concluded:

1 Primary teachers like teaching the following subjects:

- Science, Art, English, History, Maths and P.E.

2 Teachers dislike teaching the following subjects:

- ICT, Music and R.S.

3 Teachers like the following classroom activities:

- Artwork, group work, role-play, practicals and story-time.

The 47 % said their favourite subject(s) to teach were their specialist subject in which they obtained their degree. All of the science qualified primary teachers said they enjoyed teaching science. 47% of the teachers reported that they enjoyed teaching science.

The popular subjects that teachers enjoyed teaching were: Art (55%), English (47%), Science (47%), History (47%), Maths (42%) and Physical Education (39%).

The most common reasons for teachers liking to teach school subjects were: they were confident at teaching it (71%); the pupils enjoy it (66%) and they find it interesting to teach (63%).

The subjects that were taught and most disliked were:

ICT (45%)

R.S. (34%)

Music (34%)

Technology (21%)

None of the teachers dislike teaching Art. Geography, science, French and history were only disliked by 0.03% of the teaching sample. The one teacher who disliked teaching science said the reasons were due to not confident and has no training in it. This teacher has a B.Ed qualification and has been teaching between 11-20years. This teacher could have qualified before 1989 when science was included in the National Curriculum for England and Wales as a core subject and therefore had previously not been required to have science expertise (DES, 1985). Pell and Jarvis (2001) reported that many primary teachers still lack confidence and competence with regard to teaching science. However, these results do contrast with this finding, perhaps because the teachers were relatively new to the profession and therefore have been trained in science teaching. The reasons why these subjects were disliked were:

- ICT – not confident at it and not enough training;
- R.S. – uninteresting, not many resources;
- Music – not good at it and not many resources;
- Technology – not confident.

Other reasons why teachers did not like teaching subjects were:

- Not confident themselves in teaching it (53%)
- Not very good at it themselves (29%)
- No training on teaching it (26%)

Teachers' favourite classroom activities to teach were:

- Art Work (55%)

- Group Work (53%)
- Practicals (47%)
- Role-play (47%)
- Story-time (45%)

Conclusion

If teachers are confident with the subject knowledge, are aware of what the pupils enjoy, enjoy what they are delivering and the topics are interesting, then they enjoy teaching it. Within the constraints of the National Curriculum, a variety of topics to stretch both pupils and teachers imagination so all are 'involved' in the classroom seems to have a positive impact. If a teacher is less confident about their knowledge of a subject, they tend to dislike teaching it, especially answering difficult questions asked by pupils. This information would be useful to those providers of primary teachers to ensure that a certain level of knowledge is known. From the research questions, primary teachers do not just teach one age group, so a wide subject knowledge is required, to ensure which ever age group they are given to teach, they can cope with the subject knowledge demands. More specialist subjects requiring some practical ability, such as music, technology, P.E. and ICT need more attention within the primary school. Either these subjects are just taught by specialist teachers and not expect every class teacher to teach them could be one way around this, or more training, either within the teacher training programme or as INSET or day courses needs to be provided.

Science has not proven to be a subject that is disliked to be taught and therefore it seems that although it might be expected to be disliked since it is vast and complicated, that there are other subjects that are disliked more. Science was seemed to be liked to be taught (47%) much more than disliked (0.03%)! This could be a reason why pupils enjoy primary science as the teachers enjoy it and deliver it well but it still does not explain why there is such a decrease in interest and attitude when pupils arrive at secondary school.

From this limited research, it can be concluded that primary school teachers like teaching science due to the practicals and therefore are not to be wholly blamed for pupils' poor attitudes towards science. Pupils are enthusiastic in lessons from what the researcher observed and this must aid the teaching of lessons. More research is needed to see why teachers like or dislike teaching subjects. Teachers do not necessarily like teaching what they are trained in; the response to this question was quite varied.

Although it would be most useful, it would be difficult to obtain parent information on their approach to introducing and displaying interest in science at home.

Overall, it has appeared that primary school teachers are committed to teaching science well and that they enjoy it.

The question remains, at what age does the decline in attitude towards science begin? One can answer that it is before secondary school and before Yr 6 at primary school.

5.1. Conclusions

The results in conclusion of the Pre and Post TOSRA Test, show the majority of pupils have some positive attitudes towards science. In terms of Klopfer's themes, the following was found:

- Each age group of pupils has a strong positive attitude towards the social implications of science.
- Yr 6 and 7 show a strong positive attitude towards scientific inquiry; Yr 9 only display a positive attitude in the post test.
- Varied attitudes exist towards the normality of scientists with Yr 6 and 7 agreeing but Yr 9 show ambiguity.
- Pupils give a varied response to their enjoyment of science lessons. Only Yr 6 pupils gave a high response in both the pre and post test.
- Pupils gave a varied response to adopting a scientific attitude. Yr 6 pupils were the most stable giving a high positive response in both the pre and post test.
- Pupils have a negative attitude towards leisure interests in science and career interest in science.

The final bullet point is in agreement with Sears' (1997) research where pupils were also negative about watching television programmes about science or reading about science. His research also found that pupils displayed a negative attitude towards the idea of having science as a hobby and the enjoyment of dual award GCSE science lessons.

Analysis between each school in the year group showed that the largest differences were in Yr 6 and in themes 6 and 7 in the pre test and in themes 4 and 5 in the post test. Yr 7 had some differences in themes 2, 4 and 5. Yr 9 had similar means in each theme in both schools.

Bar chart representation confirmed that the attitudes look stable over time since they are similar in both the pre and post tests. This was confirmed by the chi square values which showed no significant difference in attitude was measured between the pre and post test. This finding is in contrast of findings from work by Simpson and Oliver (1985) who found a decline in attitude from the point of entering secondary school. However, with the Cronbach alpha scores higher than 0.7 the data are deemed reliable.

Analysis of the pre and post TOSRA data and gender issues showed some patterns. In Yr 6, it was the girls, when comparing the mean values in each of the seven themes, who had more of them that were higher than the boys mean values in the seven themes. Yr 7 had a similar set of results with the girls having more mean values, for the seven themes, higher than the boys. In the post test, all of the girls' seven themes had higher mean values than the boys. However, Yr 9 had the opposite results. Boys had the higher number of mean values in both the pre and post test results. In conclusion, in the younger ages, girls had the more positive attitude towards science, whereas in Yr 9, the boys showed the more positive attitude. Theme 7 showed a pattern across the year groups: in all ages, in the pre test boys had a higher mean than the girls towards a career in science and in the post test, the girls had a higher mean value in all three year groups. Research by Francis and Greer (1999) found that girls held a less positive attitude than boys to the possibility of a career in science. This is not the case with these results. Stables (1990) found no gender differences in science related attitudes between boys and girls in a single sex school. Some evidence does show that girls are now confident in their ability to take science courses (Whitehead, 1996).

In the final study, finding out more about pupils' favourite subjects was required. This was added to the questionnaire and pupils ranked grouped subjects in order of which they preferred. The subjects were grouped as practical nature, mixture of practical and core subjects and science.

Pupils' favourite practical subjects were Art and Physical Education. Science was not apparent in any age group. Research by Hendley et al. (1995) found that out of the core subjects science, English, mathematics and technology that science was the least popular of these. In the mixture of core/practical subjects, again all of the subjects except science were mentioned. When addressing this apparent antipathy for science, Jovanic and King (1998) suggest girls dislike science when ranking subjects is because they perceive that they are better at other subjects. When comparing the separate sciences, pupils ranked biology and chemistry as their favourites. Osborne and Collins (2000) also found that biology was seen as relevant and addressed concerns about their self-interest, however, pupils disliked aspects of chemistry such as the periodic table.

Pupils in all three age groups stated that they liked subjects if they found them 'interesting' or if they 'liked the teacher'. Yr 6 and 7 pupils also liked computers and field trips; Yr 7 and 9 pupils liked a subject if they were good at it and Yr 9 liked subjects if they found them easy. When providing variety in lessons, as good teachers do, the above could be used in their planning.

> *'By providing opportunities for a variety of teaching and learning strategies, we can encourage students to be mentally active and to work in the way that suits them best (Chin, 2003, p. 102).*

For example, in science having field work for calculating speed outside, using pooters to look at habitats, testing soil pH levels. Building in use of a computer with a learning outcome does require time and effort; however, pupils enjoy the use of computers. Positive encouragement to all pupils and appropriate rewards can help pupils to feel like they are good at a subject and using differentiation and Vygotsky's notion of giving slight assistance must be present in classrooms so that all pupils learn.

In summary, the results of the study show that there is no significant change in attitude over the time period of one academic year with the Yr 6, 7 and 9 pupils. Attitudes are already fixed in most cases. The pupils in each year group did not necessarily show a decline in their attitude; it was of a fixed nature. Other research suggests that girls' and boys' positive attitude towards science declines with secondary school pupils (Simpson and Oliver

1985; Murphy, 1997). However, this trend has started as pupils' progress through primary school. This is supported by Pell and Jarvis (2001). Data reported from Hadden and Johnstone (1983) show that pupils' attitudes show no improvement from the age of 9 so research of this age group and younger is required.

Younger pupils at primary school (Yr 2) were therefore used in the final year study. The results from the Yr 2 activity do show that already the pupils have a good knowledge of scientists and what they do.

Klopfer's Theme	Main Responses
1 – Social Implications	Dentist, Doctor, Nurse and Paramedic
2 – Normality	Like to read, wears a white coat, smiles, quiet
3 – scientific inquiry	Repeat an experiment, ask questions, read books, try a new experiment
4 – adopting a scientific attitude	Computers, cars, medicines and mobile phones
5 – enjoyment of science lessons	Computers, group work, making things, experiments
6 – leisure interest	Watch television, play with friends, playa computer games
7 - career	Actor, vet, policeman, school teacher, hair dresser

Table 5.1.1: Main Responses for each Themed Question in the Yr 2 Pupil Activity.

In the group discussion, used to triangulate the findings of the activity and also to gain further knowledge of what the pupils think, the following points were made:

- Knowledge gained through reading books, going to visit the doctor/dentist, watching television or from their parents' jobs.
- How scientists look comes from jigsaws, drawings in science lessons, pictures seen, been to see a doctor and they have worn a white coat.
- Pupils are used to asking questions if they do not know something or if a medicine has not made them well, another one or the same one has been tried again.
- A feeling that scientists are clever so they make complicated things.

Life experiences such as television, books, school, friends and family are the methods that supply knowledge, share interests, develop hobbies in this age group. This age group of pupils appear to have a good knowledge of scientists and a lot of enthusiasm for their school science lessons, however, there was a mixed attitude towards whether they would want to be a scientist or pursue scientific activities in their leisure time.

> *'Feelings of enjoyment and interest in science combined with success in junior science courses are likely to lead to a positive commitment toward science that is enduring' (Osborne et al., 2003, p. 1072).*

The main influences on young primary school children are parents, teachers, toys and the television. The easiest to research of these was the teachers. From the questionnaire findings, the school which participated showed a positive enjoyment of teaching science, regardless of whether they were trained in it or not. Science being a core subject in the National Curriculum since 1989 had many primary school teachers attend INSET training in science teaching. This was due to the DES (1985) stating that many primary school teachers had a poor scientific knowledge base (Pell and Jarvis, 2001). However, this was not apparent in the schools that participated in this study. Pollard et al. (1994) also showed that:

> *'...teachers' moral and personal commitment to the education of young children remained strong, despite the pressures on them' (p. 236).*

From the research in primary school with Yr 2 pupils their obvious enthusiasm for science was apparent in the discussions and this is in agreement with Stables (1990) that younger pupils demonstrate a more positive attitude towards school science than older pupils. This is also consistent with findings of Choppin (1974), Hadden and Johnstone (1983) and Kelly (1986). The question of when exactly do pupils' attitudes change, is not yet known.

