Stats and Figures

Statistical Consultancy

Report Title:	**Children Challenging Industry** **Analysis of children's & teachers' data from the West Yorkshire region, September 2003 to July 2005.**
CCI project Manager:	Joy Parvin
Author:	Charlotte Evans
Report Date:	March 2006
Version:	1.1

Table of Contents

1 Executive Summary 4

1.1 Children's data 4

1.2 Teachers' data 5

2 Introduction 6

2.1 Background 6

2.2 Methods 7

3 Children's views of science 9

3.1 Enthusiasm for science 9

3.2 Reaction to the CCI project 10

3.3 Measure of attitudes towards CCI project 15

3.4 Importance of scientists 16

3.5 Chapter summary 17

4 Children's views of industry 18

4.1 Industrial environment 18

4.2 Drawings analysis 19

4.3 Industrial careers 28

4.4 Jobs in industry chosen by children 29

4.5 Chapter summary 30

5 Evidence to support the provision of training 32

5.1 Training and qualifications 32

5.2 Teaching of industry within the curriculum 33

5.3 Industrial links 34

5.4 Chapter summary 35

6 Teacher's reaction to the CCI project 36

6.1 Strengths 36

6.2 Weaknesses 38

6.3 Chapter summary 39

7 Knowledge and attitudes of teachers 40

7.1 Knowledge of industry and science 40

7.2 Attitudes towards links with industry 41

7.3 Chapter summary 41

8 Conclusions 43

8.1 Children's data 43

8.2 Teachers' data 44

8.3 Summary 44

9 Appendix 1: Points system for analysing drawings 45

10 References 46

Table of figures

Figure 3-1: Children's enjoyment of science after CCI 9
Figure 3-2: Positive opinions of science 10
Figure 3-3: Positive attitude towards the CCI project 11
Figure 3-4: Negative attitude towards the CCI project 11
Figure 3-5: Favourite aspects of CCI identified by the children 12
Figure 3-6: Least favourite aspects of CCI identified by the children 13
Figure 3-7: Score of children's attitude towards the CCI project 15
Figure 3-8: Proportion of children who stated they enjoyed science more 16
Figure 3-9: Why scientists are important 16
Figure 4-1: Children's descriptions of industry 18
Figure 4-2: Children's descriptions of industry 18
Figure 4-3: Scores for external and internal drawings of industrial sites 20
Figure 4-4: Child 1, external picture of industry after the CCI project 21
Figure 4-5: Child 2, external picture of industry after the CCI project 22
Figure 4-6: Child 3, external picture of industry after the CCI project 23
Figure 4-7: Child 4, external picture of industry after the CCI project 24
Figure 4-8: Child 1, internal picture of industry after the CCI project 25
Figure 4-9: Child 5, internal picture of industry after the CCI project 26
Figure 4-10: Child 3, internal picture of industry after the CCI project 27
Figure 4-11: Child 4, internal picture of industry after the CCI project 28
Figure 4-12: Industrial jobs that children were aware of in industry 29
Figure 5-1: Training and qualifications 32
Figure 5-2: Number of days of science & industry training 33
Figure 5-3: Subjects covering industry in the curriculum 33
Figure 6-1: Strengths of the CCI project 36
Figure 6-2: Teachers' rating of the CCI project 37
Figure 6-3: Teachers' views of the CCI project 38

1 Executive Summary

Classroom-based training, consisting of three 2½-hour sessions, was delivered to primary school teachers and their year 5 and 6 pupils. The children completed one of four topics on offer, chosen by the teacher. These were, *Water for Industry*, *A Pinch of Salt*, *Plastics Playtime* and *Exploring Colour and Industry*.

The advisory teacher demonstrated how industry could be used as a resource, by providing a real and motivating context in which to teach science. The classroom activities were set within an industrial context, and the children visited an industrial site. The advisory teacher conducted a 1½-hour training session on science–industry links for the whole staff in each school.

The Children Challenging Industry (CCI) project aims are to:

- Provide classroom-based training for teachers in aspects of the National Curriculum for science
- Increase children's enjoyment of science
- Improve primary school children's perception of the chemical industry and other science based manufacturing industries, and their relationship with science
- Improve teachers' knowledge and confidence of teaching science
- Improve teachers' perception of the chemical industry and other science based manufacturing industries, and their relationship with science.

1.1 Children's data

318 children completed questionnaires from the academic years 2003-2005, after completing the CCI project. They were asked questions regarding their awareness of industry and its relationship with science.

Two thirds of the children said they enjoyed science more since the positive experience of the CCI project. The aspects of the project enjoyed the most were the practical experiments. The children rated the project extremely highly with two thirds of children giving it the highest possible rating. The vast majority of the children said they enjoyed the project because they learned something new and it was fun.

Virtually all the children learned about the importance of science demonstrated by the fact that 96% of children said scientific testing was important and gave reasons for their opinion.

In addition to their increased enjoyment of science, the children increased their awareness of industry. After the CCI project, the children were able to describe modern industry more accurately. They were more likely to say that an industrial site was safe and employed fewer people than expected, compared to baseline data. They were less likely to say that a site was hot, smelly, dirty or dark. The children who had a site visit were particularly able to describe modern industry more accurately.

Children's drawings of their perceptions of industry were scored, with a positive score indicating a more informed image of industry as a result of the project. The children's drawings of the internal and external views of an industrial site were more detailed and accurate after the project.

The project also raised the children's awareness of the variety of jobs held in industry. The children learned about the importance of scientists and engineers and their roles on industrial sites. After the CCI project, the proportion of children who were aware that scientists and engineers worked in industry increased. 40% of the children stated that scientists and/or engineers worked in industry.

When asked which job they would choose to do in industry, there was an increase in the proportion of children who chose scientist as a job they would like to do. The reasons the children chose to be a scientist were that it would be fun or interesting or they would enjoy it.

These results demonstrate how much the children learned about industry and the types of jobs in industry during the CCI project. By the end of the project, the image of scientists was immensely positive. If these views were sustained it would be expected that the number of children who wanted to work in science and industry would rise in the future.

1.2 Teachers' data

49 teachers returned questionnaires in the academic years 2003-2005, after involvement in the CCI project. It was clear that this type of training was greatly needed. A third of the teachers had not had recent science training, and training related to industry was even less common.

Before they had any CCI training there was very little awareness of the manufacturing industry. More than half of the teachers had not received any information about the manufacturing industry either through resources developed by industry or through links with the chemical industry. However, the teachers who had used resources were most likely to say that they did so because they were of good educational quality. Teachers were more likely to teach about industry in the context of geography, than science.

The feedback from the training was overwhelmingly positive. The sessions and site visits were of an extremely high standard and were highly rated by the teachers. Aspects of the sessions most often cited as strengths were the practical science activities. Teachers who rated the visit most highly were twice as likely to say they would arrange a future visit.

The change in attitudes towards industrial links that occurred during the project was impressive. Virtually all the teachers said they had learned something about industry and teaching science. In addition, 9 out of 10 teachers intended to re-use the CCI materials again and repeat the industrial visit in the future.

These results provide strong evidence that the CCI training has changed the attitudes of teachers. At the beginning, the teachers were mostly neutral about involving industry with primary science. By the end of the training, the majority of teachers were extremely receptive to involving the manufacturing industry to teach science with a more practical approach, with the implication that permanent changes were to be made to their science teaching methods.

2 Introduction

2.1 Background

In 1988 the Education Reform Act prescribed the curriculum to be taught in state schools in England and Wales. The first set of national guidelines for science were published the following year (DES, 1989). Science was to be taught as a 'core subject' and for the first time primary teachers were being told to teach children a broad science curriculum, covering investigation skills and aspects of physical and life sciences.

However, research carried out in recent years has highlighted teachers' lack of scientific knowledge and confidence to teach science (Parvin 1999). Close links have been found between primary teachers' ability to question children effectively and their understanding of scientific concepts (Whitby, 1993, Jelly, 1985). Productive questions promote science as a way of working, in which a variety of solutions can be sought from first hand experiences (Parvin, 1999). Further evidence of this argument is provided by Jarvis and Bell (2002). They concluded that there was a relationship between teaching behaviour and children's attitudes to science. Children with more positive attitudes towards science are more likely to be found in classrooms which have high levels of involvement, teacher support and use of innovative teaching strategies. Teachers who lack ability, confidence and enthusiasm for the subject tend to use less stimulating, more didactic methods and do not respond effectively to the children's questions making them more likely to have pupils with poor attitudes to science.

For this reason, the Qualifications and Curriculum Authority feel that primary teachers should obtain a minimum of a GCSE in one or more areas of science (biological, chemical or physical) in order to be able to teach the subject (Blackburn, 1997). In addition to qualifications that provide adequate knowledge, successful teaching of science is dependent on a good understanding of scientific concepts and time in which to properly teach these concepts. However, the introduction of the National Literacy Strategy and the Numeracy strategy are having profound effects on science in primary schools, with schools reducing the time spent on science (ASE, 1999). It is therefore important (if not essential) that teachers are given the opportunity to improve their science teaching skills with high quality in-service science training (Parvin,1999).

Using industrial contexts in primary science leads to an improvement in the quality of the teaching. By setting science activities within an industrial context, the problem of science being an isolated subject with no relevance to everyday life is overcome. The National Curriculum recognises this and states: 'Pupils should be given the opportunities to consider the part science has played in the development of many of the things that they use'. Research has shown that developing children's industrial understanding and providing a purpose and relevant context for their classroom science activities, leads to increased motivation and ownership of their work (Parvin, 1999). Good quality science teaching is extremely important during the primary school years and not just when pupils are making career choices in secondary school. Research by Pell and Jarvis (2001) found that there was a steady decline in children's enthusiasm for science during the primary school years. They also stressed that the way to improve children's enjoyment of science was through in-service training.

The attitudes of primary school children towards science have far reaching consequences. Attitudes towards science at a younger age may influence children's later views of science and scientific occupations as well as their attainment (Pell, Jarvis, 2001). Research from 1975 showed that the ages 8 to 13 are the critical ones for a child's formation of attitudes to science (Pell & Jarvis). Musgrove and

Batcock (1969) found that a third of the science and engineering students they questioned had made the choice to study science by the age of 12. Blatchford (1992) also found that pupils showed awareness of future careers before entering secondary school and children as young as four years old have perceptions about occupations (Parvin, 1999). With little information about industry taught at school many pupils and subsequently adults hold negative views of industry making it unlikely that they would consider this area as a career. The scale of the problem becomes clear when you consider that the UK chemical industry alone, employs more than 200,000 skilled people, contributing a significant amount to the Gross Domestic Product.

MORI polls have shown that the views of industry held by the public (which includes teachers) are often negative or narrow. These views are based on limited knowledge, obtained from the media, which is indifferent at best, even hostile, to the chemical industry or from news reports which cover industry in the role of polluter. The immense contribution to everyday life that the chemical industry makes is often overlooked. The MORI polls showed that the youngest group being surveyed were the most negative towards industry, an indication that these negative perceptions start earlier than adulthood. It is no surprise that concern has been expressed recently at the drop in young people pursuing a scientific career in industry.

To increase the proportion of pupils who enjoy science and may consider a career in industry in the future, children must receive high quality science teaching and demonstrate a positive attitude towards science and industry. In-service training provided by the Chemical Industry Education Centre (CIEC) at the University of York has therefore been designed and is delivered to demonstrate to teachers how industry can be used as a resource, providing a real and motivating context in which to teach science.

Project aims

The five main aims are to:

- Provide classroom-based training for teachers in aspects of the National Curriculum for science
- Improve teachers' knowledge and confidence of teaching science
- Improve teachers' attitudes towards the manufacturing industry and its relationship with science
- Increase children's enjoyment of science
- Improve children's attitudes towards the manufacturing industry and its relationship with science.

2.2 Methods

Science in-service training was provided to 89 classes in West Yorkshire, including 40 in Bradford by two advisory teachers between September 2003 and July 2005. The methods are explained in full detail in reports previously published in 2004 and available on the Chemical Industry Education Centre web-site (www.ciec.org.uk).

Questionnaires were returned for analysis from 49 teachers and 318 children from 55 schools (3 schools had 2 classes involved). In 13 schools only teachers or children's questionnaires were returned. The data were analysed to measure the impact of the project.

The advisory teachers were able to offer a variety of topics to the teachers and children, to suit their needs and interests, together with company visits. The teachers chose from the following topics, *Water for Industry, Plastics Playtime, A Pinch of Salt* and *Exploring Colour and Industry.* The proportion of teachers

choosing each topic are shown in Table 2-1. This result varies from region to region and from year to year with *Water for Industry* often being the favourite, due to the most promising opportunity for a site visit. Bradford houses the Colour Museum which explained why *Exploring Colour and Industry* was also very popular in this region.

