Stats and Figures

Statistical Consultancy

Report Title:	**Children Challenging Industry** **Analysis of children's & teachers' data from the North West region, 2000-2003.**
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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 87% of children visited one of twenty possible industrial sites. 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
- Improve primary school children's perception of the chemical industry and its relationship with science
- Increase children's enjoyment of science
- Improve teachers' knowledge and confidence of teaching science
- Improve teachers' perception of the chemical industry and its relationship with science.

1.1 Children's data

344 children completed questionnaires from the year 2000 to 2003, before and after the CCI project.

The children were asked about the environment of industrial sites. Before the project, the predominant view of industry was that it was noisy, smelly, dirty and hot with many people working on production lines.

After the CCI project the children, whether they had been on a site visit or not, portrayed a significantly more accurate view of industry. They were more likely to say that an industrial site was safe and employed fewer people than expected.

The children drew pictures of their perceptions of industry, both before and after the project. They were scored, with a positive score indicating a more informed image as a result of the project. The children's drawings of the internal and external views of an industrial site were significantly more detailed and accurate after the project. The children who had been on a site visit were particularly more likely to attain a higher positive score than the children who had classroom lessons only.

The children were asked to draw someone in industry and give this person a job title. After the project, two jobs that were significantly more likely to be mentioned, were scientist and engineer. The children were three times more likely to draw a scientist, while the number of children drawing a 'materials handler', e.g. a job involving handling materials directly, such as pouring or stirring, dramatically decreased. When asked to list other jobs carried out on industrial sites, children were also much more likely to list scientist as a job carried out in industry.

After the project, when asked which job they would choose to do in industry, the children were much more likely to choose scientist as a job they would like to do.

The reasons the children chose to be a scientist were that it would be enjoyable or fun. They were far less likely to choose to be a 'materials handler'. By the end of the project the children were significantly less likely to say that they did not want any job in industry or that they did not know which job they wanted to do.

Many of the children learnt new things about science, as shown by the number of children who said that the ingredients or the processes of making materials were not as they expected. Virtually all the children learnt about the importance of science in industry shown by the fact that nearly all the children said scientific testing was important.

The children enjoyed the project, as shown by the number who indicated activities that interested them. The most popular activities were those that were practically-based and contained new information.

These results demonstrate how much the children learnt 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. Nearly half of all the children mentioned that scientists and engineers worked in industry. They felt that these professional jobs were far more attractive than before the project. If these views were sustained it would be expected that the number of children who wanted to work in industry would rise.

1.2 Teachers' data

91 teachers returned questionnaires from the year 2000 to 2003, before and after the CCI project. Half of the teachers had not had recent training in delivering the science curriculum and many had no science qualifications. Training related to industry was even less common.

Few teachers had links with industry and only a quarter of the teachers had used any resources developed by industry. Teachers were more likely to teach about industry in the context of history or geography, than science.

The feedback from the training was overwhelmingly positive. The sessions were of an extremely high standard and were highly rated by all the teachers. The weaknesses most likely to be mentioned were that there was too much to cover and there were difficult concepts covered in the project. The latter was more strongly associated with younger age groups.

Prior to involvement in CCI, when prompted, nearly all teachers thought there were positive and negative things about the chemical industry. Many teachers had not seen or received any information about the chemical industry either through resources developed by industry or through links with the chemical industry. By the end of the project, 88% of teachers said they had learnt something about science or industry.

Those that had used resources, prior to involvement in CCI, were most likely to say they did so because they were free, and of good educational standard.

The change in attitudes towards industrial resources that occurred during the project was impressive. Virtually all the teachers thought that industrial visits would be useful in future and 81% of teachers wanted to use resources developed by the industry after the training. This was a vast improvement when compared with the half of teachers who wanted links with industry, and the quarter who had used industrial resources, before the training.

2 Introduction

2.1 Background

Research carried out in recent years has highlighted teachers' lack of scientific knowledge and confidence to teach science. Close links have been found between primary teachers' ability to question children effectively and their understanding of scientific concepts. Productive questions promote science as a way of working, in which a variety of solutions can be sought from first hand experiences. For this reason, the Qualifications and Curriculum Authority feel that primary teachers should obtain a minimum of a GCSE in science in order to be able to teach the subject (Blackburne, 1997).