The transition from primary to secondary school can be a time when there is a dip in pupil progress (Ryan, 2002). However, the results from the questionnaire and the interview showed a very positive transition to this particular secondary school with pupils having made good new friends and they like the teacher. However, there are changes in their favourite subjects throughout their first year. Their reasons for liking or disliking a certain science can be helpful to the teacher and enhance their awareness when teaching of all the needs within the classroom. No specific data on the transition affecting a pupils' attitude toward science was found.

The final conclusion from this study is that pupils' attitudes towards science are mainly set at an early age in primary school. The study supports the view of Ormerod and Duckworth (1975) that primary ages are critical for a child's formation of a positive attitude towards science. Until the mid 1980s little science was taught in primary school. In order to enhance pupils' attitudes towards science, suggestions could be drawn from this work such as promoting everyday experiences of science and overall, together parents, teachers, the media working to promote and excite pupils about science.

In a final conclusion, referring back to the main research questions:

- How do pupils feel about the activities undertaken in school science lessons?
- When do pupils' attitudes towards science tend to be fixed? Primary school? Secondary school?
- What affects a pupil's attitude? Parents? Teachers? Friends? Media?
- Are there some of Klopfer's themes that are positive and others negative in each age group and for each gender?
- Which of Klopfer's themes are a concern to society due to causing a

decline in pupils displaying positive attitude towards science and hence not taking up a scientific career?

There are many activities that pupils state they like in lessons which teachers can incorporate into their lessons to help improve and maintain pupils' attitudes. Attitudes towards science have been set at an early age, probably for most pupils during primary school, but when exactly is not clear. There are many factors that affect a pupils' attitude, however, this research shows that teachers enjoy teaching science and this should impact on the pupils in their class. Not all pupils heavily display a negative attitude to all aspects of science. However, pupils do tend to have poor attitudes towards a career in science and this requires further investigation as this is the critical point for society.

5.2. Implications for Teachers

This research has shown that pupils do show some positive attitudes towards science and even though the results found may not be valid for all schools, it can be of use to teachers. Teachers must ensure that pupils are taught about the relevance of science in their lessons and relate this simply to their everyday life. An intervention on introducing more information on careers into science lessons could be an area for a school to develop.

Pupils do like some aspects of science lessons:

1. Experiments;
2. To find things out;
3. Different activities;

4 Fun!

Pupils dislike some aspects of science lessons:

1 writing too much;

2 not being challenged enough (Gifted and Talented, 2005, DfES);

3 teacher talking too much;

4 too many new words to learn;

5 complicated experiments;

6 hard homework;

7 too many sheets;

8 hard to remember everything.

These comments can be of use when teaching a large class. To try and anticipate some of these problems could help prevent pupils disliking science and perhaps not affecting their attitude negatively towards it. It could be argued that these suggestions to teachers are simply 'just good practice in the classroom'. Practical suggestions could be:

1 Short writing exercises of main points;

2 Key words as wall displays (Henderson and Wellington, 1998);

3 Work through complicated experiments step-wise as a class;

4 Homework's relating to the lesson and explained beforehand;

5 Enthusiasm for their subject;

6 Short bursts only of discussion and sheets only when necessary.

Teachers can use the above as starting points in their classroom but also a study by Myers and Fouts (1992) suggests some methods of promoting positive attitudes – high level of involvement in lessons, high level of personal support, strong positive relationships with friends in the class and teachers using a variety of teaching strategies and unusual learning activities.

Researchers Cooper and McIntyre (1996) studied what aspects of teaching were used in the popular subjects of English and history. These could be used in science:

- Clear goals for pupil learning;
- Clarity of communication of lesson goals and agenda to pupils;
- Use of preview and review of lesson content;
- Helping students to contextualize content in terms of their own experience and knowledge, as well as in terms of other teaching goals and learning experiences;
- Some willingness to allow pupils to have input into goals and agenda setting;
- A supportive social context designed by the teacher to help pupils feel accepted, cared for and valued;
- An ability and willingness to allow for different cognitive styles and ways of engaging with the learning process among pupils, through multiple exemplification, and the use of different types of illustration

and mode of presentation, and offering pupils a choice from a menu of possible ways of engaging; and

- A willingness to take into account pupil circumstances and to modify/pace/structure learning tasks accordingly.

The quality of science teaching in school is a dominant factor in promoting positive attitudes towards science in pupils (Woolnough, 1994). The National Strategy for secondary schools consisting of a 3 part lesson (starter – main- plenary) is one way of teachers achieving clear goals for a lesson, with lesson objectives given at the beginning of the lesson and summed up at the end, variety of tasks used in the main activity, delivered to each pupil's need by differentiation.

5.3. Further Work

Following on from the results obtained in this research, some suggestions for further work on the TOSRA Test work are:

- Rewording of the questions in themes 5, 6 and 7 since they showed negative responses. This would elicit if it is the question or the answer e.g. 'I enjoy watching science programs on the television' could be reworded as 'I enjoy watching wildlife programs, Brainiac, documentaries on the changing earth and hearing about space exploration on the television'.
- Use of the TOSRA Test for younger pupils in primary school. If attitude is fixed in pupils earlier on, it would be useful to try and test in

KS1 and foundation stage. This could be achieved using the word cards or a new method to be designed that is appropriate for this age group.

- Curriculum content has been under review with the new specification changes for National Curriculum and GCSE. Pupils in Yr 6 and 9 take National Curriculum tests at the end of the year and does the pressure of this year, and the repetition of work likely to be covered in preparation for the examinations, have an effect on pupils' attitude?
- Primary school curriculum to be modified so that science is not pushed out by pressures of the Literacy and Numeracy hours? Could science receive a morning slot in the timetable?
- Using Yrs 3, 4 and 5 at primary school in the study to investigate their attitude towards science and to observe if there's a particular year when it changes.
- Parental influence on their child and the media's input.
- Research work on one of the sciences and the attitudes, in particular, towards that science.
- How a pupil's motivation links to their attitude.

Some questions arising from the study are:

1 What do pupils find and mean by 'interesting' in lessons?

2 What features of teachers pupils like do they possess?

3 Why do some pupils like biology and chemistry and not physics? Is it just a question of mathematics?

In consideration of the transition period and its effect on a pupils' attitude, more research needs to focused on specifically their attitude towards science and this could be tracked through their end of primary school and into secondary school. Questions relating to whether or not science met expectation, did they feel they had made progress? The difficulty with this type of longitudinal study is keeping pupils interested over a long period of time.

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Appendix 1

Schools Participating in the Research

Schools used for TOSRA Questionnaires

School A – Independent Junior School, Nottinghamshire co-educational pupils aged 3-11yrs
School B – Independent Senior School, Nottinghamshire – co-educational, pupils aged 11-18yrs
School C – State Senior School, Staffordshire – co-educational, pupils aged 11-18yrs
School D - State Junior School, Nottinghamshire – co-educational, pupils aged 7-11yrs

Yr 2 Activity. Schools used:

- State Primary School, Derbyshire, ages 5-11yrs, co-educational
- State Primary School, Derbyshire (ages 5-11yrs, co-educational)
- Special School, Nottinghamshire (ages 5-16yrs, co-educational)
- State Infant School, Nottinghamshire (ages 5-7yrs, co-educational)
- State Junior School, Nottinghamshire (ages 5-7yrs, co-educational)
- State Primary School, Derbyshire (ages 5-11yrs, co-educational)

Teachers' Participating were:

- State Primary School, Derbyshire
- Independent Junior School, Nottinghamshire

(other schools in the East Midlands were unknown as forms administered by post and these schools did not enclose their letter stating which school it was from).

Appendix 2a

Background Information

Case Study

Gender: female
Age: 15
School: B
GCSEs Studying: English language and literature, Mathematics, Chemistry, Design (resistant materials), Biology, Art, French, Spanish, Italian
Sports: U15As for hockey and netball
Acting: In the school play (Adrian Mole)
Music: Doesn't play an instrument any more (used to play the violin); singing
Outside interests: read books (true stories) not science fiction or horror books (only horror films), shopping, pop concerts
Educational Trips: Paris (Science and History trip), army trip (over night camp)
Future Career plans: Lots of different things – medical profession or a translator (though it might be boring as she likes things that change), travelling and go abroad
A levels?: Biology and see how well she does in her GCSEs, maybe a language as well. She will choose them because she likes them and if she does well in chemistry then perhaps that too. Maybe maths but she doesn't find it interesting. Told to do what you enjoy – doesn't feel she would enjoy maths.

Appendix 2b: ***<u>Interview Key Questions – Case Study</u>***

At the beginning of the interview the Case Study was reminded of why the interview was taking place and the aims of it (Drever, 1997). The first questions are general questions followed by more specific ones on Chemistry.

<u>Interview: Part 1</u>
Which subjects are you studying for GCSE?
Which subjects are your favourite?
Why do you like them?
Which subjects do you think you will achieve the best GCSE results in at this stage of the courses?
Which subjects do you least look forward to at school?
Are you in any sports teams at school?
Do you play a musical instrument?
Do you enjoy acting?
Do you enjoy dancing?
What outside interests from school do you have?
Have you been on any educational trips this year at or outside school?
Do you have any future career plans?
Which 'A' levels do you plan to take?
Why these 'A' levels?

<u>Interview: Part 2</u>
Which parts of Chemistry have you enjoyed this term?
Which topics do you feel you have understood well? What do you think helped you to understand them?
What are your favourite classroom activities?
Do you remember things from doing things such as experiments?
What things can you remember from lessons that we've done this term?
How do you feel when coming to a science lesson?
Do you engage in science activities outside of school?
Are there any other comments or feelings on chemistry lessons that you have and would like to share with me?

Jan-March Term – Interview with Case Study 26th March 2003
Questions asked:

1 Which topics have you enjoyed this term in chemistry?
2 Why have you enjoyed them?
3 Which topics have you disliked this term in chemistry?
4 Why have you disliked them?
5 How have you felt when approaching chemistry lessons this term?
6 Which teaching activities can you remember?
7 Have you participated in any science-related activities outside of school?
8 Have you considered any more about your future career?
9 Have you continued to enjoy biology this term?
10 Which parts of biology have you particularly liked?
11 How have you felt towards science lessons this term?

12 Any other comments on chemistry or about this term's work?

<u>Summer Term – Interview with Case Study 23 June 2003</u>

Questions asked:

1. How has this term of chemistry been?
2. How did you feel about your examination result?
3. What has been good about this term in chemistry?
4. How did your biology examination go?
5. How have you felt towards biology this term?
6. Have you participated in any scientific activities outside of school?
7. Any thought on your approach to the sciences next year?
8. Have you had any changes in your thoughts on your career?

<u>Key Points from the Interview – Interview 1</u>

Favourite Subjects: Art now, Biology and Sciences since now she is understanding them more and paying more attention. She picks up languages easily. Some lessons she gets bored in e.g. Design and there's a small class. She enjoys chemistry because her friend is there and therefore its fun. She thinks shell get the best GCSEs in Spanish, average in her sciences, well in art and to do very good in her languages not Italian as only just started it.

Least lucks forward to maths (doesn't think she'll do well in). She finds it hard as do so much stuff. It is confusing – some similar and then change to something else just as she understands it. Everyone seems so far ahead in maths. She likes things with logic not rules as finds it hard to remember them. English is boring as literature and lots of essays which won't come in handy.

She likes interesting parts in plays. She used to do dancing – disco, classic, modern, ballroom.

Chemistry

- Enjoys experiments
- At first didn't' understand the mass number etc and then finally realised she could do it and feel really good.
- She didn't think she would get on in chemistry but has
- Likes it when the teacher links things
- Liked the rock topic – because she's always liked rocks and stones
- She's understood (atomic structure) and electron arrangement
- What has helped her to understand things- paying more attention, not giving up and keeps thinking and how they link together, questions things on the BB particularly when questions given to do
- In lessons she enjoys practical things as its more fun, doesn't like it in silence and being told she can't ask questions, more involved enjoy it and understand it more, the games on CD-ROM she enjoyed.
- Experiments – helps her to remember the practical. See the sheet and remember it e.g. iron and copper sulphate and the nail "disappeared".
- Specific things in lessons – pushed the oxygen over copper to see percentage of oxygen in air, sulphates/flame tests, rocks

How do you feel when approaching a lesson – Bio not always as sometimes

- the teacher is in a bad mood; never a bad lesson in chem., always cheery! Her friend makes her laugh, brightens her up and its fun!
- Science outside school – talked about a tv prog she'd seen
- She tries if she can and then if she can understand its. Notes in the back of her book where I write notes to help her – can refer back to it! Small sheets of notes etc as reference (not too big with useful stuff).