Table 2-1: The Science topics chosen by teachers

Name of topic	Frequency	Percentage
Water for Industry	108	34
Exploring Colour and Industry	102	32
A Pinch of Salt	66	21
Plastics Playtime	36	11

41% (130) of the children were in year 6, and 53% (170) were in year 5. The remaining 6% (18 children) were in year 4. This result can vary from region to region and from year to year. In some regions the number of children in year 6 exceeds the number in year 5 taking part in the project. The balance of boys and girls was approximately even with 47% (150) boys and 53% (168) girls. The teachers had been teaching for an average of 15 years.

Approximately half the children (30 classes) that returned questionnaires visited an industrial site. The sites visited by schools in this region are shown in Table 2-2.

Table 2-2: Site visits in the region

Site Visited	Number of pupils sampled	Representing classes	Representing pupils
Colour Museum	60	10	300
Rohm & Haas	35	6	180
McBride	18	3	90
Total	15	3	90
Jacuzzi UK	12	2	60
Grosvenor chemicals	11	2	60
Kalon Paints	6	1	30
Linpac	6	1	30
Shipley paints	6	1	30
Cytec	5	1	30
Total	**174**	**30**	**900**

The range of visits is more limited in this region than in other regions because the project has not been running in this region for as many years and the number of contacts is therefore a little smaller.

All the following diagrams are displayed as percentages unless otherwise specified.

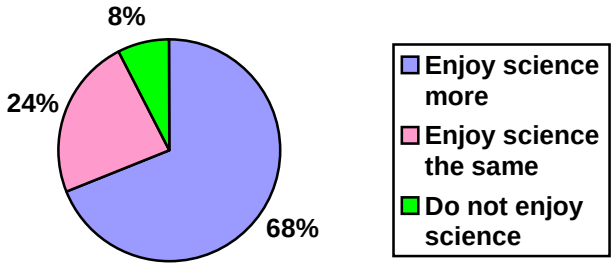
3 Children's views of science

This section discusses the children's views of science and how the children's positive views of the CCI project have effected their attitudes towards science.

3.1 Enthusiasm for science

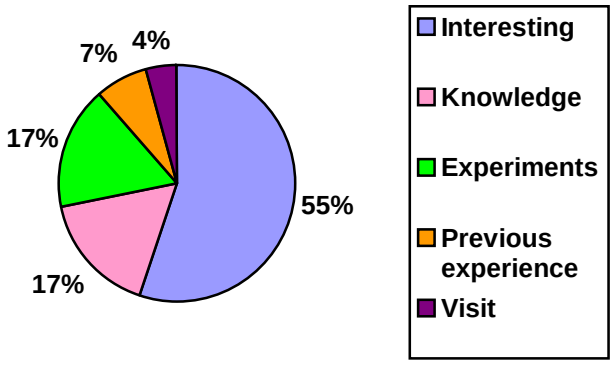
The children were asked if they liked science more, the same, or did not like science since involvement with the CCI project. The children overwhelmingly replied that they liked science more as shown in Figure 3-1.

Figure 3-1: Children's enjoyment of science after CCI



These results demonstrate the projects extraordinarily positive effect on the children's attitudes towards science with more than two thirds of the children saying they enjoyed science more than they did before the project. The children were given the opportunity to go into more detail on their opinion of science. As expected the vast majority (80%) were positive about science and included aspects of science that they enjoyed. Some children included positive aspects of science when they had said they liked science the same because they already enjoyed science. Some children were neutral about science (10%) and some described their reasons for not enjoying science (10%). Some of the children who said they enjoyed science the same stated both positive and negative things about science. The positive reasons for liking science have been divided into five categories. These are shown in Figure 3-2.

Figure 3-2: Positive opinions of science



The most common reply was that the children enjoyed science because it was interesting and fun, frequently asserting that this was as a result of the project. Many children mentioned that they learned a lot about science during the CCI lessons and others also mentioned that they enjoyed the practical experiments of the project. Some examples of the many positive responses are provided below:

"I like science more because we did lots of fun and interesting experiments and it showed me that science is really interesting." (girl, year 5)

"I like science because it's really interesting and I want to be a scientist when I grow up." (boy, year 6)

"I like science more because I've done things in science that I didn't think I would be able to do." (boy, year 6)

"I like doing science more because I like doing a lot of experiments." (girl, year6)

"I like science more because I find it more fun actually doing it instead of just reading from text books." (girl, year 6)

"I like science more because all the practical work we do is really fun and you can pretend you're in industry." (boy, year 6)

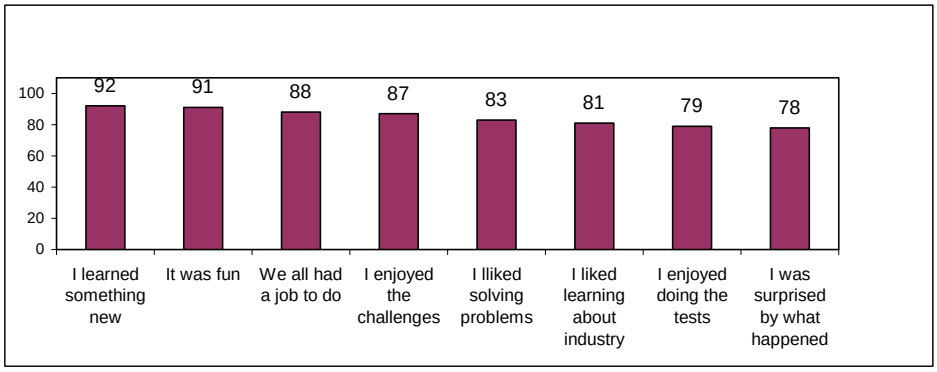
"I like science more because I have now found out new fabulous things about science." (girl, year 5)

"I really like science because I like doing and watching fascinating experiments. I want to try some experiments at home now that I like science." (boy, year 6)

3.2 Reaction to the CCI project

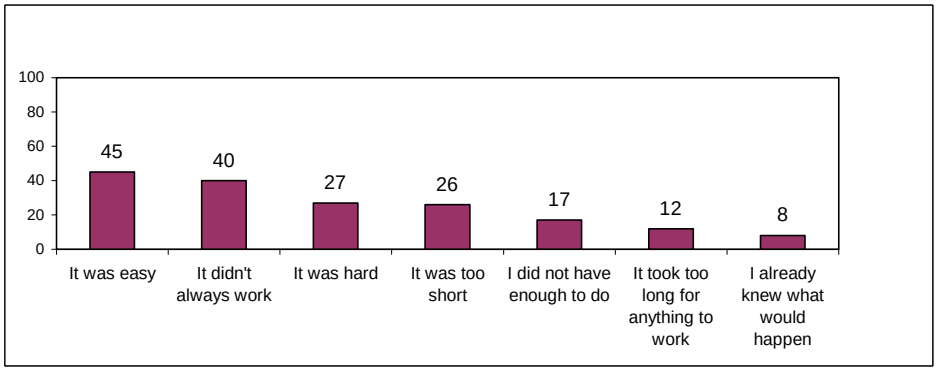
The children were asked a series of questions to find out their opinions of the CCI project. The questions were separated into positive and negative aspects of the project and shown with the proportion of children who answered 'yes' to each question in Figure 3-3 and Figure 3-4.

Figure 3-3: Positive attitude towards the CCI project



The most popular opinions the children held of the CCI project were; they had learned something new, it was fun and they had enjoyed the challenges. 9 out of 10 of the children held these very positive views of the project. The CCI project demonstrated that the most successful science lessons involve and challenge the children and ensure that their learning is taken to the next level.

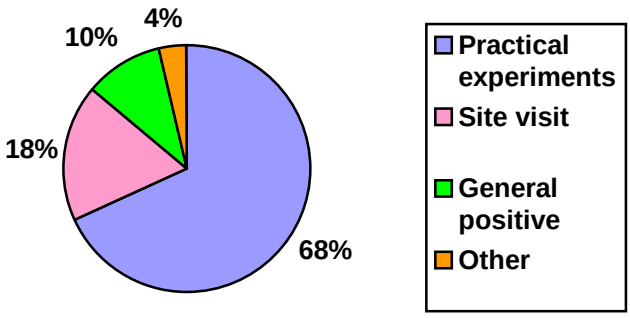
Figure 3-4: Negative attitude towards the CCI project



The number of children who gave negative opinions on the CCI project was far smaller. The children were most likely to say that it was easy or some of the experiments did not always work. Approximately a quarter of the children thought that aspects of the project were too hard or that the project was too short. Only 15 children (5%) said the project was boring, and probably felt this way because they were not kept busy at all times. These children were twice as likely to say that they did not have enough to do (33% compared to 15%) and 5 times more likely to say that the project was too long (47% compared to 9%).

The children were asked for their opinions on what they enjoyed doing the most during the project. The responses were categorised into three groups plus miscellaneous responses which are illustrated in Figure 3-5. The children's first answer only was taken into account.

Figure 3-5: Favourite aspects of CCI identified by the children



The majority of the children highlighted the practical science experiments as the most enjoyable part of the CCI project, with two thirds mentioning this aspect of the project as their favourite activity. Many of the children thought that the industrial site visit was the aspect they enjoyed the most. Both of these activities are new and interesting to the children as they are often not included in the primary science curriculum. Methods of teaching science that include practical experiments increase the children's involvement and enjoyment of science, which has many benefits for the children. The site visit also involves the children in science in a way that they are not accustomed to in most primary schools. Previous research (Analysis of CCI project data, five years on, Evans & Parvin, 2004) found that a high proportion of children remember the practical aspects of the project and the site visit when surveyed 5 years later, evidence that the enjoyment of CCI makes a lasting impression on children. More evidence is needed to assess whether these positive experiences and memories of CCI, and high quality science teaching influence pupils decisions' on pursuing science later in their school life.

Some of the children with responses categorised under 'experiments' simply wrote that they liked 'the experiments' or 'the hands on investigations'. Others went into more detail and specified exactly which experiments they enjoyed and why. Children with responses categorised under 'general positive' included comments such as 'I liked it all' or 'I liked/enjoyed everything', for example:

*"Everything because it was fun and interesting." (*girl, year 4*, A Pinch of Salt)*

Some quotes are provided below together with the gender, school year, topic and site visited (if relevant) of the pupil, to illustrate the range of responses.

"I really liked it when we had to test the best salt to use on ice." (girl, year 5*, A Pinch of Salt*)

*"I liked mixing dye and I liked finding out what would happen with experiments." (*girl, year 5*, Exploring Colour and Industry*)

"I liked doing investigations, sorting plastics, recording, doing graphs, and putting the thermometer under water." (boy, year 5*, Plastics Playtime*)

"I really liked doing the pigment and chalk and doing all the exciting experiments." (girl, year 5*, Exploring Colour and Industry*)

"I liked putting the pipe together, filtering water and making hot water cool." (boy, year 6*, Water for Industry*)

"I liked making a filter and stopping the water from leaking out the pipes." (boy, year 6*, Water for Industry*)

"I liked finding good sealants, making heat exchangers and going to Total." (boy, year 6*, Water for Industry,* Total Fina-elf)

"I liked doing the experiments, comparing the results and working as a team." (girl, year 6, *Water for Industry*)

"I liked doing the experiments and predicting what was going to happen." (girl, year 5, *Plastics Playtime*)

Quotes about the site visit:

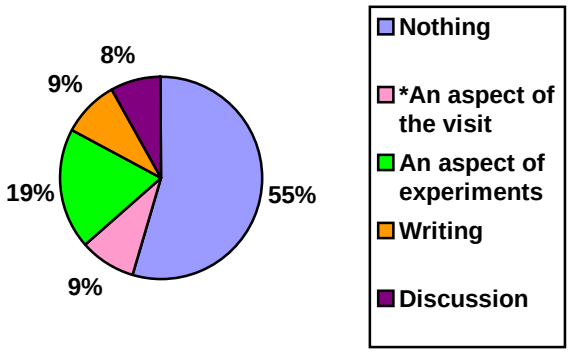
"I liked it when we saw the tank and I liked everything from there." (boy, year 5, Rohm & Haas)

"I liked mixing the strips of dye material, mixing the pallets with colour and using pipettes." (girl, year 6, Colour museum)

"Finding out if the machines are run by the computer." (boy, year 6, Grosvenor chemicals)

The children were asked if there was anything about the CCI project that they did not enjoy. More than half the children said there was nothing they did not enjoy or they left the question blank. Of the children who said there was something they did not like, the majority mentioned an aspect of the experiments such as working in groups. The results are shown in Figure 3-6.

Figure 3-6: Least favourite aspects of CCI identified by the children



*e.g. walking up the stairs

If the children had not enjoyed a part of the project it was most likely to be an aspect of the experiments. Many of the children who gave negative comments regarding the experiments also cited other aspects of the experiments as their favourite part of the CCI project. A similar picture was seen for site visits. The aspects of a site visit enjoyed the least were wearing certain items of clothing, walking around a large site or the noise/smell of certain areas. However, despite these issues these site visits were very popular as the children

thoroughly enjoyed watching the process of the products being made, as shown by the number of children who cited the site visit as their favourite part of the project. Some children need more priming before the visit than others to ensure that they are thoroughly prepared. This reduces the risk of this anxious group being scared or unnerved by what they experience. Some examples of the views of the children are expressed here.