Successful teaching of science is dependent not only on adequate knowledge of science but also on the ability of placing science in context. 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.

It is clear that using an industrial context becomes highly valued by primary teachers when teaching science. However, research has 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, usually obtained from the media, which is indifferent at best, even hostile, to the chemical industry. News reports often cover industry in the role of polluter, rather than as providing benefits to society or playing an important role in scientific research.

In-service training has therefore been designed and delivered to show teachers how industry can 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 many children also visited industry.

2.2 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' perception of the chemical industry and its relationship with science
- Increase children's enjoyment of science
- Improve primary school children's perception of the chemical industry and its relationship with science.

2.3 Method

The schools were approached using a mail-shot within the Local Education Authorities that make up the North West region.

The teachers of year 5 or year 6 children, wishing to participate, were then approached to select from a range of teaching topics. These included *Plastics*

Playtime, A Pinch of Salt or *Water for Industry*. A web-based colour topic was introduced in September 2002, *Exploring Colour and Industry* (www.colour-ed.org).

After initial planning meetings and data collection, the advisory teacher carried out three activity sessions, of 2½ hours duration, with the class of children. Although a variety of teaching methods was used, the majority of the activities were practical and investigative in nature, with classes being divided into groups of four children for these activities. After the classroom training was completed, a site visit was arranged to a local company site.

The training was provided to 95 classes between 2000 and summer 2003 in the North West region. The teachers were asked to complete three different forms during their training.

The first form, a background information questionnaire, was completed before the training and asked questions about the school and teaching methods used. The second form was the pre-questionnaire and was also completed before the training. It covered questions about the teachers' training and qualifications, their knowledge of the chemical industry, their use of industrial resources, and in which classes they taught.

The post-questionnaire was completed after the training and asked teachers about their reaction to the training as well as their attitudes towards the chemical industry.

Questionnaires were returned for analysis from 91 teachers and 344 children from 91 schools. The teachers' and children's data were collated and input into Stata, a statistical software package. The data were analysed to measure the impact of the project. The main areas of interest were:

- Background information on children, schools and teachers
- Children's views of industrial settings
- Children's views of industrial jobs
- Children's views of science and industry
- Evidence of a need for science training
- The reaction of teachers to the training
- Knowledge and skills of the teachers with regard to the teaching of science and industry
- Perceptions of the teachers regarding science and industry.

The findings are reported and discussed in the following sections. All the graphed results are displayed as percentages unless otherwise specified.

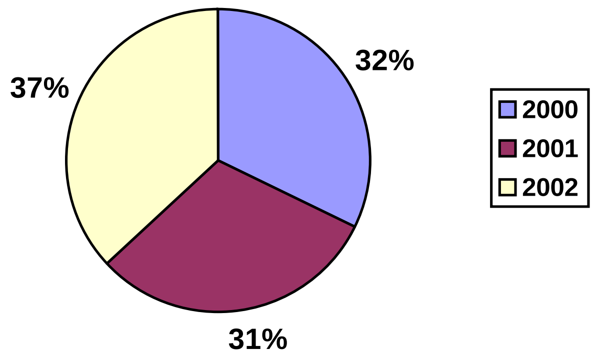
3 Background information on children

Many of the variables analysed in this section are compared with the results obtained in the previous study by Joy Parvin (Parvin, 1999). In 1996 to 1998, training was provided, and teachers and children were interviewed to assess what they had gained from the sessions. These original findings lay the groundwork for the current report.

3.1 Academic year

The year and term the questionnaires were completed by the children was provided by the teacher. The results are shown in Figure 3-1.

Figure 3-1: Academic year data collected

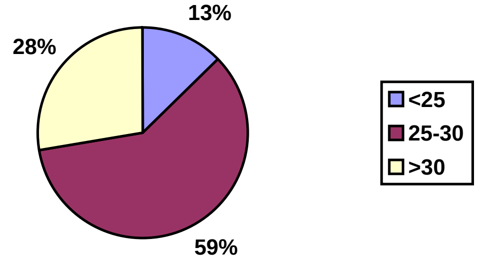


The total number of children's questionnaires collected in this region since 2000 was 344. Similar numbers of questionnaires were collected for each of the three academic years. Virtually all of the schools included four pupil's questionnaires from each class. Questionnaires were also collected from 91 teachers.