Interview 2

The interview was set in the same way as before. I began by stating my aims of the session. The tape recorder, however, wouldn't work so I wrote down the comments manually during the interview.

It was easier for Case A to answer questions specific to Chemistry this term as she has been consciously thinking about her diary and since she has been interviewed before she is aware of the type of questions to be asked.

This term she has particularly enjoyed studying atoms and ions, balancing equations (she asked for extra practice on this even though we were not specifically doing them) and has enjoyed any experiment (ones performed were extracting iron and copper, and also looking at the properties of certain structures. Case A feels that she understands then when it all clicks into place. She only likes things that she can do! However, she did dislike the extraction of metals topic as she found it boring and also didn't enjoy learning about covalent bonding. This was frustrating for her as she didn't grasp when a compound would be ionic or covalently bonded.

On her approach to Chemistry lessons, she has not felt as positive as the previous term and she has therefore not enjoyed the lessons as much. Last term a lot of her enjoyment came from her being surprised as to how well she understood the work. This term it has been harder and she has found that she has understood less and therefore has acted more negative towards the subject and gets annoyed with herself.

Teaching activities that Case A could remember well are: the experiment on bonding (as she burnt her finger!), the role-play on electrolysis (it was funny!) and she disliked but remembered the OHTs and rusting experiment which were both boring, the latter as she had done it before.

Outside of school she has watched Wildlife programmes on TV but not participated specifically on scientific activities.

Since our previous interview, she has decided that she hates biology and does not want a career in it. She feels that her A levels will be predominantly language based. She has enjoyed biology this term as she likes the ecology and adaptation (animals) side of the subject however she has felt less positive towards it due to the teacher.

In her other comments about chemistry this term, the case study said that she has found it harder this term with having a PGCE teacher and she doesn't understand the work as much and is therefore putting her off. At the end of the interview, as requested by the case study, we did go over the problems that she has been having. She is a conscientious student and had written all of her queries down so that she knew exactly what she wanted to know!

Diary Comments

The case study has been keeping a weekly diary of her feelings toward science at school. I read it and here are some comments (amendments of spelling, punctuation and grammar have been made.

'I was concentrating so I understood ionic bonding better'.
'We had a test on extraction of metals. I was quite annoyed. I only got 68% and I thought I had revised well and had understood the topic'.
'As I have said before, I doubt I will ever use a blast furnace or do any more electrolysis, but I suppose it's quite useful for GCSE'.
'I will be going on Spanish exchange this summer and another trip to France on an exchange so it should be a fun year! Plus being with the people should improve my language skills a lot more'.
'In today's lesson I was tired but it woke me up a bit when I previously remembered learning about reduction and oxidation'.
'Seeing the experiment where the iron displaced the copper was good because it helped me to understand the equation and displacement'.
'I didn't find the displacement very interesting but I was happy when I remembered the reactivity series because of the mnemonic we were told (please send Charlie's...)'
'The balancing equations extra sheets I've been doing are quite good and I've surprised myself by enjoying doing them!'

Appendix 3a

TOSRA Questionnaire – Ledbetter and Nix (2002)

Klopfer's Theme	Theme	Questions in the Theme
1	Social Implications of Science	1, 8, 15, 22 and 29
2	Normality of Scientists	2, 9, 16, 23 and 30
3	Attitude toward Scientific Inquiry	3, 10, 17, 24 and 31
4	Adoption of Scientific Attitude	4, 11, 18, 25 and 32
5	Enjoyment of Science Lessons	5, 12, 19, 26 and 33
6	Leisure Interest in Science	6, 13, 20, 27 and 34
7	Career Interest in Science	7, 14, 21, 28 and 35

Table 1: Showing the Link Between the Themes and the Questions in the Questionnaire.

Appendix 3b

Guidelines for Teachers

Thank you for allowing your class to take part in my research about pupils' attitudes towards science.

The questionnaire is designed to be quick and easy for pupils to complete. It should take a maximum of 15 minutes.

They do not need to write their names on but please could you inform your pupils that they need to complete their age and gender. Since this is the pre test, please can you write down the names on a piece of paper and give to me the names of any pupils who were not present in the class so that we can make sure they do not take part in the post test later in the year.

The questionnaire is voluntary, if there are any pupils who do not wish to take part that is fine.

Please can you ask pupils to choose their answers honestly and not to confer with their friends. Their answers will be confidential.

I have gained permission from the Head and the Head of Department for this research to take place.

Once completed, please put in the envelope provided, seal it and pass back to me.

Thank you very much for your help with my research.

Appendix 3c What do YOU think about science? TOSRA2 - pretest

This survey is completely confidential. Your participation is voluntary.

Gender: _____Male _____ Female Age: _____

Please indicate whether you Strongly Agree, Agree, are Not Sure, Disagree or Strongly Disagree with each statement by marking the best response

strongly agree	agree	not sure	disagree	strongly disagree	1	Money spent on science is well worth spending.
strongly agree	agree	not sure	disagree	strongly disagree	2	Scientists usually like to go to their laboratories when they have a day off.
strongly agree	agree	not sure	disagree	strongly disagree	3	I would rather find out why something happens by doing an experiment than by being told how it works.
strongly agree	agree	not sure	disagree	strongly disagree	4	I find it boring to hear about new ideas.
strongly agree	agree	not sure	disagree	strongly disagree	5	Science lessons are fun.
strongly agree	agree	not sure	disagree	strongly disagree	6	I would like to belong to a science club.
strongly agree	agree	not sure	disagree	strongly disagree	7	I would dislike being a scientist.
strongly agree	agree	not sure	disagree	strongly disagree	8	Science is man's worst enemy.
strongly agree	agree	not sure	disagree	strongly disagree	9	Scientists are about as fit and healthy as other people.
strongly agree	agree	not sure	disagree	strongly disagree	10	Doing experiments does not help me learn as much as finding out information from instructors.
strongly agree	agree	not sure	disagree	strongly disagree	11	In science experiments, I like to use methods which I have not tried before.
strongly agree	agree	not sure	disagree	strongly disagree	12	I dislike science lessons.
strongly agree	agree	not sure	disagree	strongly disagree	13	I get bored watching science programs on TV.
strongly agree	agree	not sure	disagree	strongly disagree	14	I would like to work with people who make discoveries in science.
strongly agree	agree	not sure	disagree	strongly disagree	15	Public money spent on science in the last few years has been used wisely.

strongly agree	agree	not sure	disagree	strongly disagree	16	Scientists do not have enough time to spend with their families.
strongly agree	agree	not sure	disagree	strongly disagree	17	I would rather do experiments than read about them.
strongly agree	agree	not sure	disagree	strongly disagree	18	I am unwilling to change my ideas even when evidence shows that my ideas are faulty.
strongly agree	agree	not sure	disagree	strongly disagree	19	School should have more science lessons each week.
strongly agree	agree	not sure	disagree	strongly disagree	20	I would like to be given a science book or a piece of scientific equipment as a present.
strongly agree	agree	not sure	disagree	strongly disagree	21	I would dislike a job in a science laboratory.
strongly agree	agree	not sure	disagree	strongly disagree	22	Scientific discoveries are doing more harm than good.
strongly agree	agree	not sure	disagree	strongly disagree	23	Scientists like sports as much as other people do.
strongly agree	agree	not sure	disagree	strongly disagree	24	I would rather agree with other people than do an experiment to find out the information for myself.
strongly agree	agree	not sure	disagree	strongly disagree	25	In science experiments, I report unexpected results as well as expected ones.
strongly agree	agree	not sure	disagree	strongly disagree	26	Science lessons bore me.
strongly agree	agree	not sure	disagree	strongly disagree	27	I dislike reading books about science in my leisure time.
strongly agree	agree	not sure	disagree	strongly disagree	28	Working in a science laboratory would be an interesting way to earn a living.
strongly agree	agree	not sure	disagree	strongly disagree	29	The government should spend more money on scientific research
strongly agree	agree	not sure	disagree	strongly disagree	30	Scientists are less friendly than other people.
strongly agree	agree	not sure	disagree	strongly disagree	31	I would rather do my own experiments than find out information from instructors.
strongly agree	agree	not sure	disagree	strongly disagree	32	I dislike listening to other people's opinions.
strongly agree	agree	not sure	disagree	strongly disagree	33	Science is one of the most interesting school subjects.
strongly agree	agree	not sure	disagree	strongly disagree	34	I would like to do science experiments at home.
strongly agree	agree	not sure	disagree	strongly disagree	35	A career in science would be dull and boring.

Appendix 3 What do YOU think about science? TOSRA2 - posttest

This survey is completely confidential. Your participation is voluntary.

Gender: _____Male _____ Female Age: _____

Please indicate whether you Strongly Agree, Agree, are Not Sure, Disagree or Strongly Disagree with each statement by marking the best response

strongly agree	agree	not sure	disagree	strongly disagree	1	Too many laboratories are being built at the expense of the rest of education.
strongly agree	agree	not sure	disagree	strongly disagree	2	A scientist can have a normal family life.
strongly agree	agree	not sure	disagree	strongly disagree	3	I would rather find out about things by asking an expert than by doing an experiment
strongly agree	agree	not sure	disagree	strongly disagree	4	I enjoy reading about things which disagree with my previous ideas.
strongly agree	agree	not sure	disagree	strongly disagree	5	Science lessons are a waste of time.
strongly agree	agree	not sure	disagree	strongly disagree	6	Talking to friends about science outside of school would be boring.
strongly agree	agree	not sure	disagree	strongly disagree	7	I would like a career teaching science.
strongly agree	agree	not sure	disagree	strongly disagree	8	Science helps make life better.
strongly agree	agree	not sure	disagree	strongly disagree	9	Scientists do not care about their working conditions.
strongly agree	agree	not sure	disagree	strongly disagree	10	I would rather solve problems by doing an experiment than be told the answer
strongly agree	agree	not sure	disagree	strongly disagree	11	I dislike repeating experiments to check that I got the same results.
strongly agree	agree	not sure	disagree	strongly disagree	12	I enjoy doing science lessons.
strongly agree	agree	not sure	disagree	strongly disagree	13	I would enjoy having a job in science during my school break.
strongly agree	agree	not sure	disagree	strongly disagree	14	A job as a scientist would be boring.
strongly agree	agree	not sure	disagree	strongly disagree	15	This country is spending too much money on science.

strongly agree	agree	not sure	disagree	strongly disagree	16	Scientists are just as interested in art and music as other people are.
strongly agree	agree	not sure	disagree	strongly disagree	17	It is better to ask teachers the answer than to find it out by doing experiments.
strongly agree	agree	not sure	disagree	strongly disagree	18	I am curious about the world in which we live.
strongly agree	agree	not sure	disagree	strongly disagree	19	The material covered in science lessons is uninteresting.
strongly agree	agree	not sure	disagree	strongly disagree	20	Listening to science reports on the radio is boring.
strongly agree	agree	not sure	disagree	strongly disagree	21	A job as a scientist would be interesting.
strongly agree	agree	not sure	disagree	strongly disagree	22	Science can help to make the world a better place in the future.
strongly agree	agree	not sure	disagree	strongly disagree	23	Few scientists are happily married.
strongly agree	agree	not sure	disagree	strongly disagree	24	I would rather do an experiment on a topic than read about it in science magazines.
strongly agree	agree	not sure	disagree	strongly disagree	25	Finding out about new things is unimportant.
strongly agree	agree	not sure	disagree	strongly disagree	26	I look forward to science lessons.
strongly agree	agree	not sure	disagree	strongly disagree	27	I enjoy visiting science museums during my leisure time.
strongly agree	agree	not sure	disagree	strongly disagree	28	I would dislike being a scientist because it requires too much education.
strongly agree	agree	not sure	disagree	strongly disagree	29	Money used on science projects is wasted.
strongly agree	agree	not sure	disagree	strongly disagree	30	If you met a scientist, he/she would look like anyone else you might meet.
strongly agree	agree	not sure	disagree	strongly disagree	31	It is better to be told scientific facts than to find them out from experiments.
strongly agree	agree	not sure	disagree	strongly disagree	32	I like to listen to people whose opinions are different from mine.
strongly agree	agree	not sure	disagree	strongly disagree	33	I would enjoy school more if there were no science lessons.
strongly agree	agree	not sure	disagree	strongly disagree	34	I dislike reading newspaper articles about science.
strongly agree	agree	not sure	disagree	strongly disagree	35	I would like a career as a scientist.