"Putting ear plugs in." (boy, year 6)

"Wearing the goggles, coat and helmet." (boy, year 6)

"Wearing the hair net." (boy, year 5)

"Walking a lot." (girl, year 6)

"I didn't like it when we went up the stairs." (boy, year 5)

"I didn't like hearing the noise, and the smell." (girl, year 6)

"Sometimes I didn't understand what was going on as I couldn't see." (girl, year 6)

Some children said they did not like a particular experiment in the classroom. Examples of this type of response are provided below.

"I didn't like sealing the pipes or filtering the dirty water." (boy, year 6, *Water for Industry*)

"Waiting for the strips of material with dye on them to dry." (girl, year 6, *Exploring Colour and Industry*)

"I didn't like doing the wax experiment because I didn't find that as good and interesting as the others." (girl, year 5, *A Pinch of Salt*)

Below are quotes from children who described in more detail aspects of the practical work they did not like. Some children seem to find it particularly hard working in a group and need extra support to ensure success.

"Fighting or arguing with my team, not co-operating, shouting." (girl, year 5*, A Pinch of Salt*)

"I didn't like being the resource manager because you didn't do anything." *(girl, year 5, Exploring Colour and Industry*)

"I did not like it when one of our team players did not do what they were told." (boy, year 5, *Plastics Playtime*)

"I didn't like it when we were being put into our groups." (boy, year 5*, Plastics Playtime*)

Apart from certain practical work, it was the writing up of experiments that children liked the least, with 1 in 20 children citing this as their least favourite part of the project. Less often other aspects of the project were mentioned that have been grouped under the category 'discussion'. Examples are provided below.

"Talking in a big group." (girl, year 6, *Exploring Colour and Industry*)

"Listening to the teacher talking." (girl, year 5, *Water for Industry*)

"Answering too many questions." (boy, year 6, *A Pinch of Salt*)

Over half of the children had nothing negative to say about the project at all implying that they enjoyed everything the project had to offer. Most of the remaining half mentioned very specific aspects of the project such as a specific experiment or a specific part of the site visit that they had not enjoyed. The children's enthusiasm for the project is obvious. This is an extremely successful project in terms of the children's enjoyment and consequently, their increased enjoyment of science. More analysis was carried out to see whether a scale could be developed to measure the children's enjoyment of the CCI project.

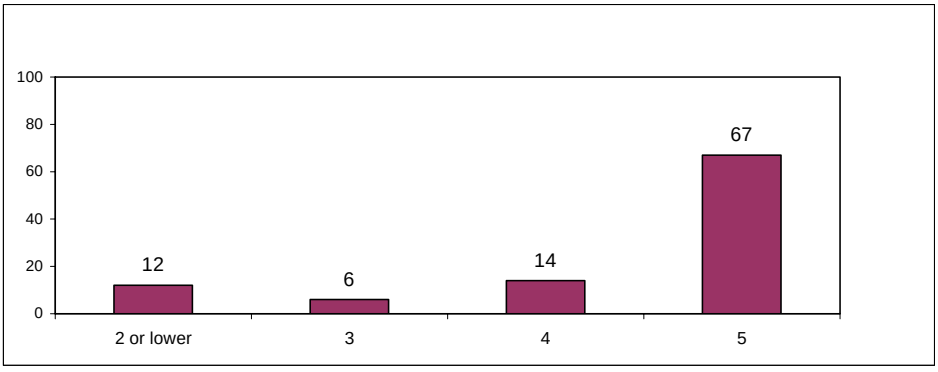
3.3 Measure of attitudes towards CCI project

It is possible to design an attitude scale for measuring the children's attitude towards the CCI project by identifying a group of questions that are related and thereby provide a scale with high internal reliability (the ability of a scale to accurately measure whatever it is measuring). This is measured using Cronbach's alpha, which, if over 0.7 is considered reliable enough to use as a scale. Upon closer inspection there were five questions that were related and seemed to be measuring the positive attitude of children towards the CCI project. The most positive children with the highest score of 5 out of 5, said yes to all five questions:

1. It was fun
2. I liked solving problems
3. I liked learning about industry
4. I enjoyed doing the tests
5. I enjoyed the challenges

The Cronbach alpha value for these five items was 0.88, evidence of good reliability. The percentage of children with each of the resulting scores between 0 and 5 are displayed in Figure 3-7.

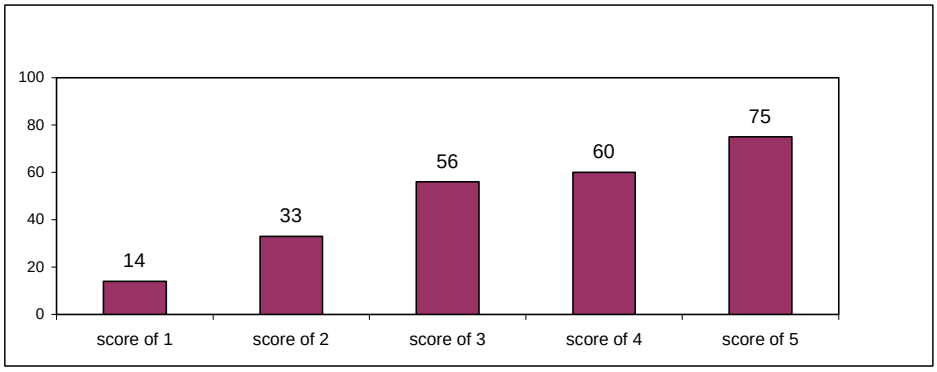
Figure 3-7: Score of children's attitude towards the CCI project



Two thirds of the children scored the maximum of 5 points on the attitude scale and nearly 8 out of 10 children scored 4 or 5, indicating that the pupils were extremely positive about the CCI project. The children enjoyed the project and the challenges of the practical experiments while at the same time learning about industry. These positive results provide evidence of the utility of using real life industrial examples when teaching science to make it more interesting and relevant for children.

It would be expected that the children who had a very positive attitude towards the CCI project, that is, a higher attitude score, would be more likely to state that they enjoyed science more, and this is indeed the case. The proportion of children saying that they enjoyed science more, increased as the positive attitude score increased (statistically significant with Chi squared p value of 0.001). Figure 3-8 illustrates this trend in positive attitude towards science.

Figure 3-8: Proportion of children who stated they enjoyed science more

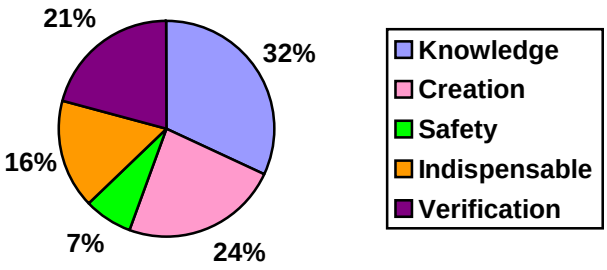


Three quarters of the group of children who were extremely positive about the CCI project and gave it a maximum score of 5, said that they enjoyed science more since the project, compared with only 14% of children who had a score of 1. This provides further evidence that the strength of the CCI project is it's influence on children's attitudes towards science. The children who enjoyed science more by the end of the project were the children who enjoyed the challenges and problem solving during the project. If this increased enthusiasm was sustained it would have a significant impact on these children's subject choices later in their school life.

3.4 Importance of scientists

The children were asked whether they thought scientists were important in industry and 96% of them agreed that they were important. This is the same as the figure seen in previous years. There are many reasons why the children held these views, the most common ones being that scientists increase our knowledge of science and they create new things we need. The results are shown in Figure 3-9.

Figure 3-9: Why scientists are important



During the project the children clearly increased their awareness of the roles of scientists in industry. They learned that scientists have a range of roles that

include creating or designing products such as medicines, and discovering new ideas or methods that add to our existing knowledge. Some children stated that scientists were indispensable as without them we would not have 'X'. Others stated that scientists were important for carrying out tests or verifying processes or product activity. There were two categories not included on the pie chart which were, those children who simply said that scientists were important with no further explanation (28 children), and those who gave responses that did not relate to the question (19 children). Only a very small proportion of children mentioned safety issues in regard to the role of scientists. Quotes are provided to illustrate the range of children's responses.

The following three children felt that scientists were indispensable:

"Because if we didn't have scientists we wouldn't have these things."

"Because we wouldn't have electricity."

"Because you wouldn't have paint or PVA glue."

The following quotes are from children who's responses were categorised under 'verification':

"Because they have to test and clean the products."

"Scientists are important to industry because they need to check if everything is ok and everything is going the way it should do."

"Because the scientists check the thickness of the different liquids."

"If you are making pigment or something like that then scientists need to test the product using science skills."

The following quotes are from children who's responses were categorised under 'knowledge':

"So they can discover medicines and what's happening around the world."

"They find out many things that people didn't know before."

"Because they invent new things."

The following quotes are from children who's responses were categorised under 'creation':

"Because they tell them how to make the product."

"Because they make things like medicine to cure people."

3.5 Chapter summary

Two thirds of the children stated that they enjoyed science more as a result of their positive experience of the CCI project. The most common reason was because it made science interesting and fun. The most popular opinions of the CCI project were; 'I learned something new' and 'it was fun'. The aspects of the project enjoyed the most were the practical experiments. The children rated the project very highly, with two thirds of the children giving it the highest possible score for positive feedback. Nearly all of the children felt that scientific testing was important and relevant for a number of reasons such as the work of scientists in researching and developing products for society.

Attitudes towards science and scientists were extremely positive by the end of the project as demonstrated by the positive feedback collected from the children.

4 Children's views of industry

This section explores the children's views of industry in three parts.

- Children's descriptions of industrial sites
- children's drawings of the inside and outside of industrial sites
- children's views of jobs in industry.

4.1 Industrial environment

As part of the questionnaire the children received at the end of the project, they were asked to draw the inside and outside of a place where things are made, an analysis of which is covered in the next section of this chapter. The question immediately after the drawings presented the children with eighteen words that may describe industry and asked them to choose the six words that they thought most accurately described the place they had drawn. The words were:

safe	dirty	clean	smoke	
dark	small	computers	smells	men
cold	hot	light	dangerous	women
machines	large	people	noisy	

The proportion of children who circled each word is summarised in Figure 4-1 and Figure 4-2.

Figure 4-1: Children's descriptions of industry

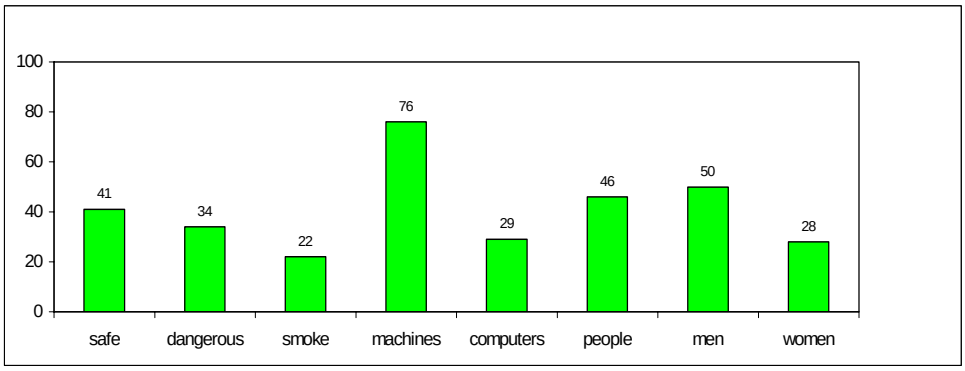
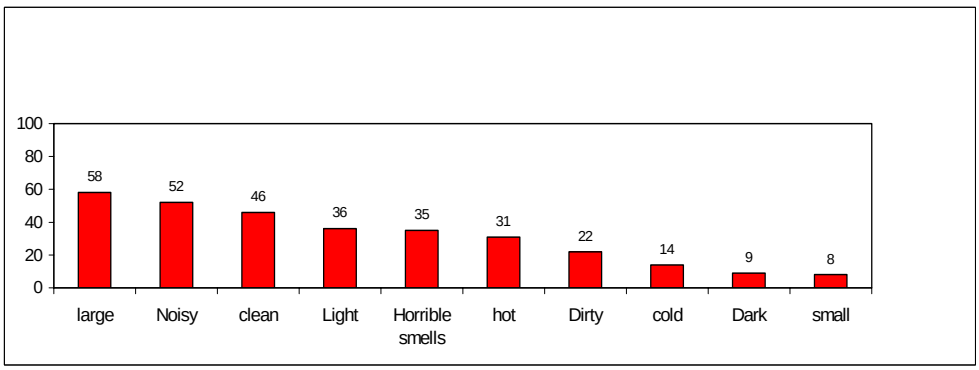


Figure 4-2: Children's descriptions of industry



Before the project, the predominant view held by children was that the manufacturing industry was dangerous. Data collected from more than a thousand children between 2000 to 2003, before taking part in the CCI project, were used as baseline data. Three quarters of these children thought that industry was dangerous and only a quarter thought that it was safe. However by the end of the project in this study only a third of the children believed industry to be dangerous and significantly more viewed it as safe. The children who had been on a site visit were significantly more likely to say that industry was safe (45%) compared with those that had not had a visit (37%), further evidence of the importance of the site visit in addition to the classroom sessions. The lessons and site visit combined, greatly increased the children's awareness of safety practices in the manufacturing industry and showed them first hand how important safety issues are in the work place.