3.2 Number of children in the class

Teachers were asked how many children were in their class. The results are shown in Figure 3-2.

Figure 3-2: Number of children in the class

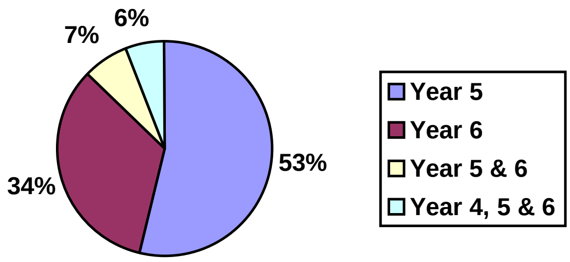


These figures are broadly similar to those seen in the previous study. However, there were more classes with 25-30 children, and slightly fewer classes with small and large numbers of children. This is a larger sample where you would expect the trend to move towards having more classes nearer the average number. In this study, the mean number of children in the class was 29. The minimum was 16 and the maximum was 38. The smaller classes tended to be in areas that are more rural.

3.3 Year groups and gender

Teachers were asked which year groups they were teaching. The results are shown in Figure 3-3.

Figure 3-3: Year groups taught



Slightly more than half the pupils were from year 5 with the remainder mainly made up of year 6 pupils. Year 5 has become the most popular age group to be involved in the project, as the focus on the SATs (Standard Assessment Tasks) in year 6 often moves the attention away from investigative work. However, a high proportion of teachers still value investigative work, and year 6 pupils are often involved in the summer term, after the tests in May. Year 4 pupils are involved when they are in a mixed year class with year 5.

Due to smaller schools taking part in the previous study, it is no surprise that there were more classes with mixed year pupils (37%) than in this study (13%). Smaller schools are more likely to combine year groups whereas larger schools tend to keep the years separate. The ratio of girls to boys was 177 (51.5%) female and 167 (48.5%) male.

3.4 Ethnic profile

The teachers were asked about the ethnic profile of their school. Some teachers (5%) did not answer this question, maybe because they did not feel able to.

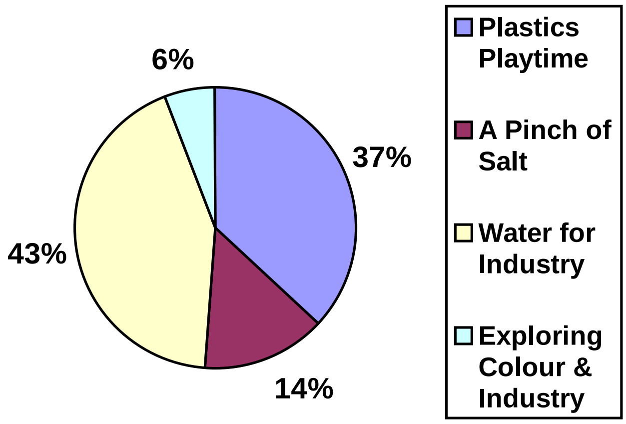
Table 3-1: Ethnic profile

Ethnic profile	Percent
Mainly white	77
5-15% ethnic	10
Multiracial	8

3.5 Topic

The class teacher from each school chose one of the topics provided. The proportion of children experiencing each topic is shown in Figure 3-4.

Figure 3-4: Topic



The most popular topic was *Water for Industry* with nearly half the teachers choosing this topic. Approximately a third chose *Plastics Playtime*. A small percentage chose *A Pinch of Salt* and *Exploring Colour and Industry.* The topic on colour was a new topic introduced much later than the others, in autumn 2002.

3.6 Industrial sites visited

The sites visited by schools in the North West region are shown in Table 3-2.