Appendix 3d (Turner (2003) – adapted Ledbetter and Nix)

What do YOU think about Science? TOSRA posttest

This survey is completely confidential. Your participation is voluntary.

Gender: _________ Male __________ Female Age: ____________

Please indicate whether you strongly agree, agree, are not sure, disagree or strongly disagree with each statement by marking the best response.

strongly agree	agree	not sure	disagree	strongly disagree	1	Laboratories are being built to aid education
strongly agree	agree	not sure	disagree	strongly disagree	2	A scientist can have a normal family life
strongly agree	agree	not sure	disagree	strongly disagree	3	I would rather find out about things by asking an expert than by doing an experiment
strongly agree	agree	not sure	disagree	strongly disagree	4	I enjoy reading about things which disagree with my previous ideas
strongly agree	agree	not sure	disagree	strongly disagree	5	Science lessons are not a waste of time
strongly agree	agree	not sure	disagree	strongly disagree	6	Talking to friends about science outside of school would be interesting
strongly agree	agree	not sure	disagree	strongly disagree	7	I would like a career teaching science
strongly agree	agree	not sure	disagree	strongly disagree	8	Science helps make life better
strongly agree	agree	not sure	disagree	strongly disagree	9	Scientists care about their working conditions
strongly agree	agree	not sure	disagree	strongly disagree	10	I would rather solve problems by doing an experiment than be told the answer
strongly agree	agree	not sure	disagree	strongly disagree	11	It is important to repeat an experiment to check that I get the same result
strongly agree	agree	not sure	disagree	strongly disagree	12	I enjoy doing science lessons
strongly agree	agree	not sure	disagree	strongly disagree	13	I would enjoy having a job in science during my school break
strongly agree	agree	not sure	disagree	strongly disagree	14	A job as a scientist would be interesting
strongly agree	agree	not sure	disagree	strongly disagree	15	This country spends the right amount of money on science
strongly agree	agree	not sure	disagree	strongly disagree	16	Scientists are just as interested in art and music as other people are

strongly agree	agree	not sure	disagree	strongly disagree	17	I would rather find out the answer by doing an experiment myself than by asking the teacher
strongly agree	agree	not sure	disagree	strongly disagree	18	I am curious about the world in which we live
strongly agree	agree	not sure	disagree	strongly disagree	19	The material covered in science lessons is interesting
strongly agree	agree	not sure	disagree	strongly disagree	20	It is interesting to listen to science reports on the radio
strongly agree	agree	not sure	disagree	strongly disagree	21	A job as a scientist would be interesting
strongly agree	agree	not sure	disagree	strongly disagree	22	Science can help to make the world a better place in the future
strongly agree	agree	not sure	disagree	strongly disagree	23	Many scientists are happily married
strongly agree	agree	not sure	disagree	strongly disagree	24	I would rather do an experiment on a topic than read about it in science magazines
strongly agree	agree	not sure	disagree	strongly disagree	25	Finding out about new things is important
strongly agree	agree	not sure	disagree	strongly disagree	26	I look forward to science lessons
strongly agree	agree	not sure	disagree	strongly disagree	27	I enjoy visiting science museums during my leisure time
strongly agree	agree	not sure	disagree	strongly disagree	28	Being a scientist requires a good education
strongly agree	agree	not sure	disagree	strongly disagree	29	Money used on science projects is not wasted
strongly agree	agree	not sure	disagree	strongly disagree	30	If you met a scientist, he/she would look like anyone else you might meet
strongly be agree	agree	not sure	disagree	strongly disagree	31	It is better to find out scientific facts from an experiment than to told them
strongly agree	agree	not sure	disagree	strongly disagree	32	I like to listen to people whose opinions are different from mine
strongly agree	agree	not sure	disagree	strongly disagree	33	I would like more science lessons at school
strongly agree	agree	not sure	disagree	strongly disagree	34	I like reading newspaper articles about science
strongly agree	agree	not sure	disagree	strongly disagree	35	I would like a career as a scientist

Appendix 4 (Pre Test) **What do YOU think about Science?**

Your responses are completely confidential. Your participation is voluntary.

Gender: male/female **Age: ___________**

Please indicate whether you Strongly Agree, Agree, are Not Sure, Disagree, Strongly Disagree with each statement by circling your best response.

Strongly agree	**Agree**	**Not Sure**	**Disagree**	**Strongly disagree**	1	Money spent on science is well worth spending
Strongly agree	**Agree**	**Not Sure**	**Disagree**	**Strongly disagree**	2	When scientists have a day off, they spend it with their families, not in their laboratory
Strongly agree	**Agree**	**Not Sure**	**Disagree**	**Strongly disagree**	3	I would rather find out why something happens by doing an experiment than by being told how it works
Strongly agree	**Agree**	**Not Sure**	**Disagree**	**Strongly disagree**	4	I find it interesting to hear about new ideas
Strongly agree	**Agree**	**Not Sure**	**Disagree**	**Strongly disagree**	5	Science lessons are fun
Strongly agree	**Agree**	**Not Sure**	**Disagree**	**Strongly disagree**	6	I would like to belong to a science club
Strongly agree	**Agree**	**Not Sure**	**Disagree**	**Strongly disagree**	7	I would like a job as a scientist
Strongly agree	**Agree**	**Not Sure**	**Disagree**	**Strongly disagree**	8	Scientific discoveries are doing good in the world
Strongly agree	**Agree**	**Not Sure**	**Disagree**	**Strongly disagree**	9	Scientists are about as fit and healthy and enjoy sports just as much as other people

Strongly agree	**Agree**	**Not Sure**	**Disagree**	**Strongly disagree**	**10**	Doing experiments helps me to learn just as much as finding out from teachers
Strongly agree	**Agree**	**Not Sure**	**Disagree**	**Strongly disagree**	**11**	In science experiments, I like to use methods that I have not used before
Strongly agree	**Agree**	**Not Sure**	**Disagree**	**Strongly disagree**	**12**	School should have more science lessons per week
Strongly agree	**Agree**	**Not Sure**	**Disagree**	**Strongly disagree**	**13**	I enjoy watching science programs on television
Strongly agree	**Agree**	**Not Sure**	**Disagree**	**Strongly disagree**	**14**	I would like to work with people who make discoveries in science
Strongly agree	**Agree**	**Not Sure**	**Disagree**	**Strongly disagree**	**15**	The government should spend more money on scientific research
Strongly agree	**Agree**	**Not Sure**	**Disagree**	**Strongly disagree**	**16**	Scientists are just as friendly as non-scientists
Strongly agree	**Agree**	**Not Sure**	**Disagree**	**Strongly disagree**	**17**	I would rather do an experiment and reach a conclusion myself than just agree with other people
Strongly agree	**Agree**	**Not Sure**	**Disagree**	**Strongly disagree**	**18**	In science lessons, it is good to report unexpected results as well as expected ones
Strongly agree	**Agree**	**Not Sure**	**Disagree**	**Strongly disagree**	**19**	Science is one of the most interesting school subjects
Strongly agree	**Agree**	**Not Sure**	**Disagree**	**Strongly disagree**	**20**	I would like to be given a science book or piece of scientific equipment as a present
Strongly agree	**Agree**	**Not Sure**	**Disagree**	**Strongly disagree**	**21**	I would like to work in a science laboratory

Appendix 4 Post Test **What do YOU think about Science?**

Your responses are completely confidential. Your participation is voluntary.

Gender: male/female **Age: ___________**

Please indicate whether you Strongly Agree, Agree, are Not Sure, Disagree, Strongly Disagree with each statement by circling your best response.

Strongly agree	**Agree**	**Not Sure**	**Disagree**	**Strongly disagree**	**1**	Laboratories are being built t be used for scientific researc and this is good for society
Strongly agree	**Agree**	**Not Sure**	**Disagree**	**Strongly disagree**	**2**	A scientist can have a norm: family life
Strongly agree	**Agree**	**Not Sure**	**Disagree**	**Strongly disagree**	**3**	I would rather find out abo things by doing an experime than asking an expert
Strongly agree	**Agree**	**Not Sure**	**Disagree**	**Strongly disagree**	**4**	I enjoy reading about thing that challenge my existir ideas
Strongly agree	**Agree**	**Not Sure**	**Disagree**	**Strongly disagree**	**5**	Science lessons are valuab for learning about everyday li
Strongly agree	**Agree**	**Not Sure**	**Disagree**	**Strongly disagree**	**6**	Talking to friends abo science outside of school wou be interesting
Strongly agree	**Agree**	**Not Sure**	**Disagree**	**Strongly disagree**	**7**	I would like a career teachir science
Strongly agree	**Agree**	**Not Sure**	**Disagree**	**Strongly disagree**	**8**	Science helps make life better
Strongly agree	**Agree**	**Not Sure**	**Disagree**	**Strongly disagree**	**9**	Scientists care about the working conditions

Strongly agree	**Agree**	**Not Sure**	**Disagree**	**Strongly disagree**	**10**	I would rather solve problems to answer a question than to read the answer in a magazine
Strongly agree	**Agree**	**Not Sure**	**Disagree**	**Strongly disagree**	**11**	I realise the importance of taking repeats in an experiment to check the results
Strongly agree	**Agree**	**Not Sure**	**Disagree**	**Strongly disagree**	**12**	I enjoy science lessons
Strongly agree	**Agree**	**Not Sure**	**Disagree**	**Strongly disagree**	**13**	I would love to have a job in science during my school holidays
Strongly agree	**Agree**	**Not Sure**	**Disagree**	**Strongly disagree**	**14**	A job as a scientist would be very exciting and interesting
Strongly agree	**Agree**	**Not Sure**	**Disagree**	**Strongly disagree**	**15**	This country is not spending enough money on science
Strongly agree	**Agree**	**Not Sure**	**Disagree**	**Strongly disagree**	**16**	Scientists are just as interested in art and music as other people are
Strongly agree	**Agree**	**Not Sure**	**Disagree**	**Strongly disagree**	**17**	I enjoy scientific experiments because I learn a lot from them
Strongly agree	**Agree**	**Not Sure**	**Disagree**	**Strongly disagree**	**18**	I am curious about the world in which we live
Strongly agree	**Agree**	**Not Sure**	**Disagree**	**Strongly disagree**	**19**	Material covered in science lessons is interesting
Strongly agree	**Agree**	**Not Sure**	**Disagree**	**Strongly disagree**	**20**	Listening to science reports on the radio is really interesting
Strongly agree	**Agree**	**Not Sure**	**Disagree**	**Strongly disagree**	**21**	Being a scientist would be an interesting career

Appendix 5 (Pre Test) **What do YOU think about Science?**

Your responses are completely confidential. Your participation is voluntary.

Gender: male/female **Age: ___________**

Please indicate whether you Strongly Agree, Agree, are Not Sure, Disagree, Strongly Disagree with each statement by circling your best response.