Another aspect of the manufacturing industry that was explored was the relationship between the presence of machines, computers and people in an industrial work place. Previous data found that children overwhelmingly viewed industry as predominantly machinery worked by many people, with four out of five children mentioning that both people and machines were associated with industrial sites. The effect of the training was to reduce the number of children associating large numbers of people with industry, however machinery was still strongly related to an industrial site. Women were mentioned as being associated with industry only half as often as men, and this is possibly reflected during the visit, evidence that industry should actively involve technical female staff in site visits.

Many of the children viewed industrial sites as large and noisy places and this is very often true. However the number of children reporting that they thought industrial sites were clean and light was also high. The proportion of children reporting that industrial sites are hot, smelly, dirty and dark greatly reduced compared with previous data.

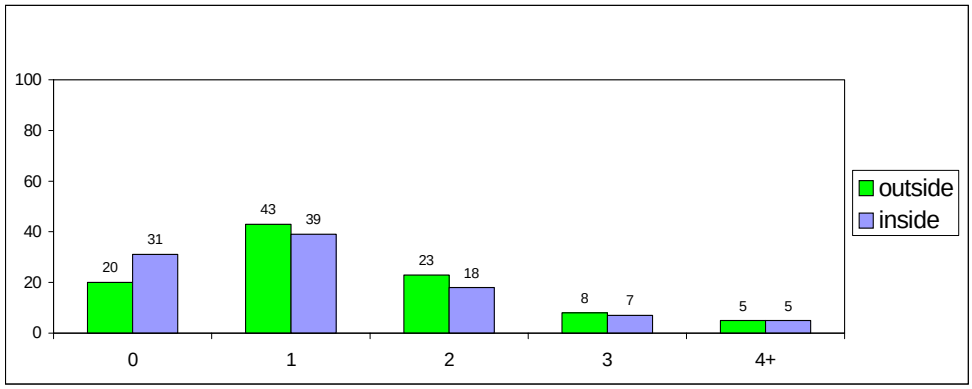
The views of many of the children are largely accurate by the end of the project. They were aware that many industrial sites were large and contained noisy machinery. However, there was a heightened awareness that much of the machinery was automated and involved fewer people, with computers also taking on an important role. In addition, the children were aware that many practices are in place to ensure everyone's safety on site.

4.2 Drawings analysis

After completing the project, the children were asked to draw pictures of their impressions of an industrial site (inside and out). The pictures were coded according to the criteria in Appendix 1 and given a score. A high score demonstrated good knowledge of an industrial site and a score of zero demonstrated no knowledge gained as a result of the project.

The range of scores obtained from the children of their external and internal pictures are shown in Figure 4-3.

Figure 4-3: Scores for external and internal drawings of industrial sites



By scoring the children's drawings, a measure of how much the children were able to illustrate what they had learned about industrial sites during the project was obtained. The higher the score the better a child was able to depict the appearance of modern industrial sites and the modern processes involved in industry. 90% of the children obtained a score of more than zero for one or both of their drawings of an industrial site indicating that nearly all the children had demonstrated additional knowledge learned about industry. The mean score was 1 for both the external and the internal drawings, which was significantly greater than zero for both groups. This is strong evidence that the children drew more detailed pictures of industry than would have been expected if they had not had the CCI training.

In the next section, examples of drawings are provided to illustrate the differences between a high score of 3 or more, a medium score of 1 or 2 and a zero score. Drawings of the outside are displayed first, followed by drawings of the inside of industrial sites.

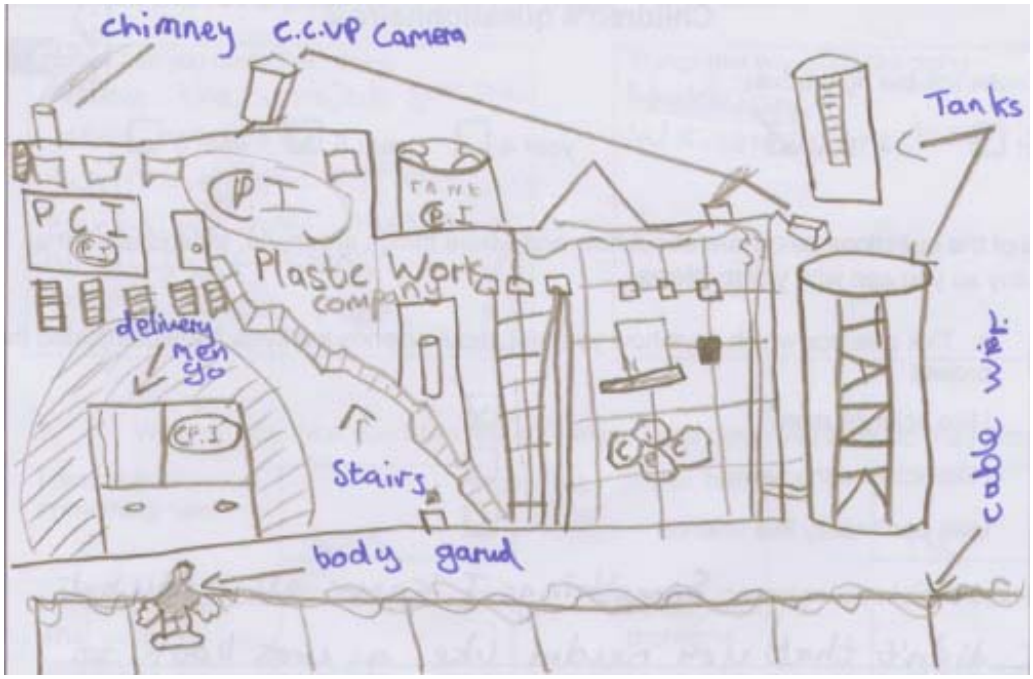
DRAWINGS OF THE EXTERNAL IMAGE OF INDUSTRY

The children were asked to draw what they thought the outside of an industrial site would look like. Pictures drawn at the start of the project in previous years typically depicted a 'historical' and old fashioned image of industry that included dark and sombre buildings with huge smoking chimneys and many small windows. Children rarely included a lot of detail in their drawing, such as pipes connecting different parts of the site. Many of the children who carried out the topic on *A Pinch of Salt* drew pictures of the sea or buildings beside the sea as they thought that salt came from salt water. This was because very few children knew about 'solution mining' or salt quarrying before the project started.

The pictures drawn by children after the project tended to be more modern images of industry, and included more detail.

The following picture is an example of a high positive score obtained by a child who carried out the topic *Plastics Playtime*. In addition, this child had an industrial visit to McBride.

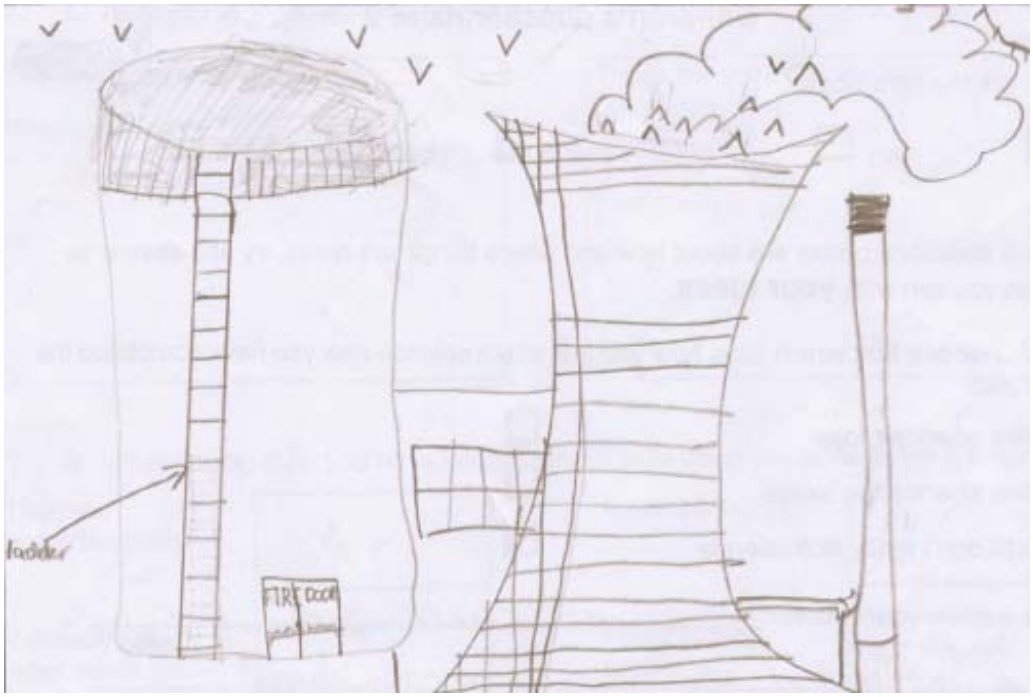
Figure 4-4: Child 1, external picture of industry after the CCI project



This child's drawing is very detailed. There are several areas included that depict storage containers and a loading bay. There is what appears to be closed pipe-work originating from the building on the right. There is also evidence of stairs and ladders and signs on the wall. One employee is included rather than a large number of workers. There is emphasis on security, with a guard and cameras clearly labelled. In summary, this child has significantly added to her knowledge of modern industry as a result of the project.

The following picture is an example of a high positive score obtained by a child who was involved in the topic *Water for Industry*. This child had an industrial visit to LINPAC.

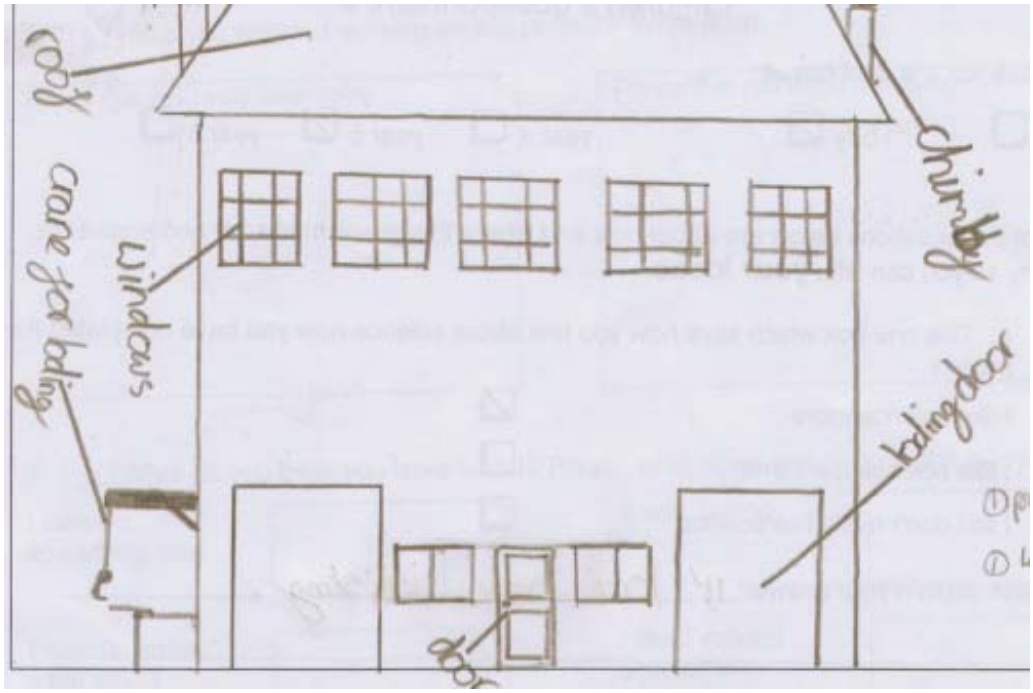
Figure 4-5: Child 2, external picture of industry after the CCI project



This child has drawn a modern cooling tower and included storage containers and enclosed pipe work, connecting different parts of the site. The birds flying in the sky through the steam imply that it is not smoke coming out of the cooling tower. It is possible that this child has combined information from an educational industrial related web site as there are similarities to LINPAC but also differences.

The following picture is an example of a medium positive score obtained by a child who completed *Water for Industry*. This child visited Grosvenor Chemicals.