Table 3-2: Site visits in the North West region

Site Visited	Number of pupils
Nexpress Solutions	43
AKCROS Chemicals	23
Solvay Interox	16
Contract Chemicals	14
Great Lakes	13
Deesside Power	12
Daresbury Labs	11
Rhodia	9
Duckworth Group	8
BASF Huyton	8
EVC	8
BPI films	8
CIBA	8
Linpac Plastics	8
Rockwood	7
Thompson & Capper	7
Eli Lilly	6
Avecia Blackley	4
Bayer Crop Science	4
BPI Brombrough	4

BPI Plastics	4
AGP Fiddler's Ferry	4
Cabot Carbon Ltd	4
Catalyst Museum	4
Ineos Fluor	4
Jiffy Packaging	4
Lubrizol	4
Quest International	4
Uniqema	4
Van Leer	4
Colloids	4
Victrex	4
NW Water	3
Initial Packaging	3
Total	**275**

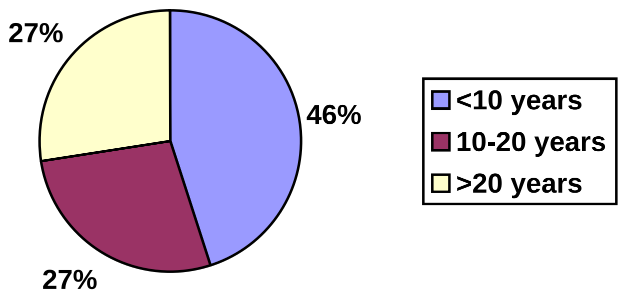
The two most common sites visited by the children were Nexpress solutions and AKCROS Chemicals. There were thirty-two other sites involved in arranging visits for the children. In this region, there was a huge range of companies involved in the CCI project.

A small proportion of children (20%) did not visit any of the industrial sites.

3.7 Years in teaching

Teachers were asked how many years they had been teaching. They were split into three groups, fewer than 10 years, 10-20 years and more than 20 years, to enable the results to be compared with the previous study.

Figure 3-5: Years spent teaching



The mean number of years that teachers had been teaching was 13 years in this study. The maximum was 33 years and the minimum was 0 years (a newly qualified teacher).

The teachers in both this study and the previous study were split into the three categories approximately equally. In this study, more teachers had been teaching for fewer than 10 years.

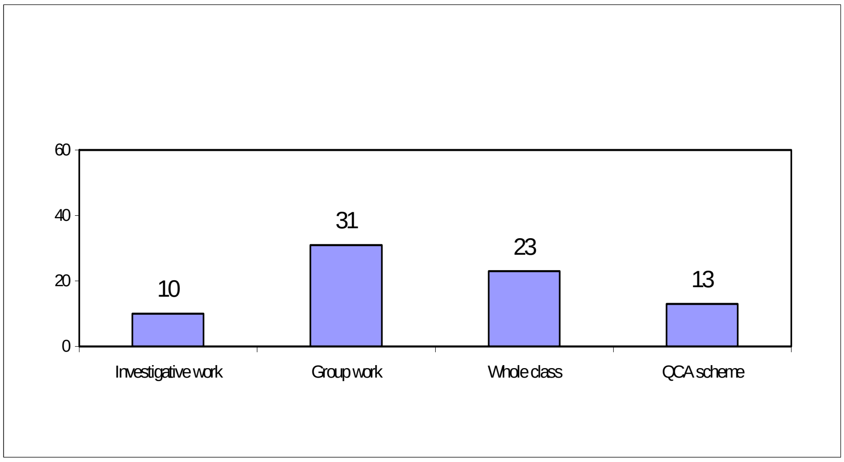
3.8 Teaching science

91% of the teachers stated that they were the only teachers that taught science to their class. The remaining 9% (8) teachers had input from other members of staff.

A small number (5%) of teachers also taught science to other classes. One teacher said that they taught other year groups and three teachers said they supported other classes during SAT revision.

Teachers were asked about their teaching methods but many teachers (45%) did not answer this question. This may have been because it was not clear on the questionnaire that an answer was required by all teachers, not just those that had said that they taught other classes. Alternatively, it may have been because they were not sure what answer to give. This question has since been clarified on the questionnaire.

Figure 3-6: Details of teaching methods



Those that did answer the question were most likely to say ‘whole class and group work’. The number of teachers teaching investigative work was quite low at 10%.