Strongly agree	**Agree**	**Not Sure**	**Disagree**	**Strongly disagree**	1	Scientific discoveries are doin good in the world
Strongly agree	**Agree**	**Not Sure**	**Disagree**	**Strongly disagree**	2	Scientists are about as fit and health and enjoy sports just as much as othe people
Strongly agree	**Agree**	**Not Sure**	**Disagree**	**Strongly disagree**	3	I would rather find out wh something happens by doing a experiment than by being told
Strongly agree	**Agree**	**Not Sure**	**Disagree**	**Strongly disagree**	4	I find it interesting to hear about nev ideas
Strongly agree	**Agree**	**Not Sure**	**Disagree**	**Strongly disagree**	5	Science lessons are fun
Strongly agree	**Agree**	**Not Sure**	**Disagree**	**Strongly disagree**	6	I would like to belong to a science clul to try new experiments
Strongly agree	**Agree**	**Not Sure**	**Disagree**	**Strongly disagree**	7	I would like to work with people wh make discoveries in science
Strongly agree	**Agree**	**Not Sure**	**Disagree**	**Strongly disagree**	8	The government should spend mor money on scientific research
Strongly agree	**Agree**	**Not Sure**	**Disagree**	**Strongly disagree**	9	Scientists are just as friendly as non scientists
Strongly agree	**Agree**	**Not Sure**	**Disagree**	**Strongly disagree**	10	Doing experiments helps me to lear just as much as finding out fron teachers and books
Strongly agree	**Agree**	**Not Sure**	**Disagree**	**Strongly disagree**	11	In science lessons, it is good to repor unexpected results as well as expecte ones
Strongly agree	**Agree**	**Not Sure**	**Disagree**	**Strongly disagree**	12	Science is one of the most interestin school subjects
Strongly agree	**Agree**	**Not Sure**	**Disagree**	**Strongly disagree**	13	I enjoy watching science programs o the television
Strongly agree	**Agree**	**Not Sure**	**Disagree**	**Strongly disagree**	14	I would like to work in a scientifi laboratory finding out new things

From the following lists of school subjects, rank your favourite to least favourite by numbering 1 -5 (1=favourite – 5 least favourite).

1

School Subject	Rank from Favourite (1) to Least Favourite (5)
Maths	
English	
Science	
Geography	
French	

2

School Subject	Rank from Favourite (1) to Least Favourite (5)
Science	
Technology	
Art	
Music	
Physical Education	

3

School Subject	Rank from Favourite (1) to Least Favourite (5)
English	
History	
Science	
Technology	
ICT	

4

Science Subject	Rank from Favourite (1) to Least Favourite (3)
Biology	
Chemistry	
Physics	

5 Tick any of the following reasons why you particularly like a school subject.

Reason	Tick ✓	Reason	Tick ✓
It's practically-based		Field trips	
Like the teacher		Lots of videos	
Interesting topics		Use computers a lot	
Can use my imagination		Like thinking and solving puzzles	

(Post Test) **What do YOU think about Science?**

Your responses are completely confidential. Your participation is voluntary.

Gender: male/female Age: __________

Please indicate whether you Strongly Agree, Agree, are Not Sure, Disagree, Strongly Disagree with each statement by circling your best response.

Strongly agree Agree Not Sure Disagree Strongly disagree	**1**	Laboratories are being built to be used for scientific research and this is good for society
Strongly agree Agree Not Sure Disagree Strongly disagree	**2**	A scientist can have a normal family life
Strongly agree Agree Not Sure Disagree Strongly disagree	**3**	I would rather find out about things by doing an experiment than asking an expert
Strongly agree Agree Not Sure Disagree Strongly disagree	**4**	I enjoy reading about things that challenge my existing ideas
Strongly agree Agree Not Sure Disagree Strongly disagree	**5**	Science lessons are valuable for learning about everyday life
Strongly agree Agree Not Sure Disagree Strongly disagree	**6**	Talking to friends about science outside of school would be interesting
Strongly agree Agree Not Sure Disagree Strongly disagree	**7**	I would like a career teaching science
Strongly agree Agree Not Sure Disagree Strongly disagree	**8**	Science helps make life better
Strongly agree Agree Not Sure Disagree Strongly disagree	**9**	Scientists care about their working conditions
Strongly agree Agree Not Sure Disagree Strongly disagree	**10**	I enjoy scientific experiments because I learn a lot from them
Strongly agree Agree Not Sure Disagree Strongly disagree	**11**	I am curious about the world in which we live
Strongly agree Agree Not Sure Disagree Strongly disagree	**12**	The material covered in science lessons is interesting
Strongly agree Agree Not Sure Disagree Strongly disagree	**13**	Listening to science reports on the radio is really interesting
Strongly agree Agree Not Sure Disagree Strongly disagree	**14**	A job as a scientist would be very exciting and interesting

From the following lists of school subjects, rank your favourite to least favourite by numbering 1 -5 (1=favourite – 5 least favourite).

1

School Subject	Rank from Favourite (1) to Least Favourite (5)
Maths	
English	
Science	
Geography	
French	

2

School Subject	Rank from Favourite (1) to Least Favourite (5)
Science	
Technology	
Art	
Music	
Physical Education	

3

School Subject	Rank from Favourite (1) to Least Favourite (5)
English	
History	
Science	
Technology	
ICT	

4

Science Subject	Rank from Favourite (1) to Least Favourite (3)
Biology	
Chemistry	
Physics	

5 Tick any of the following reasons why you particularly like a school subject.

Reason	Tick ✓	Reason	Tick ✓
It's practically-based		Field trips	
Like the teacher		Lots of videos	
Interesting topics		Use computers a lot	
Can use my imagination		Like thinking and solving puzzles	
I'm good at it		I find it easy	

Appendix 6 Primary School Subjects

Your participation is voluntary. All information will be treated as confidential.

Please complete the following details by circling your appropriate response:

Male/Female

Number of Years in teaching: 0-2yrs 3-5yrs 6-10yrs 11-20yrs 30+yrs

Year Groups taught during career: 1 2 3 4 5 6

Specialist qualification(s) to teach e.g. degree, postgraduate:

English Maths Science Art ICT Technology

Geography History French Music P.E. R.S.

Other: ______________________________

For the following questions, please circle the appropriate response(s) or add a response on the line given:

1 Which subject(s) do you enjoy teaching the most at school?

English Maths ScienceICT Art R.S. Geography

Music French Technology Physical Education History

2 Why do you enjoy teaching these subjects?

I'm good at it Many resources Interesting topics

Feel confident Pupils enjoy it Practical aspects

Other: ____

3 Which subject(s) do you lest enjoy teaching at school?

English Maths ScienceICT Art R.S. Geography

Music French Technology Physical Education History

PLEASE TURN OVER

4 Why do you dislike teaching these subjects?

I'm not good at it	Not many resources	Uninteresting topics
Don't feel confident	Pupils don't enjoy it	No practical aspects
Pupils find it hard	No training on it myself	Taught it too many times

Other: ____

5 What are your favourite classroom activities in lessons?

Videos	CD-ROMs	Interactive Whiteboard	Story-time
Writing	Comprehension	Practicals	Art work
Group work	Role-play	Demonstrating experiments	

Other: ____

Thank you for your help; it is very much appreciated.

Information on Teachers' Participating in the Research

Primary School Teachers Questionnaire

Teacher No.	Gender	Years Teaching	Year Grps Taught	Qualification (degree)
1	f	11 ~ 20	all	English/R.S.
2	f	11 ~ 20	3, 4, 5, 6	ICT/Geography/First Aid
3	f	3 ~ 5	all	Art/Ttechnology/P.E.
4	f	3 ~ 5	1, 2	R.S.
5	f	3 ~ 5	all	ICT
6		11 ~ 20	1, 3, 4, 5, 6	
7	f	11 ~ 20	all	History
8	m	3 ~ 5	all	English
9	f	11 ~ 20	1, 2, 3, 4, 5	B.Ed
10		6 ~ 10	3, 4	Music
11	f	6 ~ 10	4, 5, 6	
12	f	6 ~ 10	1, 2	English/Technology
13	f	3 ~ 5	1, 2	Art/ICT
14	f	11 ~ 20	all	English/SEN
15	f	3 ~ 5	reception, 1, 2	PGCE
16		6 ~ 10	4, 5, 6	Maths/History
17	f	11 ~ 20	3, 4, 5, 6	History
18	f	11 ~ 20	1, 3, 4, 5, 6	Science
19	m	0 ~ 2	3, 5	PGCE
20	f	6 ~ 10	3, 5, 6	Science
21	f	30+	3, 4	Primary Curriculum
22	f	6 ~ 10	3, 4, 5, 6	R.S.
23	m	0 ~ 2	5	Maths
24		6 ~ 10	reception, 1, 2	B.Ed Science
25	m	6 ~ 10	3, 4, 5, 6	Envirionmental Studies and PGCE
26	f	6 ~ 10	all	English
27	f	11 ~ 20	1, 2, 3, 4	Special Needs
28	f	11 ~ 20	all	P.E.
29	f	0 ~ 2	4, 6	Science/Art
30	f	30+	reception, 1, 2	Geography
31	f	11 ~ 20	2, 3, 4, 5, 6	History/Humanities
32		30+	all	General Subjects - Primary
33	f	25	all	English
34	m	30+	all (incl secondary)	English/Art
35	f	0 ~ 2	4	English/History
36	f	11 ~ 20	2, 3, 4, 5, 6	Geography/History
37		11 ~ 20	3, 4, 5, 6	P.E.
38	f	0 ~ 2	5	BA Primary Education

Table 2: Information on Primary School Teachers Participating in the Research.

Appendix 7: Attitudes towards Secondary School

This survey is completely confidential. Your participation is voluntary.
Gender: ____________; Age: ______; Prep School: ____________________

1 Rank your 5 favourite school subjects (your most favourite being number 1):
1 ____
2 ____
3 ____
4 ____
5 ____

2 Why do you like these subjects? (State the subject and then why you like it).

----

3 Rank your 5 least favourite school subjects (your least favourite as number 1):

1 ____
2 ____
3 ____
4 ____
5 ____

4 Why do you dislike these subjects so much? (state the subject and say why you dislike it).

----

5 Which subjects have been new to you at Secondary School?

....
....
....
....

6 What have been your most memorable moments from this term?

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7 What have been your worst moments of this term?

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8 Have you got any other comments that you would like to add about your first term at Secondary School?

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(Question 8 on the end of year form had a question on what advice would the pupils give to a new Yr 7 and what were they looking forward to in Yr 8).

Appendix 8: Full Review of Interview with Yr 7 Pupils about their first term at Secondary School.