Figure 4-6: Child 3, external picture of industry after the CCI project



The drawing contains some modern elements of the manufacturing industry such as low level buildings and a crane at the side of the building. The building depicts the training centre and canteen which are housed in a converted old farm building. The child has improved their knowledge of the external image of industry as a result of the project.

The following picture is an example of a very low score obtained by a child who did the topic *Water for Industry*. This child had a site visit to Cytec.

Figure 4-7: Child 4, external picture of industry after the CCI project

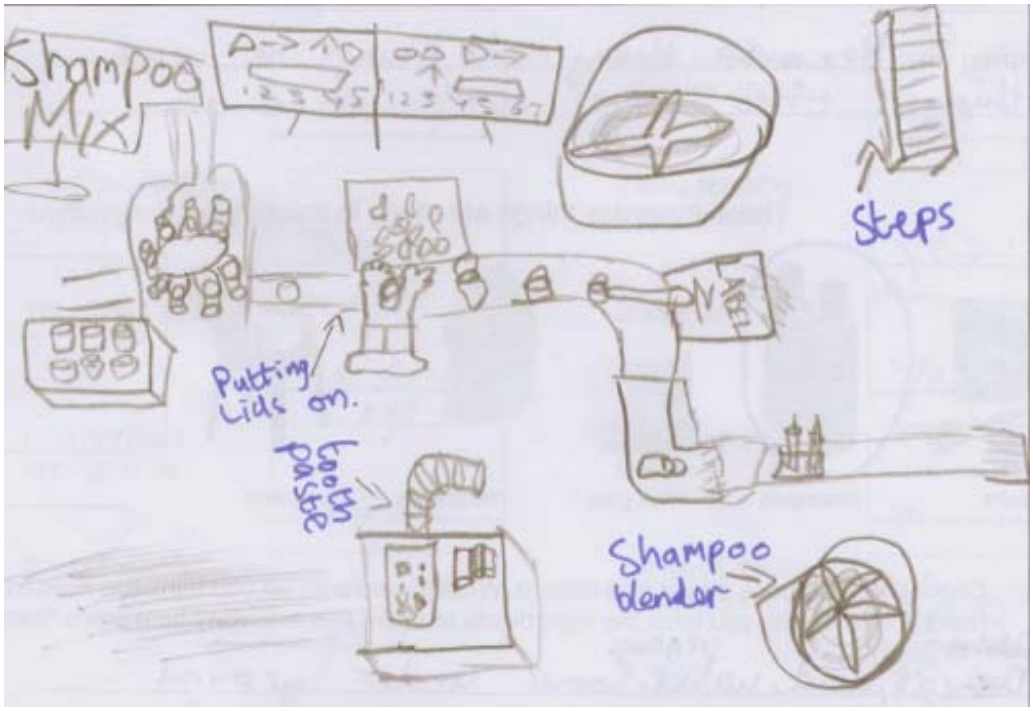
This child's views on industry are fundamentally the same as would be expected before the project. The child has drawn a simple building with a door and many windows, depicting a Victorian view of an industrial site.

DRAWINGS OF THE INTERNAL IMAGE OF INDUSTRY

The children were then asked to draw what they thought the inside of an industrial site would look like. Before the project, many of the children drew pictures depicting an 'old fashioned' view of industrial processes, with dangerous substances being poured into huge vats, and conveyer belts staffed by lines of people. The pictures drawn after the project tended to be images that were more modern which contained more pipes and closed vessels, as well as fewer people.

The following picture is an example of a high positive score obtained by child 1 who had an industrial visit to McBride.

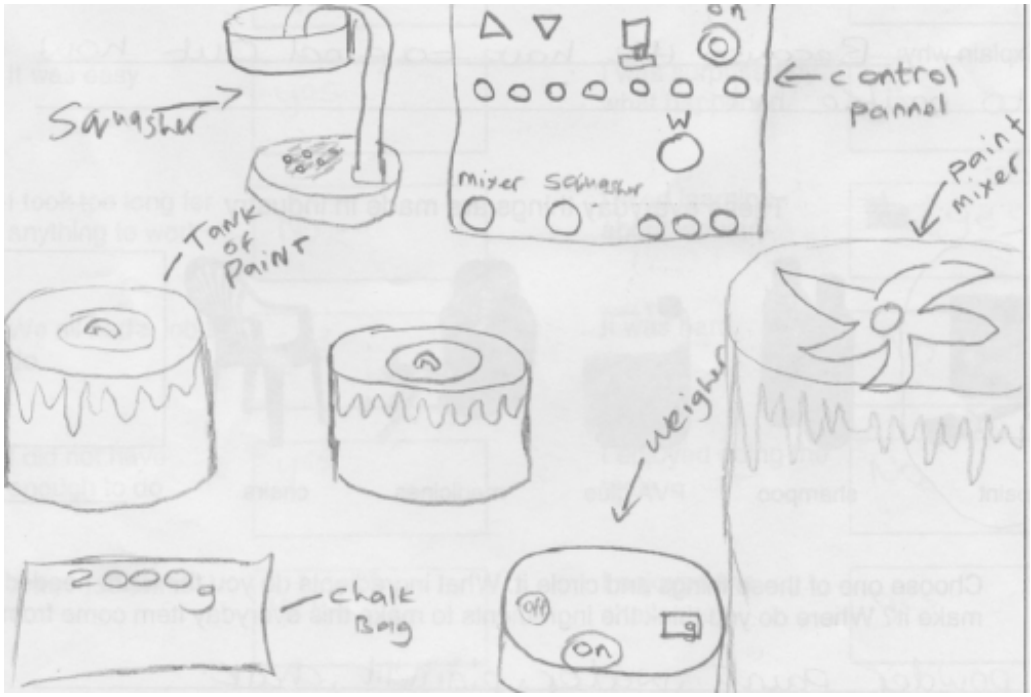
Figure 4-8: Child 1, internal picture of industry after the CCI project



The picture appears to portray an accurate image with a range of machines and equipment including a conveyer. They have drawn the processes involving shampoo and toothpaste with vats that seem to be open. The lids are removed for viewing and mixing but are closed at other times. Various parts of the drawing are labelled to illustrate the process.

The following picture is an example of a high positive score obtained by child 5 who carried out the topic Exploring Colour and Industry and had a visit to Shipley Paints.

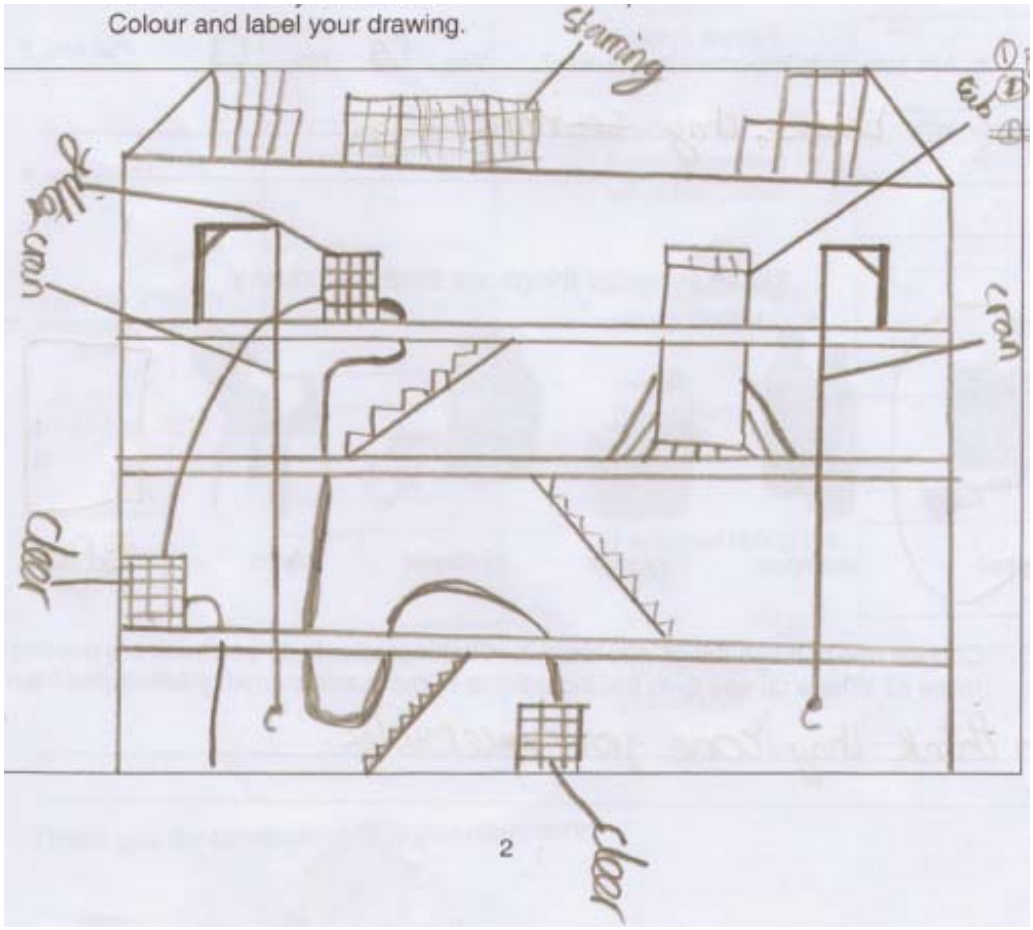
Figure 4-9: Child 5, internal picture of industry after the CCI project



The child has depicted a more modern environment with modern scientific equipment found in the laboratories at the museum. There is a control panel and other automated machinery as well as specific ingredients used to make paint.

The following picture is an example of a medium positive score obtained by child 3 who had an industrial visit to Grosvenor Chemicals.

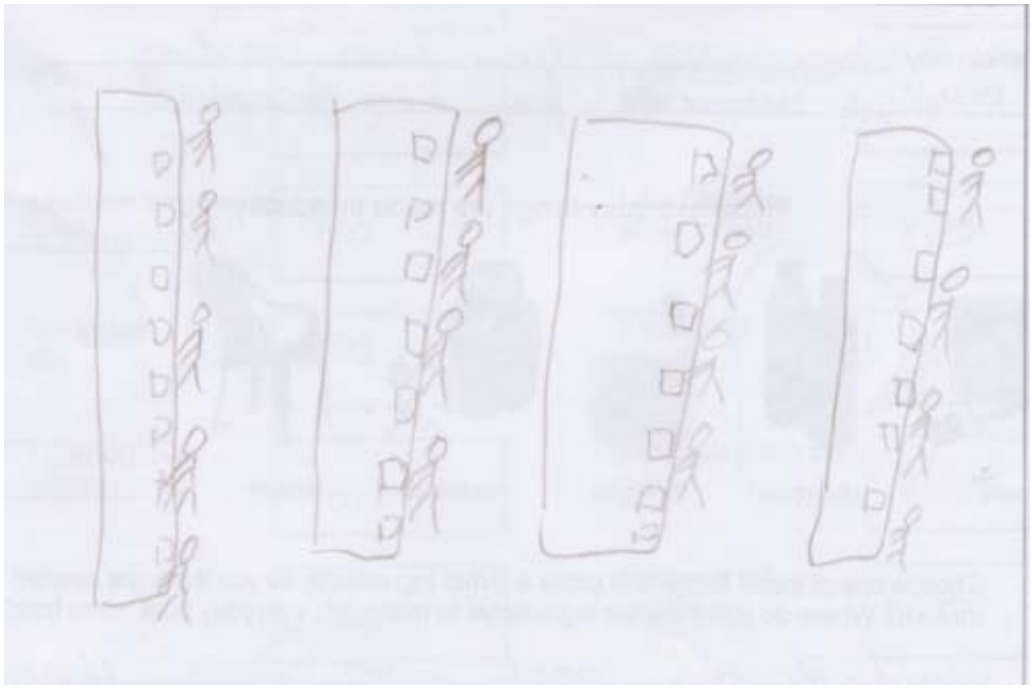
Figure 4-10: Child 3, internal picture of industry after the CCI project



This child has drawn a more modern image of the internal aspect of an industrial work place. Modern automated machinery has been included such as filtering equipment and storage equipment. The space is accurate as the building is on separate levels with the reactor occupying space on two levels.

The following picture is from child 4 who obtained a very low score.

Figure 4-11: Child 4, internal picture of industry after the CCI project



This child's views of industry are fundamentally the same as would be expected before the project. What looks like an open plan room with hundreds of workers is depicted is reminiscent of the working conditions depicted in the story 'Charlie and the Chocolate factory'. Indeed, Parvin found in her original study, that children's films can be a source of industrial knowledge for some children.

After the project, the children were more likely to draw detailed external and internal images of industry. This indicated that they were more aware of the appearance and processes involved in modern industry after the project. Parvin concluded that the best way to improve children's knowledge of industry is via classroom activities followed by a well-planned visit to an appropriate company and these results confirm this view.