3.9 Chapter summary

The CCI project sought the views of science and industry from 344 children in primary years 4 to 6 and 91 teachers. The average number of children in a class was 29 in this study, higher than in the previous study. 87% of the year groups being taught were either solely year 5 or year 6.

The advisory teacher was able to offer a variety of topics to the teachers and children, to suit their needs and interests, together with company visits. *Water for Industry* was the most popular choice. There was a huge range of industrial sites for the children to visit, with many companies taking on impressive roles in the CCI project. Only 20% of the children did not visit industry.

The mean number of years teachers had been teaching was 13. 91% of the teachers said they were the only teacher to teach science to their class and 95% said they did not teach science to any other classes.

4 Children's views of industrial settings

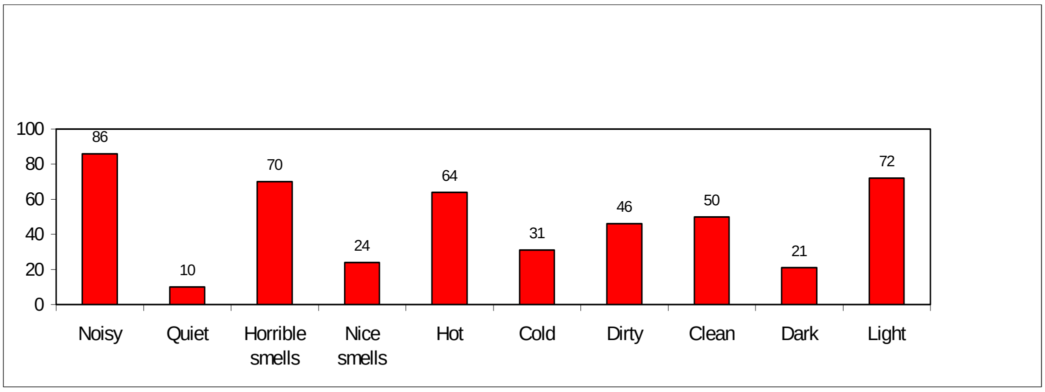
This section discusses the children's views of industry in two parts. The first part involves questions on words that describe industrial sites and the second part involves analysis of the children's drawings of the inside and outside of an industrial site.

4.1 Industrial environment

The children were asked a series of closed questions about industrial sites before and after the project. The questions included a choice of two answers, for example, industrial sites are cold or hot, have horrible smells or nice smells, are noisy or quiet, etc. Some children ticked both answers or left the answer blank. These answers were considered neutral and were not included in the following analysis.

The first group of questions included questions on the industrial environment, light, noise, cleanliness, smell and temperature. The results of these questions are shown in Figure 4-1.

Figure 4-1: Children's descriptions of industry before intervention

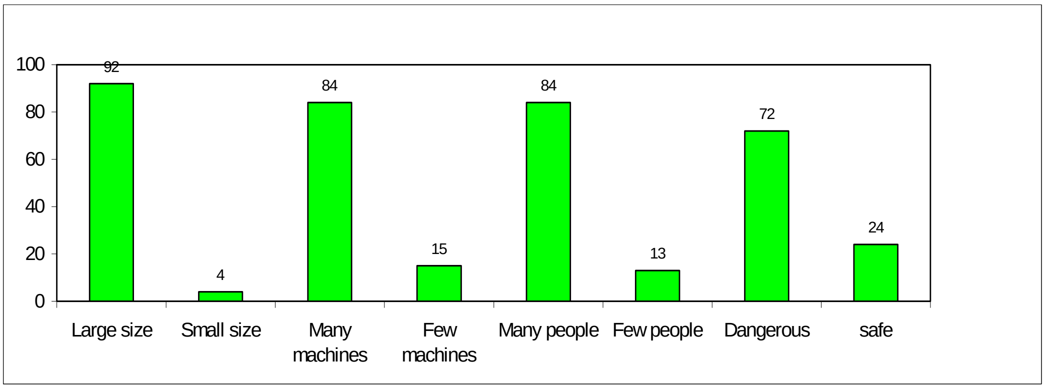


Before the project, the predominant view of industry was that it was noisy, smelly and hot. The results are similar to those obtained by Parvin (1999). She found that 80% of children thought an industrial site would be noisy and 75% thought it would have horrible smells. She also found that 55% of children thought that it would be hot. All the figures are very close to the results obtained in this study. The only result that varied significantly from Parvin's study was the percentage of children who said it would be dark. In this study, far fewer children thought an industrial site would be dark compared with Parvin's study.