8th December 2004, 1.15 – 1.45pm, Lower School, Trent College

Y7

List of Questions: End of Term 1 at Secondary School

1 What has been good this term?
2 What has not been good this term?
3 Is anything at secondary as you expected it would be?
4 Is there anything at secondary school that is not as you expected?
5 Are there any subjects that are new to you? What are they?
6 What are your teachers like?
7 What are your lessons like?
8 Which subjects do you like?
9 Which subjects do you dislike?
10 Are your lessons different from primary school? How?
11 What are your favourite parts of secondary school?
12 What are your least favourite parts of secondary school?
(Question 13 omitted due to time)

Question 1

Good things that have happened this term:

- A pupil being given a nickname from their friends
- Making friends on the first day of secondary school
- Tuck shop – and they have a different time than Yr 10
- Fish and chips on Friday for lunch
- Bus ride to school – get to know other people and make friends
- Muffin and mince pies in PSHE
- Girls won quiz in PSHE
- Independence – they don't have to sit all day in the same classroom and they are treated more like adults
- One girl has become the U12A hockey team captain

Question 2

Not so good things that have happened this term:

- Bus ride – Yr 7 have to sit at the front and at the bottom if a double decker
- Buses being late to school
- Exams
- Don't like being given a granny bag to carry their books in – they are too small
- Don't like all of the lunches or the packed lunches
- Some classes aren't allowed to decorate their classroom
- Girls felt their skirts had to be too long and would prefer to wear trousers in winter
- Boys didn't like having to do up their top button for ties
- Girls wanted more freedom on the choice of their shoes

Question 3
Things that pupils expected as they came to secondary school:

- They expected the work to be hard but it hasn't been as bad as they thought
- One girl was looking forward to being at a coeducational secondary school as she'd been at an all girls school
- It would be more fun as there are more pupils and therefore more friends (and enemies)
- One thought his form tutor would be horrible but he's really nice
- Some expected it to be so big that they would get lost but it's OK
- Some were expecting to forget all their teachers names but they've coped well

Question 4
Things that pupils had not expected at secondary school:

- In a bullying situation, the pupil was surprised that they were asked about what they would like to do about it
- One girl thought that she would stay friends with her old friends but she's moved on and is closer to other people
- Some hadn't thought the school day would be so long – some days go quickly as they are active in lessons or have activities, others are very long
- Teachers are nicer than expected
- More variety to their school day than expected
- Boys though teachers would be very strict in lessons – no talking but it's been OK
- Boys thought if they were caught with their top button undone, that they would get a detention, but haven't
- They thought that teachers would make them work really hard, but don't
- They thought that at break time they would have to stay in one room, but they can go and play on the Astroturf, on netball courts, in the library or go into other classrooms

Question 5
Which subjects are new to the Yr 7's:

- Spanish
- 3 separate sciences
- PSHE
- Design Technology
- Geography/History (just one pupils as he had only done a term of each at his primary school)
- Religious Studies

Question 6
What are your teachers like?

- Nice
- Swear – one in particular
- Evil
- Some treat us like babies

- One says 'um' all the time
- One makes you think like a historian – great!

Question 7
What are the lessons like?
- Some are horrible, some are good
- One hour is too long
- Lots of stories in lessons, little fact
- Music/drama in history and geography
- Videos
- At the beginning, sometimes told they are doing one thing, and then do another!
- Teachers are not as sensitive e.g. racism in PSHE was dealt with insensitively to the class being talked to

Question 8
Which subjects do you like?
- Biology
- All sciences
- Games
- ICT
- Art
- Chemistry
- Spanish

Question 9
Subjects which are not liked:
- Maths
- Spanish
- English
- Art
- Religious Studies
- Physics

Question 10
How are the lessons different from primary school?:
- Some are the same
- Range of different subjects
- The way the lessons are now taught keeps the pupils more active – less time to sleep
- All of the yr 7 subjects are more challenging

Question 11
What are your favourite parts of secondary school?
- Tuck shop
- If no activities at lunchtime, can play outside
- In music, can go and play instruments
- Girls/boys play on the Astroturf

- Lots of activities in free time

Many responses seemed negative so I added a question:
How can we make it better?

- Girls have somewhere separate to play orm the boys who dominate the Astroturf
- Other things to do in freetime – quad bikes, girls's only café

Question 12
Least favourite parts of secondary school are:

- Getting up early (6.30am as have to get a bus at 7.30)
- Long day – up at 6.30am and don't get home until 7.45pm
- 1hr of prep time and then go home at 6pm on the uses
- Going home!
- Being teased
- Too much prep
- All friends from other schools play together after school as they finish at 3.30pm but they can't join in
- Dark when they get home so can't play out
- Not enough free time in the school day
- Sometimes they have no prep and have to sit doing nothing in prep time
- Like the computers in IT but never get time to go and play on them
- Spanish

Appendix 9: Yr 6 Pupils – Lesson Observations

It is now common that primary schools organise days for secondary school teachers to go in and speak to the pupils and for pupils to undertake a day in the secondary school. One observed when the Yr 6 pupils came up to our secondary school for the 'Junior Science' activity. The pupils met some science teachers and saw the physics and biology departments. The sessions were led by sixth form pupils so they enjoyed their input since it was more informal than it being a 'proper' teacher. Experiments that the pupils were shown included:

- Van Der Graff generator
- Slides of the Planets (with questions)
- Liquid Nitrogen
- Hydrogen Peroxide decomposition
- Looking through microscopes at pond life
- Looking round the Biology 'live' section – hamster, giant snail, locusts, spiders

Here is a summary table from my observations during the afternoon:

Activity	**Pupil Behaviour**
Electrostatics experiments	'wow' when teacher put his hand by the sparks
Space slide show	Questions well answered on the planets. Some pupils were very inquisitive – 'Will life end when the sun explodes?'
The preserved eye	As soon as this was shown to the pupils a gasp went round the room – when pupils were able to go and look around

	themselves, this was a popular first choice, especially by the boys
Skeleton	'OOhh – is it real?' was a first question.
Looking at the animals	'Can we hold a snail? Stick insect? I asked the pupils how they felt –'sticky, slimy'.
Tropical fish tank	'Ooh there's a cat fish'; 'I've got some neon tetras'
Hydrogen balloon	'Wow' at the loud bang!
Van der Graff generator	Girls took part – laughing when her hair stood on end; 'oohh' when a girl came and touched her hand and there was a crackle
Hydrogen peroxide decomposition	'OOhh' as the steam/oxygen shot out of the conical flask and hit the ceiling
Sound machine	Pupils smiled when the waves were moved closer together – all watched intently

Table 3: Pupil Observations.

A general observation from the pupils' point of view was that many of the pupils were interested and really enjoyed the afternoon. However, there was a minority, of mainly girls, who looked distracted and talked through demonstrations.

Four primary science lessons were observed at School A (prep school to School B). The pupils had been on a week long field trip to Dale Fort in Wales after their SATs so the pupils were doing follow-up work in their science lessons.

The first table provides a summary of tasks the pupils were observed to be doing. The second table provides information on the pupil's behaviour during the lessons.

Science Topic	**Pupil Activity**	**Special Comments**
Crabs	Discussion on the trip and then wrote about crabs (what they did, results - counting of them from their diary, measurements of them) on paper. Also talked about plankton.	Pupils remembered the trip well – specific parts that were really enjoyed stimulated excitement again e.g. the speedboat trip.
Sand Hopper counting	After discussion, wrote what they did, the results, estimated calculation of the number seen, evaluated their results	Wrote on yellow paper; teacher gave subtitles only; pupils entered average on the laptop (interactive whiteboard being used)
Grasses Comparison	What they could remember about the differences of woodland and grassland; which insects/animals they caught and the methods of catching	Wrote on green paper; step-wise to write – all wrote title, then drew a line down the page, then all did the comparisons; time limits for each task given

Adaptation	Powerpoint presentation and discussion on how certain animals they saw were adapted; music was played during the presentation (the boys particularly liked this), Wrote about two animals they particularly liked and how they are adapted	Open questions by the teacher – How are the dolphins adapted? Lots of interaction between teacher and pupils during the discussion; 'oohh' when the pupils saw the picture of a dolphin

Table 4: Observations of Pupil Activity.

Pupil Activity	**Behaviour Issue**	**How it was dealt with**
Discussion	Swinging on chairs (different in the science room to their 'normal' classroom)	Asked calmly to sit properly
Discussion	Pupils Talking	Pupil talking asked a question; 'ssshhh'; asked to listen
During written work	Fidgety; not on task - talking	Teacher went to table to see what they'd done and talked to them about the

		trip and then encouraged them to write about it – very positive as pupils loved the trip
Discussions	Shouting out - pupils generally put their hand up but sometimes, and it seemed when they were excited, shouted out the answer	Teacher reminded pupils to put hand up

Table 5: Observation of Pupils' Behaviour.

It was apparent that the Dale Fort trip was very much enjoyed by all. Two girls told me that they really enjoyed the speedboat trip to the island to collect the plankton. Two boys told me that they liked the flat fish and the crabs. Another boy told me he liked fishing in the rock pools. In the evenings on the trip, the pupils filled in weather charts (cross-curricular geography), graphs (bar chart of the sizes of crabs), lists of animals seen in the rock pools and completed a survey of which animals they caught in the river.

Whilst the pupils were working, I observed the science classroom that the pupils were in. This is a new room which has an interactive white board, television, laptop and a computer, sink, and simple equipment displayed on shelves (beakers, test tubes, test tube rack, scales, funnels, measuring cylinder). The chairs are higher (than in their normal classroom) and more like lab stools. Other points of interest were the globe and all of the textbooks. The displays were very colourful and made the room very welcoming – displays on gases (research undertaken on computers and typed up), forces, colour, space.

The teacher told me some of the key topics they had studied this year:

Biology

- Sex education
- Food chains and adaptation
- Predator and prey

Physics

- Space
- Light
- Sound

Chemistry

- Water
- Solids/liquids/gases
- Dissolving – undertake an experiment
- Separating sand and salt experiment
- Chemical and physical changes

The teacher told me that when writing up experiments they generally focus on one part of the write-up. For example, in one experiment the pupils would write their own plan and the results and conclusions would be teacher led. This approach was commented on in work by Hargreaves and Wall (2002). In one of the research schools, one primary school teacher said to the researcher:

'What we tend to say is what it's focusing on, for example,...on measuring, or an prediction, or on setting out the work'.

Suddenly at the secondary school, pupils are expected to write-up a whole practical. If teachers were more aware of the primary school experience, they could adapt to this approach to start with and then lead into writing up full investigations.

Work done was completed in an exercise book. The pupils wrote generally in pencil and underlined titles. For experiment write-ups pupils were used to:

- Title
- Equipment
- Plan – What we did
- Results
- Conclusion
- Evaluation

Pupils were always given a spelling list for each topic. In their books, the teacher used stickers, an ink stamper as a way to motivate and encourage the pupils.

In order to triangulate my observations from the school that was visited for Yr 6 observation last year, I went to one lesson which was the same lesson on the field trip the pupils had been on and one different one with the new Yr 6 pupils. I also visited a maths lessons.

14/6/05

During the lesson, I circulated and had a look at pupils work and asked them questions relating to the work and where appropriate offered help. With the class being of a more mixed ability than the previous year, it was of use to the Yr 6 class teacher to have another member of staff for support.

The lesson began with the power-point presentation comparing the grassland in grassland and woodland. The pupils had a discussion, which was much livelier than before, with some pupils shouting out and not obeying the hands up rule, to remind themselves about the practical on the field trip. The more confident pupils participated but less able were much quieter. The pupils had to produce a poster on the different grasses they saw on their field trip. They specifically had to write about what they used to find living things and what they caught in the different areas. Verbally, the pupils were good at communicating to me what they used in the experiment and since they'd enjoyed it, remembered many of the creatures they caught. The 'behaviour' table (since they were of mixed behavioural problems) were very loud, however, one boy, who loved art, produced an excellent poster with lots of detail about all the creatures. The overall classroom dynamics were much louder and pupils worked at a slower pace. Some of the pupils were lazy and needed constant reminders about what they had to do and for when. There was extension work available to those who had finished (it was displayed on the power-point slide kept up). The teacher explained to me the seating plan in science lessons. This was the lesson where they can sit with others and in groups of four instead of pairs. She had some control as to where the pupils sat and in the groups of four there were two able and two less able. The lesson was a bit unusual as four of the brighter pupils were out of the lesson listening to Yr 5 pupils read. The standard of work produced was much more varied in the time allocated. Some examples of work are in the appendix.

The wall displays were vibrant and on a variety of science topics they had covered during the year. The topics they had studied were:

- Bouncing ball experiment
- Magnets
- Parts of the body
- Separating mixtures
- Complementary colours
- Heart – pulse rate experiment

My conclusions from the visit are that the pupils still seemed to be enthusiastic about science and loved the field trip. Although the atmosphere was much louder than the previous year, and there was more mixed ability, their attitudes towards science appeared to be good and they recalled well what they had done on the field trip.

<u>16/6/05</u>

The next lesson I observed was mainly a maths lesson. On the field trip, the pupils counted the number of crabs seen at certain places and during the lesson they were making tally charts and then learning how to do bar charts from the results.