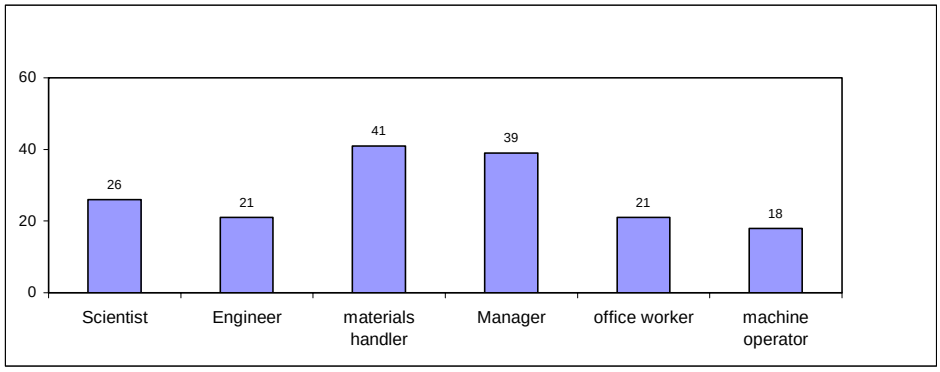
4.3 Industrial careers

This section deals with children's perceptions of jobs occurring in the industrial workplace. It is divided into two sections:

- Industrial jobs that children were aware of as a result of the project
- the industrial job children would choose as a result of the project.

The children were asked to draw a picture of a person who works on an industrial site and list other jobs that they thought existed in industry. The six jobs most frequently mentioned are shown in Figure 4-12.

Figure 4-12: Industrial jobs that children were aware of in industry



Other jobs mentioned by fewer than 15% of children included driver, packer, supervisor and computer operator.

Before the project took place, the children were very unlikely to have drawn a scientist or an engineer, as shown by the baseline data. In her original study (Parvin, 1999), Parvin found that children do not associate scientists with industry and are more likely to associate them with a research environment. They are unsure of scientists' and engineers' roles in industry and therefore feel more comfortable with jobs involving products, machines (including computers) or offices.

The situation after the project has dramatically improved. The proportion of children drawing or listing scientist or engineer was 26% and 21% respectively by the end of the project. 40% mentioned either scientist or engineer or both. These positive results provide strong evidence that the children's awareness of the importance of scientists and engineers, and their roles on industrial sites, significantly increases as a result of the CCI project.

The children were often more specific about job titles and manager was often expanded to give personnel manager, control manager or resources manager, which rarely happened before the project. This is likely to be due to the role-play included in classroom sessions, as well as the site visit.

Unlike other regions, there were still a high proportion of children who listed 'materials handler' as a job carried out in industry. This was probably because many of the children visited the Colour Museum and very much enjoyed watching the dying and colouring process demonstrated there.

4.4 Jobs in industry chosen by children

The increased awareness of scientists and engineers working in industry is the first step to improving the children's attitudes towards science and industry careers. To take this one step further the children were asked which job they would like to do in industry, to identify what proportion of children would choose to be a scientist or engineer. The children were also asked for the reason why they chose that job. The most common jobs chosen are shown in Table 4-1 together with the results from the baseline data of children surveyed between 2000 to 2003.

Table 4-1: Industrial jobs chosen by children

Which job would you choose	Percent before CCI	Percent after CCI
Scientist	4	13
Engineer	3	4
Materials handler	27	17

Manager	13	21
Computer	1	3

Before the project, by far the most popular job chosen by children was 'materials handler'. By the end of the project the profile of chosen jobs had changed. The proportion of children saying they would like to be a scientist increased more than three fold while the proportion of children saying they would like to be a materials handler decreased significantly.

The number of children who would choose to be an engineer increased slightly compared with baseline data. The increase varied by region. This was also true of computer jobs which also did not increase after the project. This may be due to the site visits being different from other regions.

The results are very positive. The classroom sessions were designed specifically to link the science carried out in the classroom with that done by professional scientists on site. The classroom sessions and the site visits clearly increased the children's knowledge of the role of scientists in industry.

The reasons why scientist was their chosen job were investigated in more detail. When the children were asked why they had chosen 'scientist' as their preferred job in industry, their response was usually that being a scientist would be fun or interesting, or that they would enjoy it.

Quotes from some of the 42 children who said they would choose to be a scientist are provided below;

"People who work in the science lab have fun work to do." (girl, year 4)

"I think it would be fun to help check which ingredient is correct." (girl, year 6)

"Because they do a lot of experiments." (boy, year 5)

"Because it's a chance to become an inventor." (boy, year 4)

"Because then I would know what would be inside medicines and also I could test them." (girl, year 5)

"I like to see changes happen and create new things." (girl, year 6)

The children were far more likely to say that a scientist was their chosen job if they were aware that these jobs existed in industry. If the children had listed scientist as a job carried out in industry they were far more likely to say they would choose to be a scientist (43% compared with 2%).

These results are similar to those seen in previous data from 2000-2003, both from pre-project and post-project data. When questioned, nearly half the children who know that scientists work in industry will say that given the choice they would work as a scientist in industry. The higher the proportion of children who know that scientists work in industry, the higher the number of children who will say that they would choose to be a scientist. Children who are not aware that scientists work in industry do not explicitly say that they would be a scientist but have a small chance of describing a job that scientists do in industry without knowing the job title.

If all children of primary school age knew that scientists and engineers worked in industry rather than only 1 in 20 children as seen in previous studies without CCI intervention, the number of children considering a career as a scientist or engineer may well increase.

4.5 Chapter summary

By the end of the project 41% of the children thought that industry was safe and far fewer thought it was dangerous. The CCI project reduced the number of

children associating industrial sites as places where many people work, for example on production lines. The project also reduced the number of children who thought industrial sites were hot, smelly, dirty and dark. Many of the children appeared to have more positive views of industry as a result of the project

The children demonstrated from their drawings of the exterior and interior of industrial sites that they had learned about industry. Drawings provided here give examples of drawings that obtained a high, medium and low score to demonstrate the range of children's abilities.

The project raised the children's awareness of the variety of jobs held in industry. The children learned about the importance of scientists and their roles on industrial sites. After the CCI project the proportion of children who were aware that scientists worked in industry and listed these jobs increased. 40% of children stated that scientists or engineers worked in industry.

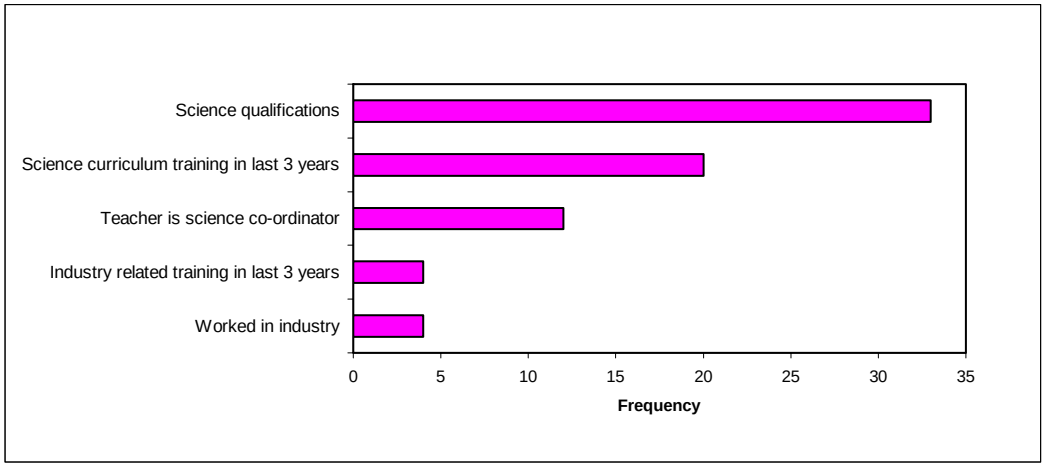
Nearly half of all the children who listed or drew a scientist then went on to say that they would choose to be a scientist if they worked in industry (13% in total).

5 Evidence to support the provision of training

5.1 Training and qualifications

The teachers were asked about their science qualifications and training they had undergone in the past three years. The graph below summarises the results from the 33 teachers who returned pre-project questionnaires.

Figure 5-1: Training and qualifications



Qualifications

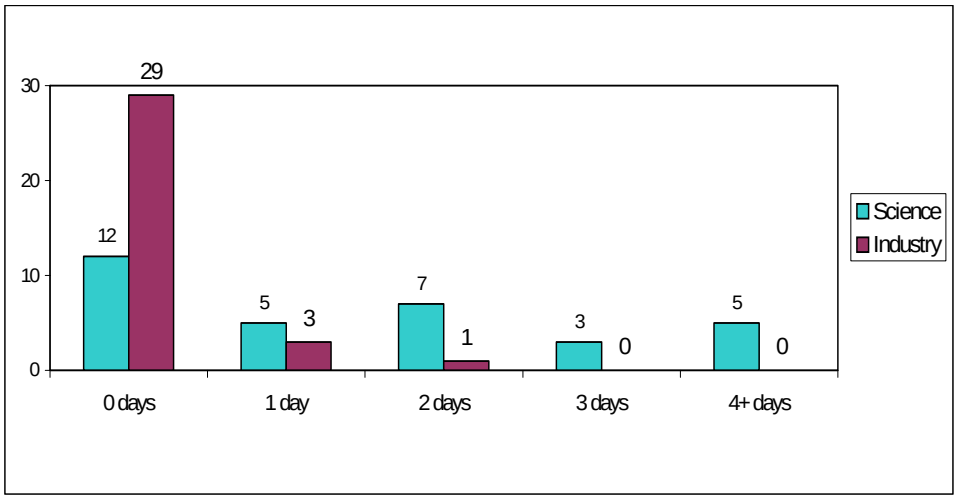
All the teachers who responded to the question on qualifications had at least a GCSE in science. This is good news and quite different to previous studies, as a science GCSE is viewed as the minimum requirement to teach primary science. This survey did not distinguish between the different branches of science, i.e. biology, chemistry and physics. However this has been changed on the questionnaire for the future to provide more detail about teachers' science qualifications. Previous research from Parvin has shown that biology qualifications are far more frequent than chemistry or physics. 15 teachers said that they had more than a GCSE in science. They either said they had a science A level (3 teachers), a degree that contained science (10 teachers) or another qualification such as a diploma (2 teachers). It appears that science qualifications have improved over the last 10 years with more teachers obtaining at least a science GCSE and many achieving more than this.

In addition to science qualifications, the teachers were asked if they had worked in industry to ascertain any industrial experience. Only 4 out of 33 teachers stated that they had worked in industry. Therefore it is likely that very few teachers have the experience to teach science with industrial context without some additional training.

Training

The teachers were asked how many days of science and industrial training they had undergone in the last 3 years. The results are shown in Figure 5-2.

Figure 5-2: Number of days of science & industry training



Nearly two thirds of the teachers had undergone some science training in the last three years. This was significantly more than in previous studies where approximately half of the teachers had not had any science training. Industry training is far less common than science training. Only 4 teachers had any experience of industrial training.

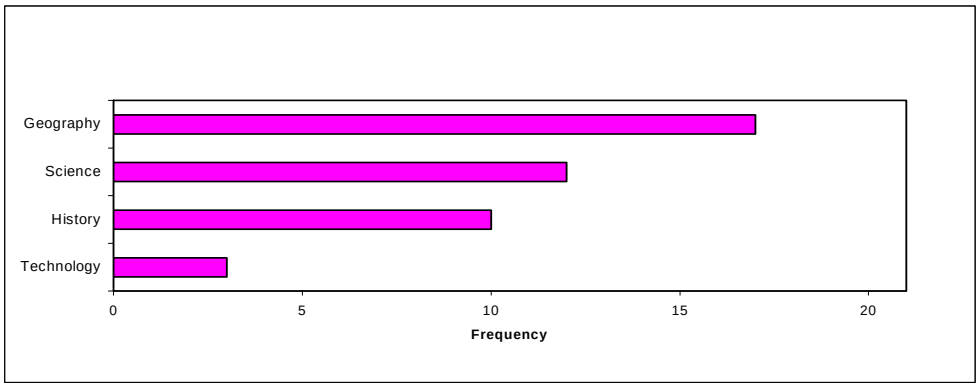
All teachers have five training days per year where they must cover all aspects of the primary curriculum. It may seem surprising that some schools are still not using any of these days to cover science. However, Numeracy, Literacy and ICT have taken a high priority in primary education since the mid-1990s which may explain why training is more likely to be in these curriculum areas.

Science co-ordinators may be expected to be more likely to have science training experience and indeed this appeared to be the case. 12 teachers stated they were a science co-ordinator with the number of years they had been a co-ordinator ranging from less than a year to 25 years. They were nearly twice as likely to have science training (90%), compared with only 50% for teachers who were not science co-ordinators. They were most likely to state that their role as science co-ordinator included supporting other staff or help with children's assessment.