Many of these perceptions of industry are not accurate for the majority of industrial sites. Although there are sites that are noisy and smelly, they are by no means all like this. The children therefore did not have an accurate picture of industry before involvement in the project.

The second group of questions focused on the number of people and machines that would normally be found on site, the size of a typical site and the degree of safety usually found. The results of these questions are shown in Figure 4-2.

Figure 4-2: Children's descriptions of industry before intervention



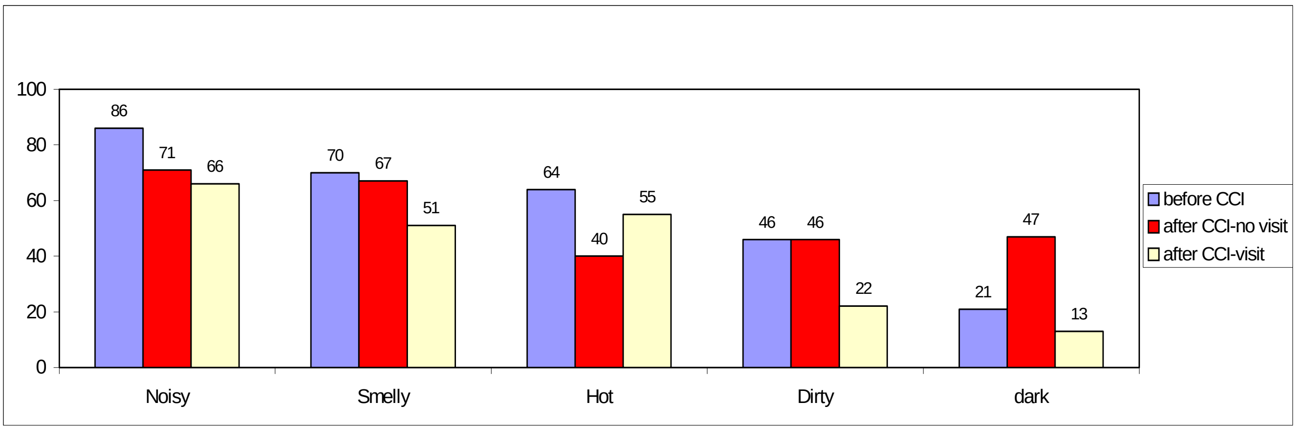
Again, the overall picture is one of a large site with lots of people and noisy machines. Many children also saw it as a very dangerous atmosphere. Parvin's study produced very similar results with the number of children stating a site would be large, with many machines and/or people between 75 and 85%. The percentage of children who thought a site would be dangerous was also very similar in Parvin's study (70%).

As before, the views of many of the children are largely inaccurate before the project. Many felt that industrial sites were huge places with lots of people on production lines using noisy, dangerous machines.

It was hoped that after the CCI project the children would hold more accurate views of industry. It was expected that the children who had been on a site visit may have increased their knowledge of industrial sites to a greater extent than the children who had not been on a visit. Therefore, the children were split into two groups for further analysis, those who had, and those who had, not been on a visit. The number of children who did not have a visit was much smaller than the number who did have a visit. This makes the results less statistically robust than if a similar number of children were in each group, however it does indicate any possible trends in the data.

The changes in the views of children were analysed to see if there were any differences in the answers given after the project (with 'visit to industry' compared with 'no visit to industry') compared to before intervention. The results are shown in Figure 4-3.