The pupils were given the results – during the discussion they were on the power-point and also a sheet was given out for use in the lesson. The task and example of how to do it was left on the screen after the discussion about it.

Some of the pupils found it hard to start to tally the results. The concentration it required proved to be challenging for some. The less able pupils needed a teacher to be present to keep them focused on the task but it was good that they were keen to talk about doing the counting on the trip even though they were not as keen on the follow-up work. This shows that the field trip is a highlight in their year and a positive way to promote science.

The bar graph was quite hard for them. Each time they draw a graph, the teacher gives them a new bit to do for themselves. In this lesson, their 'thinking' part was to come up with a suitable title. They had discussed some ideas together and she encouraged the pupils that there was no right or wrong answer but that this was the learning experience. Some pupils who were unsure of the thinking were given extra help to reassure them. The pupils were guided on how to decide on their axes and were helped in knowing the correct words to use e.g. frequency.

In conclusion, the skills in this lesson are ones that at secondary school we sometimes find are not fully developed but it is good that they are gaining experience in having the control of drawing their own graphs. It also helps the pupils understand the link between maths and science and the earlier this is taught, the better.

<u>21/6/05</u>

The third lesson that was observed was with another teacher with a mixed ability class. It was a science lesson on 'nerves'. The lesson started with the teacher leading a discussion about different parts of the body and fascinating facts about them. The pupils loved this! Then there were five pupils (who volunteered) to take part in a simple role-play on sending messages. By this time (ten minutes into the lesson) some of the pupils were getting fidgety though the teacher had carefully chosen some of the 'fidgeters' to be in the role-play!

The pupils were told about an experiment they were going to do (catching a ruler) to test their reactions. The pupils were reminded about units and how to draw tables. Most pupils thoroughly enjoyed the task and most of them stayed on task. One of the reasons they seemed to like it was it was about them and they could clearly see the link to their life. Some of them also liked the competitive element of it. The extension activity of what else they could try was really interesting – there were some very good ideas and these pupils were asked to carry them out afterwards so they had another set of results. The pupils then were told to look for patterns in their results and in the next session they were going to draw graphs of their results. This demonstrated that more lesson time was spent on the practical at primary school than at secondary school. Also, the pupils were encouraged to think about why they all might have different reasons. This shows that they were encouraged to develop some good scientific ideas. The teacher informed me that once they had drawn the graph in the afternoon, the more able would be challenged to make predictions from the results gained. Once again, the teacher was moving the pupils forward in a positive scientific way.

The teacher had a very calm approach to the lesson and she had some obvious classroom rules that worked for this lively class. The pupil knew that if she put her hand up, they had to also and be quiet as they did it. The pupils were sat in friendship groups (tables of four) with the naughty pupils on the straight line on the back row. Once the teacher asked for quiet, most of the pupils obeyed the command. The less able tended to get rather restless by the end of the lesson and messed around rather than doing this experiment. This did highlight one disadvantage of more time on the practical aspect. To end the lesson the pupils who had done well were praised but others were spoken to with a firm voice about spoiling the lesson for everybody.

In conclusion from this lesson, it was clear that a suitable amount of time should be spent on practicals and only extension pupils, who have gotten through the main task successfully, should be able to go on as less able pupils cannot cope with the demands of concentrating for that long; these pupils needed a sit down activity to calm them down and refocus their minds on the experiment. The lesson showed many introductions to secondary practical science and this is useful for teachers to know so they can continue, at secondary school, in a similar manner. The advantage of pupils being in a science room helps them to realise these lessons take place in different places and help bridge the gap to secondary school where science lessons will be in specialised laboratories. This teacher only taught the group twice a week so this again prepared the pupils for having more than one teacher to learn how to respond to.

Appendix 10 (from QCA website: www.qca.org.uk)

Programme of study: science

Key stage 4

Knowledge, skills and understanding

Teachers should ensure that the **Knowledge, skills and understanding** of how science works are integrated into the teaching of the **Breadth of study.**

How science works

Data, evidence, theories and explanations

1 Pupils should be taught:
a how scientific data can be collected and analysed
b how interpretation of data, using creative thought, provides evidence to test ideas and develop theories
c how explanations of many phenomena can be developed using scientific theories, models and ideas
d that there are some questions that science cannot currently answer, and some that science cannot address.

Practical and enquiry skills

2 Pupils should be taught to:
a plan to test a scientific idea, answer a scientific question, or solve a scientific problem
b collect data from primary or secondary sources, including using ICT sources and tools
c work accurately and safely, individually and with others, when collecting first-hand data
d evaluate methods of collection of data and consider their validity and reliability as evidence.

Communication skills

3 Pupils should be taught to:
a recall, analyse, interpret, apply and question scientific information or ideas
b use both qualitative and quantitative approaches
c present information, develop an argument and draw a conclusion, using scientific, technical and mathematical language, conventions and symbols and ICT tools.

Applications and implications of science

4 Pupils should be taught:
a about the use of contemporary scientific and technological developments and their benefits, drawbacks and risks
b to consider how and why decisions about science and technology are made, including those that raise ethical issues, and about the social, economic and environmental effects of such decisions
c how uncertainties in scientific knowledge and scientific ideas change over time and about the role of the scientific community in validating these changes.

Breadth of study

During the key stage, pupils should be taught the **Knowledge, skills and understanding** of how science works through the study of organisms and health, chemical and material behaviour, energy, electricity and radiations, and the environment, Earth and universe.

Organisms and health

5 In their study of science, the following should be covered:
a organisms are interdependent and adapted to their environments
b variation within species can lead to evolutionary changes and similarities and differences between species can be measured and classified
c the ways in which organisms function are related to the genes in their cells
d chemical and electrical signals enable body systems to respond to internal and external changes, in order to maintain the body in an optimal state
e human health is affected by a range of environmental and inherited factors, by the use and misuse of drugs and by medical treatments.

Chemical and material behaviour

6 In their study of science, the following should be covered:
a chemical change takes place by the rearrangement of atoms in substances
b there are patterns in the chemical reactions between substances
c new materials are made from natural resources by chemical reactions
d the properties of a material determine its uses.

Energy, electricity and radiations

7 In their study of science, the following should be covered:
a energy transfers can be measured and their efficiency calculated, which is important in considering the economic costs and environmental effects of energy use
b electrical power is readily transferred and controlled, and can be used in a range of different situations
c radiations, including ionising radiations, can transfer energy
d radiations in the form of waves can be used for communication.

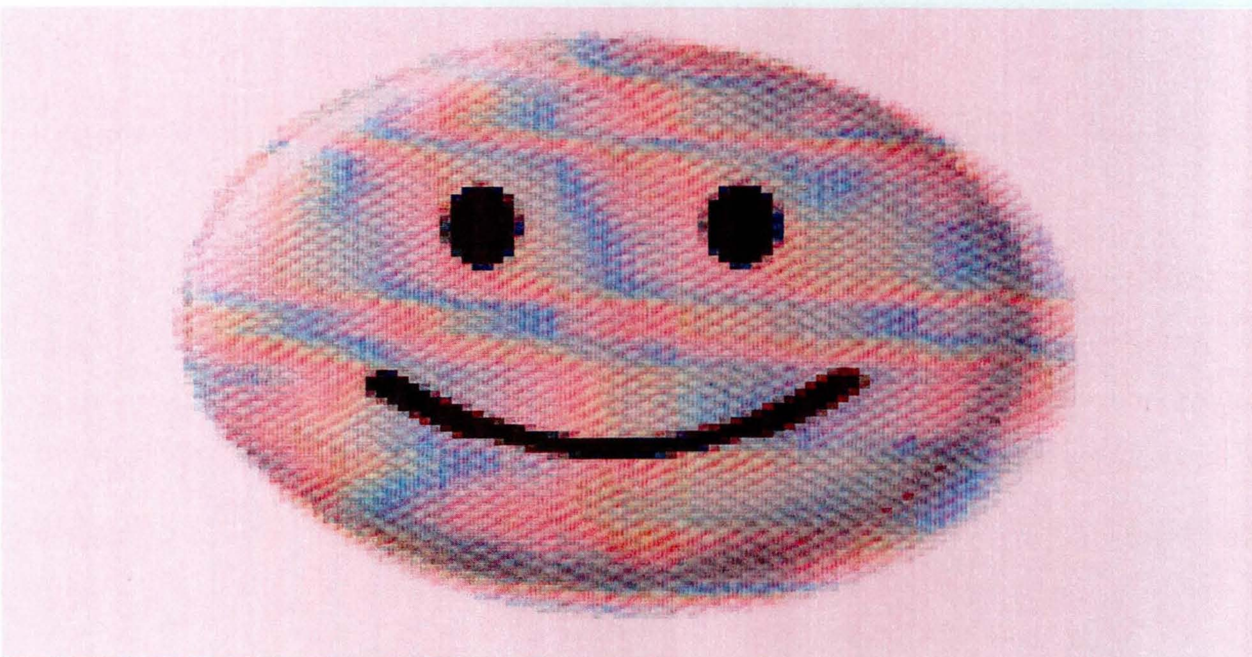
Environment, Earth and universe

8 In their study of science, the following should be covered:
a the effects of human activity on the environment can be assessed using living and non-living indicators
b the surface and the atmosphere of the Earth have changed since the Earth's origin and are changing at present
c the solar system is part of the universe, which has changed since its origin and continues to show long-term changes.

Appendix 11

Yr 2 Activity

Examples of laminated word cards used when working with the Yr 2 pupils.



Likes to play sports

Very quiet person

Dentist

Appendix 12 - Attitudes towards Secondary School – Responses to Questionnaire at the end of the first Term

Reasons For Liking School Subjects Michaelmas 2004

Subject	Reason Given	Number of Pupils	Reason Given	Number of Pupils
Art	Good at creating master pieces	3	Good at it	4
Biology	Good experiments	10	Like it	2
Chemistry	Like practical work	27	Fun	4
Design	See if your design was good or not	1	Interesting	1
Drama	Make scenes with partner	1	Like it	8
English	Videos	1	Good teacher who makes it interesting	12
Games	Being energetic	14	Chance to exercise	5
Geography	Relate to it	1	Have to think	1
History	Like digging up History facts	6	Good test result	1
I.T.	Interesting	3	We go on the computers	18
Maths	Good at it	6	Help to prove myself	1
Music	Practical lessons	6	Fun	5
P.E.	Get pushed to the limit/challenge	4	Flexible	1
Physics	Like the style of the lesson	3	Different activities	1
PSHE	Like expressing himself/herself	2	Working with others	1
R.S.	Listen to stories	1	Interesting	1
Spanish	Good to learn a/the language	7	Unusual	1

Subject	Reason Given	Number of Pupils	Reason Given	Number of Pupils
Art	Enjoy drawing	18	Calming	3
Biology	Like animals	3	Mum's a GP	1
Chemistry	Different and interesting	4	Like the teacher	4
Design	Like making things	13	Fun	3
Drama	Use talents	2	Like the teacher	3
English	Good at it	2	Plays	3
Games	Feel free/change from academic work	1	Like sport	25
Geography				
History	Interesting	6	Watch videos	1
I.T.	Fun	5	Creating things	2
Maths	Interesting	4	Fun	1
Music	Like the teacher	1	Easy	2
P.E.	Good to get to new level at something	1	Like sport	14
Physics	Interesting	6	Like to find things out	2
PSHE	Discussions	1	Good at it	1
R.S.				
Spanish	Learning new things	3	Fun	6

Subject	Reason Given	Number of Pupils	Reason Given	Number of Pupils
Art	Creative	6	Enjoy painting	1
Biology	Interesting	6	Good at it	2
Chemistry	Good at it	2		
Design	Practical work	2	Be creative	2
Drama	Like being creative	5	Don't write a lot	2
English	Fun	8	Unusual activities	1
Games	Like running	2	Good at it	8
Geography				
History	Make castles	1	Like the teacher	2
I.T.	Good at it	1	Easy	1
Maths	Like numbers	3	Nice teacher	1
Music	Like to sing	1	Like sounds	3
P.E.	Fun	3	Like being active	4
Physics	Like the teacher	2	Practicals	14
PSHE				
R.S.				
Spanish	Good at it	1	Videos	1