5.2 Teaching of industry within the curriculum

Teachers were asked where they taught about industry in the primary curriculum.

Figure 5-3: Subjects covering industry in the curriculum



Slightly less than half of the teachers (12 out of 27) covered industry in the science curriculum. Although this is an increase on the 12% obtained from the original study it is similar to the previous baseline data collected where half of teachers

covered industry in the science curriculum. Topics given were varied, although four teachers gave no details about the topic. Seven teachers mentioned that they covered industry under the 'materials' topic and one said that they covered industry under various topics.

The most common place to cover industry was in geography, and 'water and the environment' was the most commonly cited topic. This possibly gives a biased view of industry first and foremast as a polluter, if not balanced with more modern views, taught in science and technology. Many teachers also covered industry when teaching about the Victorians in history, which portrays an old fashioned view of industry.

One of the main aims of this training was to encourage teachers to teach about industry in the science curriculum. This would enable children to learn about industry as it is today and to learn about its relevance to the science curriculum taught in schools now.

5.3 Industrial links

Teachers were asked about their links with industry, including whether they had a school policy on industrial links.

Industrial links

A third of the teachers (11) replied that they had industrial links of some description. Of these, 2 teachers thought their school had a relevant policy on industrial links. Schools have the option of being involved with a number of organisations such as Education Business Partnerships (EBP) and Setnet that promote links with industry. Of the links available, links with an EBP were the most common, with 10 teachers stating they had links of this type. Five teachers described links with local companies, four of which could be categorised as manufacturing industries. These were Yorkshire Water, Rentokil cleaning products, Allied flour mills and Rhone Poulenc Chemicals. Five teachers said they had links with Setpoint and three with Science and Engineering Ambassadors (SEA).

Two thirds of the teachers had no links with industry. One of the aims of the training was to encourage teachers to forge links with manufacturing companies and learn about the benefits to the school of having these useful links. How effective the training is in achieving these goals is explored later in the report.

Use of resources

The teachers were asked whether they had used any resources from industrial sources. Only a small proportion of teachers had previously used these types of learning materials. One teacher had used a variety of materials from Yorkshire Water, Npower and Ariel, another had used just Ariel and two teachers had used materials from BP. The remaining 28 teachers who answered the question replied that they had not used any of this type of learning material. This result is very similar to that found in previous studies where three quarters of teachers had not used industrial resources sponsored by or developed by the chemical and allied industries.

The most likely reasons for using industrial resources were that they were of good educational quality and at an appropriate level.

The teachers were asked why they had not used them and the most common reason given was that they did not know about them. Only one of the teachers who had not used industrial resources said it was because of company propaganda.

5.4 Chapter summary

A third of all teachers had not had any recent science training. Training in industry was even less common (4 out of 33 teachers). Four teachers had previously worked in industry. Therefore, many teachers may not have the required skills to teach science with industrial context.

Teachers were more likely to teach about industry in the context of geography than science or technology. Teachers appeared not to be aware of the relevance of teaching the science curriculum with an industrial context to make the subject more interesting and relevant to children.

Only a third of the teachers had links with industry and most of the teachers had not used any resources developed by industry.

This training was very much needed by primary teachers to increase their confidence, knowledge and motivation of teaching science using industrial contexts.

6 Teacher's reaction to the CCI project

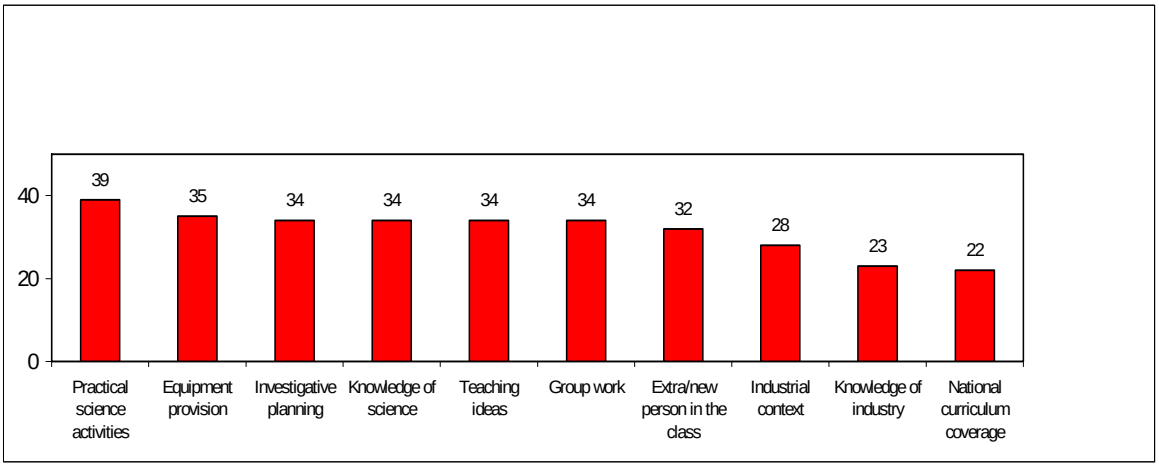
6.1 Strengths

The teachers were asked to evaluate the CCI training. All the teachers who responded to the question rated the CCI project as very good or excellent (29 teachers) or good (6 teachers). Furthermore, all but one of the teachers felt their expectations of the project had been met. One teacher summed it up as follows:

"Exciting and interesting investigations carried out by children who learned to co-operate and share responsibilities. The industry link was a good way to give more credibility to the work they do in school."

Further information was collected from teachers on their views of the classroom activities and the industrial visit. Additional evidence that the CCI project was highly rated was obtained when teachers were asked to indicate which of ten possible categories were strengths of the classroom sessions. The results are shown in Figure 6-1.

Figure 6-1: Strengths of the CCI project



Virtually all of the 40 teachers who returned a post-project questionnaire indicated that the 'practical science activities' were a strength of the sessions, followed by 'equipment provision'. Nearly 90% of the teachers also highlighted 'investigative planning, 'knowledge of science' and 'teaching ideas' as important. These are wonderful results as the main aims of the project were to improve the teachers confidence and abilities in this area.

The categories least likely to be indicated as strengths of the project, were 'knowledge of industry' and 'National curriculum coverage'. Despite the fact that investigative planning is right at the heart of the primary science curriculum many teachers seem to view it as a useful optional extra to their science lessons. Perhaps the advisory teachers need to place even more emphasis on the relationship between the CCI training and the primary science curriculum as laid out by the QCA. One teacher explicitly stated that the project gave the chance for children to develop AT1 and selected 'investigative planning' as a strength, but did not tick 'National curriculum coverage'. This indicates that both could be amalgamated to create a single strength in future.

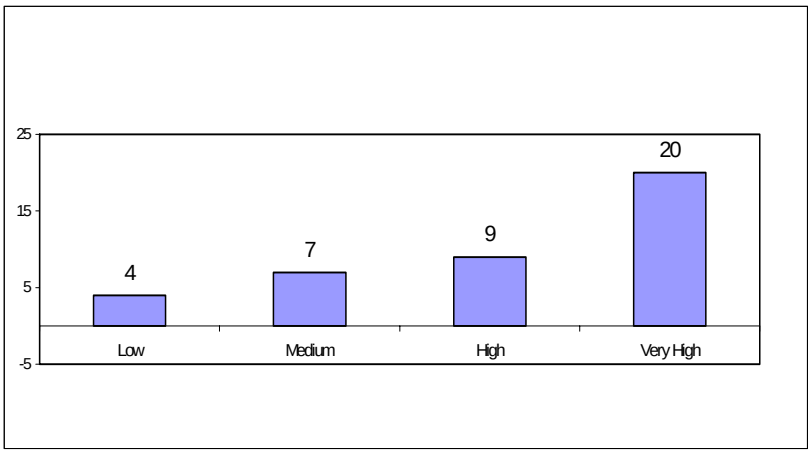
The teachers contradicted themselves slightly by not selecting 'knowledge of industry' as a strength. Later on in the questionnaire they were asked whether they thought the classroom sessions offered an effective link with industry and

many of the teachers agreed that they had been an effective link. Knowledge of industry was rated as a strength less often than knowledge of science maybe because many saw the visit as the industry side of the training, and the classroom activities as the science side of the training.

These results are very similar to those gathered previously. The two main strengths in the previous study were also that CCI training provided information on practical science activities as well as the provision of science equipment.

The mean number of strengths selected by teachers was 8 out of 10. The teachers were categorised into four groups based on their rating of the CCI project. The group labelled 'Very High' was comprised of teachers who ticked 9 or 10 items on the scale. The group labelled 'High' ticked 7 or 8 items, the group labelled 'Medium' ticked 5 or 6 items and the group labelled 'Low' ticked 3 or 4 items. None of the teachers ticked fewer than 3 items. Figure 6-2 displays the results.

Figure 6-2: Teachers' rating of the CCI project



Three quarters of the teachers gave the CCI project a high or very high positive rating. This is a strong indication of how highly the training was regarded by teachers. They were extremely enthusiastic about the project and clearly felt it had been a valuable use of their time.

Quotes are included below as examples of how the teachers felt about the sessions:

"Great practical/problem solving investigations and resources."

"I really enjoyed the lessons along with the pupils! Excellent!"

"Enjoyable and useful. The children all enjoyed it and provided evidence that they had learned a lot."

"Excellent delivery of interesting and engaging activities. Link with industry put the science into a 'real life situation' for the children giving them a purpose to their learning."

"The pupils learned to work together, follow instructions carefully and to take responsibility for theirs and others safety in their groups. The concepts were challenging, and vocabulary emphasis was excellent."

"I feel that this project is invaluable. The children thoroughly enjoyed the project – the activities were stimulating and the approaches taken to the children were very motivating."

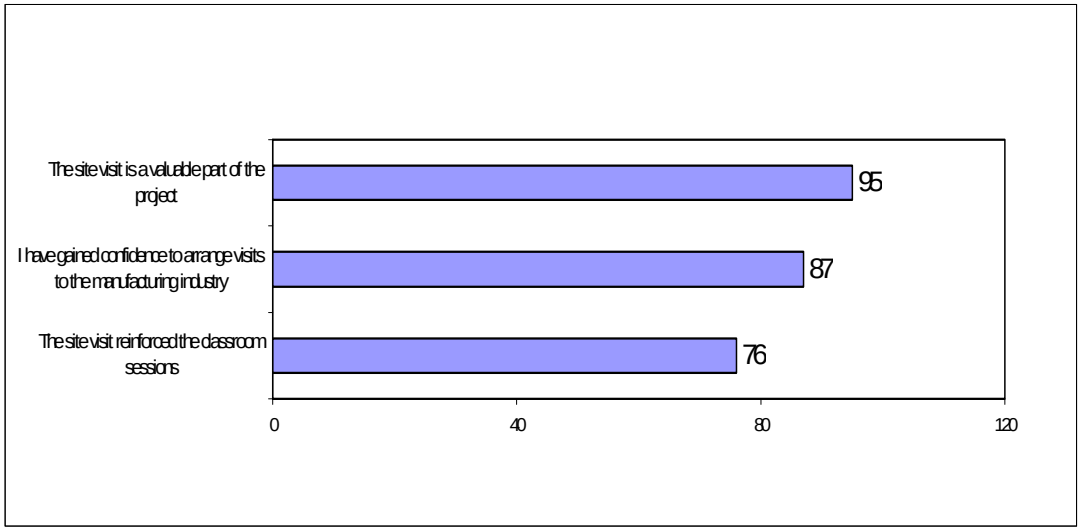
The teachers who went on a site visit with their class were also asked whether they agreed with the following three questions regarding the importance of site visits.

1. The site visit reinforced the classroom sessions
2. I have gained confidence to arrange visits to the manufacturing industry

3. The site visit is a valuable part of the project

Some of the teachers did not answer all the questions and the results are therefore displayed as percentages rather than frequencies of those that agreed with the statements, in Figure 6-3.

Figure 6-3: Teachers' views of the CCI project



All but one of the teachers thought the site visit was a valuable part of the project. Many of the teachers also thought that the project gave them more confidence to arrange visits and reinforced the classroom sessions.

Teachers who were more positive towards the site visit may be expected to be more likely to arrange a visit the next year and there was evidence that this was indeed the case. Teachers who agreed with all three of the statements were twice as likely to say they intended to visit industry again compared with 45% of all teachers.

This is further evidence that if teachers are to repeat the CCI project with a site visit it is extremely important that the site visit is a positive and relevant experience which supports the material covered in the classroom sessions.

6.2 Weaknesses

The teachers were asked whether they thought there were any weaknesses to the sessions. Very few of the teachers highlighted any weaknesses. One teacher said there was too much to cover and 6 said there were difficult concepts involved. A further 7 teachers said there were some issues with the timing. When asked whether there were any improvements that could be made to the CCI project teachers mainly spoke of needing more time in the classroom or wishing they had had a site visit when they had not. Quotes are provided below.

"More time for the recording of investigations and results and more focus on drawing conclusions from them."

"Need more than just a one hour staff meeting."

"I think the children would have enjoyed a site visit but this was unfortunately not an option for our specific topic."

"On the factory visit children need to see more that is relevant to the classroom activities."

6.3 Chapter summary

The feedback from the training was overwhelmingly positive. The sessions were of an extremely high standard and were highly rated by teachers. Aspects of the sessions most often cited as strengths were the practical science activities and the provision of equipment. The site visit was also highly rated by many of the teachers. Teachers who highly rated the site visit were more likely to say they would arrange a visit to industry in the future.

7 Knowledge and attitudes of teachers

It was hoped that one of the main outcomes of the training would be that teachers would learn more about industry, and how it relates to primary school science. The aim was to achieve this via class-based training, together with a visit to industry. The visit would give them an opportunity to experience the chemical industry first hand, thereby helping them to develop a more accurate view.

7.1 Knowledge of industry and science

Knowledge of Industry

Teachers were asked whether they had learned anything about industry, and what they had learned. All but one of the 34 teachers who answered the question stated that they learned something new about industry during the project. The most common response was that they had increased their knowledge of the processes of industry as a result of the visit to industry, followed by their increased awareness of links with the curriculum. The quotes below provide examples of how teachers felt their knowledge of industry had been improved in these ways:

"Never been before – was interested in the control technology used in operating the machinery."

"Learned a lot about the paint industry and all the processes and laws involved."

"Very automated and computerised."

"The wide coverage of areas it encompasses. How it can be developed through the science curriculum."

"Some school work is carried out in industry – it is just the scale which is larger. Health and safety is a major concern in the chemical industry."

"The industry concerned are very interested in establishing links with local schools."

It was not possible in this study to quantify how much the teachers learned about industry. They may have learned one part of an industrial process or completely changed their knowledge of industry through an increased awareness of the whole process. In future, more detailed questions are to be included in the questionnaire that attempt to grade the teachers' knowledge.

Knowledge of teaching science

Teachers were also asked what they had learned about teaching science. All of the 42 teachers who answered the question stated that they learned something new about teaching science. Many of the teachers said that they learned new teaching ideas. Some teachers said it helped them place the science curriculum in context. Quotes are included below to illustrate these points.

"Organisation of groups during activities, rewards system, use of junk equipment at low cost."

"Very useful in giving ideas in which to include all children in practical activities as opposed to 'watch me' sessions. Very productive in the way children collaborated and shared ideas."

"Watching the children participate in the practical activities and applying their knowledge showed me how much they actually knew and that there was a lot of invaluable discussion taking place. Practical is much better than written."

"How to organise group sessions to be sure all children played a full part and how to motivate the children by giving the science a real life context."

"About how to develop links with industry and real life problem for children to solve. The provision of a real context for learning developed greater thinking skills."

The classroom sessions successfully demonstrated to the teachers how to include all children in the practical work and discussions. In addition, the teachers stated how much more confident they felt in organising science lessons with real life context.

In future, the wording of the question is to be changed in order to help measure the extent to which they have learned about teaching science. Virtually all the teachers said that they had learned about both industry and teaching science, evidence of the effectiveness of the project.

7.2 Attitudes towards links with industry

At the start of the project only 4 (13%) of teachers said that they had recently used resources developed by industry. Many teachers had not used resources developed by industry because they had not seen any, rather than because they were against using this type of educational material.

Before the project 11 (33%) teachers had links with industry such as via an Education Business Partnership. Previous studies have shown that before being involved in the CCI project very few teachers are able to suggest specific links with industry that they would like to experience. Half of teachers left the answer blank and many of the remainder said they would welcome ideas but were unable to provide specific details. The teachers attitudes towards industrial resources and links could therefore be summarised as broadly neutral at the beginning of the project.

After the training sessions and visit to industry, teachers were asked about their views on using the CCI resources and visiting industry in the future. The response of teachers after they had experienced the training sessions was extremely positive. Thirty-seven (88%) of the teachers stated that they would like to use the written materials again and the same proportion said they would be interested in visiting industry again in the future. Only those teachers who had visited industry were asked the latter question. The teachers were much more aware of the benefits of teaching science with industrial context. They realised how much children appreciated learning about science with a real world context, and 9 out of 10 teachers planned on permanently changing their science teaching methods.

Nearly 90% of teachers intended revisiting industry but when teachers involved in Parvin's original study were revisited very few of the teachers had visited industry again although they had said they were keen to do this. This was because they felt they did not have the time to organise it. It is a challenge to overcome as it is rare for companies to make the first move to invite schools to visit, which is the one thing that would make the job easier for teachers. CCI advisory teachers or another organisation need to keep acting as brokers in this process. Teachers only make time to forge these kinds of links with industry if they are very motivated to do so, such as if there is a very strong link with the National Curriculum.

7.3 Chapter summary

All but one of the teachers said they had learned something about industry as a result of the CCI project. In addition, all of the teachers said they had learned something about teaching science as a result of the project.

Before they had any CCI training, many teachers had not received any information about the chemical industry either through resources developed by industry or through links with the chemical industry. The majority stated they had never seen such resources.

The change in attitudes towards resources about industry that occurred during the training was significant. Nine out of ten teachers intended to reuse the CCI materials. Furthermore, the same proportion of the teachers intended to visit an industrial site again in the future.

This study provides evidence that the CCI training has changed the attitudes of teachers. At the beginning, the teachers were mostly neutral about involving industry to teach primary science. By the end of the training, the majority of teachers were extremely receptive to linking with the manufacturing industry when teaching primary science.

8 Conclusions

8.1 Children's data

The CCI project involved approximately 2500 children attending 89 schools from primary years 4 to 6. The advisory teacher was able to offer a variety of topics to the teachers and children, to suit their needs and interests. The topic *Water for Industry* was the most popular choice of topic, and there was a choice of industrial sites for the children to visit in this region.

One of the main aims of the project was to increase the children's enjoyment of and attainment in science by demonstrating how science can be taught successfully using an industrial context. It is hoped that children who enjoy science and are good at science are more likely to then pursue science subjects at GCSE and A level. Research has shown that the ages 8 to 13 years are the critical ones for a child's formation of attitudes to science (Pell & Jarvis, 2001). Levels of uptake of Chemistry and Physics at Universities are particularly low, and decreasing, which are the areas of science that primary teachers are often least knowledgeable about. Evidence has shown that many children choose their career before they start secondary school and therefore it is important to increase primary children's awareness of scientific jobs. One of the main aims of the project was to increase children's awareness of the manufacturing industry, a major employer of scientists, in order to encourage children to consider working in industry in the future. It is an area where the reality of contemporary scientists in modern industry is most at odds with the image of old fashioned 'Einstein' style scientists and bleak 'Dickensian' factories.

By the end of the project, children's enjoyment of science was extremely high, as shown by the 68% of children who said they enjoyed science more than they did before the project. The feedback from the children was also extremely positive about the project, particularly in areas of practical work and investigation. This is important, as evidence has shown that children's enthusiasm for science decreases year on year in primary school and continues to do so in secondary school. Pell and Jarvis found that this decline in positive attitude towards science does not seem to be related to how difficult they perceive science to be. This may be because science is often not taught within a context therefore providing interesting and useful reasons to pupils for studying science.

Virtually all the children were aware of the need for scientific testing and were able to offer a range of opinions as to why testing was important. However, it has been found that a perception of the importance of science does not necessarily translate into a positive attitude towards science, particularly in girls (Jarvis & Pell, 2002). It is important, therefore, that teaching science within a context does not just include teaching about the importance of science in society but also teaches children to enjoy science at a more involved level, as the CCI project does very successfully.

The project dramatically raised the children's awareness of modern industry, and present day scientists working in industry. After participation in the CCI project, many of the children were able to depict detailed drawings of industry, demonstrating their acquired knowledge. Furthermore, significantly more children viewed industrial sites as safe and with fewer employees, a more accurate reflection of modern industry.

By the end of the project, nearly half of all the children mentioned that scientists or engineers worked in industry. When given a choice, children chose scientist as a job they would like to do in industry much more often after the project. The classroom and site visits provided ideal environments to experience, first hand,

investigative planning and learn about the important roles of scientists and engineers in industry.

8.2 Teachers' data

Evidence presented clarified the reasons why this type of training is crucial for teachers of primary science. Many of the teachers had not had recent science training and training related to industry was not common. It was also found that teachers were more likely to teach about industry as part of the geography curriculum, than the science curriculum. Previous research has emphasised that primary teachers are more confident in teaching English than Science and Technology. Furthermore in terms of the science curriculum, teachers are more confident when working with 'life processes', and less confident when conducting 'guided discovery' investigations. These findings highlight teachers' long-standing weaknesses in physical processes and scientific enquiry.

Before they had CCI training, many teachers had not received any industry related information, either through resources developed by the manufacturing industry or through industrial links. The reason they gave for this was they had not seen any resources of this kind. It was clear that many teachers are not aware of the relevance of teaching science with industrial context to make the subject more interesting and relevant.

The reaction to the training was extremely positive. Many of the teachers had nothing but praise for the training received, and rated it highly. Virtually all the teachers said they had learned about teaching science and about the manufacturing industry.

A significant change in attitudes towards teaching science with industrial context occurred as a result of the training. 90% of the teachers intended to re-use the CCI materials with future classes and the same proportion intended to visit industry again. By the end of the project, the majority of teachers were positive towards using the manufacturing industry as a tool for teaching primary science within an industrial context.

8.3 Summary

The CCI project clearly achieved its main goals. The children and teachers were more knowledgeable about industry and the role of scientists after the project. Children were able to depict industrial sites and industrial processes more accurately. Teachers felt they had learned about teaching science and were more likely to use the CCI materials and visit industry in the future. Teachers' and children's perceptions of industry, including safety, improved. More children were aware of the roles of scientists and aspired to working in this profession in the future. Teachers and children had become much more aware of the link between science in the classroom and industrial processes. Finally, teachers and children had enjoyed the project immensely.

9 Appendix 1: Points system for analysing drawings

One point is accrued for each condition met. The list of criteria for outside drawings are listed first followed by the criteria for inside drawings.

Outside drawings

- Chimneys
- Cooling towers
- Number of buildings including specific buildings e.g. warehouse
- Approximate number of levels that buildings contain
- Signs and logos
- Other features such as fencing or security barrier
- Production area such as pipes, vessels, storage drums
- Appropriate vehicles such as forklift truck or road tankers
- Other

Inside drawings

- Few people depicted (doing specific job such as scientist or computer operator or forklift truck driver)
- Closed pipes or vessels (no open vats or open furnaces)
- Automated system
- Machinery such as production equipment
- Computers
- Lab equipment
- Lab work depicted from classroom activities
- Other

10 References

Association for Science (1999) *Science and the Literacy hour*, Executive Summary (Hatfield: ASE).

Blackburn, I. (1997), *Primary sector's gravity problem*, (10 January 1997). In The Times Educational Supplement*, London*: The Times Supplements Ltd.

Blatchford, P. (1992) *Children's attitudes to work at 11 years*. Educational Studies, 18, 107-118.

Department of Education and Science (DES) (1989), *Aspects of Primary Education: the teaching and learning of science*. London: HMSO.

Evans, C.E.L., Hogarth, S. & Parvin, J. (2004), Children Challenging Industry, Analysis of CCI project data five years on. www.ciec.org.uk

Jarvis, T. & Pell, A. (2002), Changes in primary boys' and girls' attitudes to school and science during a two-year science in-service programme, *The Curriculum Journal*, 13 (1), 43-69.

Jarvis, T. & Pell, A. (2002), Effect of the Challenger Experience on Elementary Children's Attitudes to Science, Journal of Research in Science Teaching, 39 (10), 979-1000.

Jelly, S. (1985), Helping children raise questions – and answer them. *In Harlen, W. (ed.) Taking the plunge*, London: Heinemann.

Musgrove, F. and Batcock, A. (1969) Aspects of the swing from science. British Educational Psychology, 39, 320-325.

Myers, R. and Fouts, J (1992) A cluster analysis of high school science classroom environments and attitudes to science. Journal of Research in Science Teaching, 29(9), 929-937.

Osborne, J. and Simon, S. (1996) Primary science:past and future directions. Studies in Science Education 29, 99-147.

Parvin, J. (1999), Children Challenging Industry: the Research Report. *Chemical Industry Education Centre*: University of York.

Pell, T & Jarvis, T. (2001), Developing attitude to science scales for use with children of ages from five to eleven years, *International Journal of Science Education,* 23 (8), 847-862.

Whitby, V. (1993), The relationship between teachers' own scientific knowledge and their ability to ask high level cognitive questions, in order to teach the National Curriculum for science. *Paper presented at the BERA Conference*. England.