Subject	Reason Given	Number of Pupils	Reason Given	Number of Pupils
Art	Like the teacher	4	Don't write a lot	2
Biology	Fun	2	Easy	1
Chemistry				
Design				
Drama	Fun	2	Interesting	1
English	Writing stories	4	Like languages	1
Games	it's outdoors	1	Fun and exciting	9
Geography				
History				
I.T.	Enjoy it	1	Like typing not writing	1
Maths	Like it	1	Challenging	2
Music	Good at it	1	In a band	1
P.E.	Like running	1	Learn new skills	1
Physics	Fun	1	Easy	1
PSHE				
R.S.				
Spanish	Interesting	1		

Reasons for Disliking Subjects

Subject	Reason Given	Number of Pupils	Reason Given	Number of Pupils
Art				
Biology	Have to write a lot	1	Teacher talks too much	1
Chemistry	The room smells	1	Hard	1
Design	Get hard preps	1	Don't find out much	2
Drama				
English	Don't enjoy it	2	Tteacher speaks a lot	1
Games	Don't like the uniform	1		
Geography	Don't do much	1	Uninteresting	2
History	Teacher doesn't understand my needs	2	Don't like the teacher	2
I.T.	Don't like the teacher	1	Know it already	1
Maths	Don't enjoy it	3	Have to think	3
Music				
P.E.	Not sporty	1	Don't like wearing trunks	1
Physics	Don't enjoy it	2	Hard prep	1
PSHE				
R.S.	Not very good at it	6	Boring	18
Spanish	Given extra prep	2	Don't know why we do it	1
Swimming				

Reasons for Disliking Subjects

Subject	Reason Given	Number of Pupils	Reason Given	Number of Pupils
Art				
Biology	Don't enjoy it	1		
Chemistry				
Design	Boring	3		
Drama				
English	hard	1	Find spelling hard	1
Games				
Geography	Have to write a lot	1	Difficult	1
History	Can't remember dates	1	Not fun	1
I.T.	Confusing	1	Complicated	1
Maths	Uninteresting	1	Don't like numbers	2
Music				
P.E.				
Physics	Don't understand it	1	Hard to remember everything	1
PSHE				
R.S.	Don't enjoy it	5	Uninteresting	3
Spanish	Not very good at it	3	Can't speak it	1
Swimming				

Reasons for Disliking Subjects

Subject	Reason Given	Number of Pupils	Reason Given	Number of Pupils
Art				
Biology				
Chemistry				
Design				
Drama				
English	No practicals	1		
Games				
Geography	Don't like the teacher	4	Get picked on	1
History	Self taught	1	Confusing	1
I.T.				
Maths	Too easy	1	algebra	1
Music				
P.E.				
Physics	Maths bit is hard	1	Not scientific	1
PSHE				
R.S.	Hard	2	Don't understand it	2
Spanish				
Swimming				

Best Moments **At Secondary School**

Best Moments	Number of Pupils
Scoring in sports match	8
Playing sports matches	29
Biology exam result	2
Meeting new people/friends	16
Speaking first Spanish word	1
Got a star/my first star	8
Voted as Class President	1
School trip on Field Day	7
Playing sport	2
Getting 25 * award	5
Adventure weekend	13
Meeting new teachers	2
Meeting a boy	1
Not had yellow paper/detention	1
Diffusion in Chemistry lesson	1
Exam results	5
Getting into school play	1
Birthday	1
Physics result	1
Friend related	6
Watching Simba in Spanish	4
English - singing Christmas Carols	4
Blow up balloon in Physics	3
Seeing animals in Biology	1
Bunsen Burners in Chemistry	4
When it snowed	1
Our form group won tournament	2
First day	2
Coming to this school	1
Going home for holidays	1
Touched nose with tongue	1
Toilets flooding	1
No prep in exam week	1
Chapel choir service	1
When a teacher thought I was someone else	1
Experiments	1

Worst Moments **At Secondary School**

Worst Moments	**Number of Pupils**
Got a detention	7
Gum shield fitting	1
Finding way around school	1
Making friends	2
Getting a yellow paper	24
Maths and English exam results	1
Homework	2
Starting Physics	1
Exams	10
Grandad dying	1
Adventure weekend	3
Lost my football	1
Not making the sport's team	3
Doing cross country	2
Getting told off	9
R.S lessons/prep	2
Don't like lunchtime activities	1
Walking into a wall	1
4 preps on Tuesdays	2
History exam result	1
Spanish club	1
Meetings the boys	1
English results	1
Forgetting music lesson	1
Losing my locker key	1
Friend related	7
Class detention	5
First day	2
Re-doing exams	1
Being name called	2
Got lost on way to chapel	1
Getting lost	3
Letting goals in in a match	1
Told off for disorganisation	1
Accident	3
Incident with emailing	1
Being bullied	1
Told which lunchtime activity to do	1
First games lesson	1
Getting cuts in D.T.	1
Looking at dead bodies in English	1

Forgetting to hand in prep	1
Sports injury	1
Spanish Lessons	2

Any other comments?

Comments	**Number of Pupils**
Sport has helped improve skills	2
Lunches are nice	2
Subjects are interesting	2
Made progress in subjects	1
Lots of opportunities	2
I feel proud when I get a star	1
More independence/responsibility	8
Good social life	1
Meeting new people	9
Like the new teachers	3
Lunches are not very nice	1
Lots of things to do	1
Too much homework	4
Harder than expected	3
It's a very good school/cool	5
Everything is bigger	6
Hard being the youngest again	1
Fun	7
Don't like w/e as away from school	1
Enjoy lunchtime activities	1
Enjoyed adventure weekend	3
Too much homework on Tuesdays	1
Goal scoring in sport	1
Strict - yellow paper and detentions	3
Happy/like it	2
Lots of new teachers to get to know	5
Tuck shop	1
Had to grow up	1
Don't get on with Biology teacher	1
Stressful to start with	1
One hour lessons were new	2
Too many maths lessons	1
Term has gone very quickly	1
Do more practicals here	1
Tiring	2
Total change	1

Really like chapel choir	1
Scary when didn't know anyone	1
It's been the best term in the world	1

Attitudes towards Secondary School – End of First year Responses

Best Moments/Most memorable	Number of Pupils
Playing hockey for school team	12
First day when made friends/new friends	12
Singing competition	8
Canoe trip	1
Played well in cricket match	9
Friend related	16
Being first in the Bradshaw after being last	1
Changed from naughty boy to good boy	1
Playing for school rugby team	10
Using a Bunsen Burner for the first time	2
Good exam results and reports	2
Exams/exam result	9
School play	2
The first day	3
Music exam/Lamda exam	2
Winning sports matches	3
Playing for school netball team	4
Adventure Weekend	8
Getting 25*	3
Walking into the chemistry block	1
Normandy Visit	2
Albert Hall Concert	3
Watching duck hatch	1
Ski trip	1
Not getting a yellow paper	1

Worst Moments	Number of Pupils
First detention/detentions	17
Maths class	3
W/e before exams	1
Friend related	7
Being told off	8
Exams	23
Lots of prep	6
First yellow paper/yellow papers	19
Getting a Saturday detention	1
Change of Physics teacher	1
Starting new sports	3
Having to stay at school until 6pm	1
The first day	3
Change in teacher	1
Exam results	4
An activity	1
Singing competition	2
Failing Chemistry and Spanish	1
Lower School band	2
The bus to school	1
Lack of organisation and no one helped just punished	1
Being bullied	2
Being told off unfairly	4
Hockey matches	1
Lessons	1
Healthy eating week	2
Choosing people for sports day	1
Adventure w/e	1
Coming to school	1

What are you looking forward to in Yr 8?

Reason	Number of Pupils
Not being the youngest in the school/eldest in lower school	33
more respect	2
Spanish trip	2
to have the priority over the Yr 7s in Lower School/buses	16
More challenges	1
Getting new teachers	9
More freedom	3
Learning French	4
Listening to music in prep	2
Seeing how the Yr 6's have changed	3
Being a teenager	5
Getting 25 *	1
Hockey season	1
Doing more things	2
Change of friends in class/different form	12
Rugby season	4
Lamda	1
New granny bags	1
Improve my English	1
More Chemistry	1
More sports matches	9
Not being new and knowing how the school runs	2
It's a nice place to be so don't be scared	1
Learning German	1
Going to ICT first in prep	1
A new start	2
Lower School Play	1
Rock climbing trips	2
New girls	2
Games	4
Not seeing the current Yr 8s for a year	1

What advice would you give to new Yr 7s?

Advice	Number of Pupils
Do your prep and hand it in on time	12
Follow the rules	4
Be good in front of certain teachers	2
Work hard	6
Don't worry	6
Don't be over confident	1
Be good / behave	19
It's not as hard as you think	1
Try and fit in	2
Do your best	5
Have the right equipment with you	1
Don't swear	1
Don't get yellow papers or detentions	15
Get permission for music lessons	2
Have a good time/You will enjoy it	5
Work hard in lessons	1
Don't let the Yr 8's upset you	2
Make new friends quickly	4
The teachers don't bite!	1
Teachers are nice at first and then turn nasty	2
Look after your things so you don't lose them	3
Concentrate in lessons	1
Keep your shirt tucked in	1
Be polite to teachers	1
Don't get on the wrong side of teachers	6
You must like sport	1
Don't lose the map in your record book	1
Hold granny bag under arm, don't do up blazer	1
Make friends with pupils in other forms	1
Be nice to Yr 8s and Main School pupils	3
It's a nice school	1
Tell the truth	1
Expect harder work	1
Don't do stupid things	4
Be organised	1
Revise well for tests and exams	1
Get to know your teachers well	1
Don't be cheeky	2
Don't answer back to teachers	1
Don't send emails around the whole school	1
Always take prep diary to lessons	1

Appendix 13 – Exemplar letters that were sent to schools requesting Permission to Conduct Research

******
Oakwood
Derby
******
3.11.04

Headmaster
*****
*****
*****
Nottinghamshire
*****

Dear Headmaster

Following the research that I undertook at xxxxxx last year, during my second year of my PhD, I am writing to request permission to repeat the research again this year as part of my final year research.

I would like to involve all of the Yr 7 and Yr 9 pupils with the 'Attitudes towards Science' questionnaire and have some short, group interviews with four Yr 7 pupils and 2 Yr 10 pupils. If you require me to write to parents to request permission, I am willing to do that. Copies of the work are included for you to read and decide if the tasks are appropriate.

Thank you for your continued help and support with my research. I am thoroughly enjoying the work and finding it beneficial to my teaching.

Yours sincerely

Mrs Sarah Turner

Dr Gren Ireson (Supervisor, Loughborough University)

******
Oakwood
Derby
******
3.11.04

Headmistress
****
****
****
Nottinghamshire

Dear Headmistress

Thank you for your help and support so far with my research on 'Attitudes towards Science'. I am writing again to ask, as part of my final year research, if it would be possible to distribute the questionnaires to the Yr 6 pupils at the end of this term and at the end of the summer term.

Since my research is leading to learning in the primary school, I would be grateful if the teachers, at a convenient time in the year, could complete a simple questionnaire about teaching so that I can collate some general information about how teachers feel in the classroom.

Also, if there are some Yr 2 and 3 pupils that stay after school, would it be possible for me to come over and ask them to take part in some simple activities about school (they are a simple version of the questionnaire).

I have enclosed all copies of work to be used for you to read, and if you feel that the tasks are suitable to use at xxxxxxxx, I will be in contact to arrange some dates to visit again.

Thank you once again. I am thoroughly enjoying my research and it is most beneficial to my teaching and pupils' learning.

Yours sincerely

Mrs Sarah Turner

Dr Gren Ireson (Supervisor, Loughborough University)