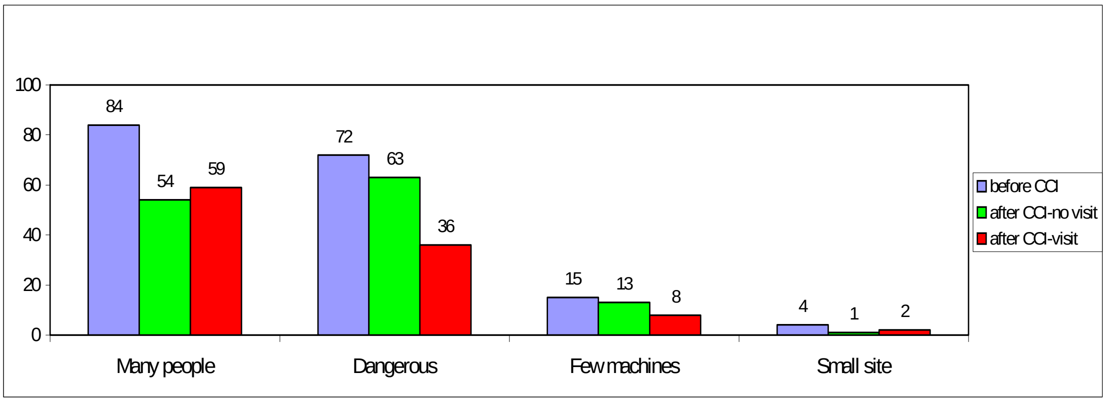
Figure 4-3: Industrial views of children



The children who had been on a site visit were significantly less likely to say that a site was noisy, smelly, hot, dirty and dark. The children who had not been on a visit were significantly less likely to say an industrial site was noisy or hot. It appears that both classroom-based lessons and site visits help children become more knowledgeable about the environment of industrial sites. Both groups of children gave a more balanced view of what an industrial site is actually like compared to their views before the project.

The results of the second group of questions are shown in Figure 4-4.

Figure 4-4: Industrial views of children



The children who visited an industrial site were particularly less likely to say that industry is dangerous. The children who had not had a visit showed a similar trend but to a lesser degree. Both groups of children were more likely to say that there are only a few people on a site. This accurately reflects the situation in many sites where fewer people work than children would expect and safety on the site is extremely important. In addition, both groups of children were more likely to say there were many machines in industry and that industrial sites are large. Both classroom lessons and site visits play a role in teaching children about the environment of industrial sites.

In Parvin's original study the question was framed slightly differently with the post-intervention question being more open. The percentage of children who said industrial sites were safer was smaller at 4% because many children chose to leave the question blank.

4.2 Drawings analysis

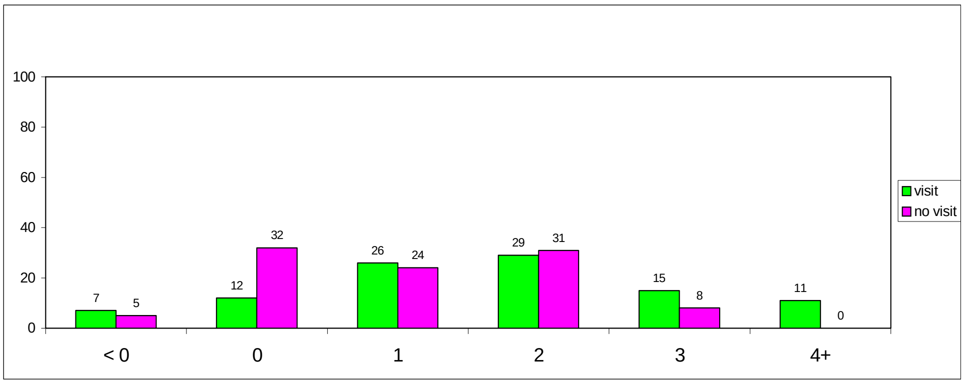
The children were asked to draw pictures of their impressions of an industrial site (inside and outside), before and after the CCI project. The pictures were compared and given a score based on the difference between the pre and post-intervention pictures.

A high positive score demonstrated good knowledge of the site and a high negative score demonstrated poor knowledge. A score of zero indicated no change in the child's knowledge as measured by their drawings. The criteria used for scoring the external and internal drawings are listed in Appendix 2.

Children who had an industrial visit may have learned more about the appearance of sites, and therefore the scores of children who went on an industrial visit were compared with the scores of children who did not. These results were analysed using a t-test.

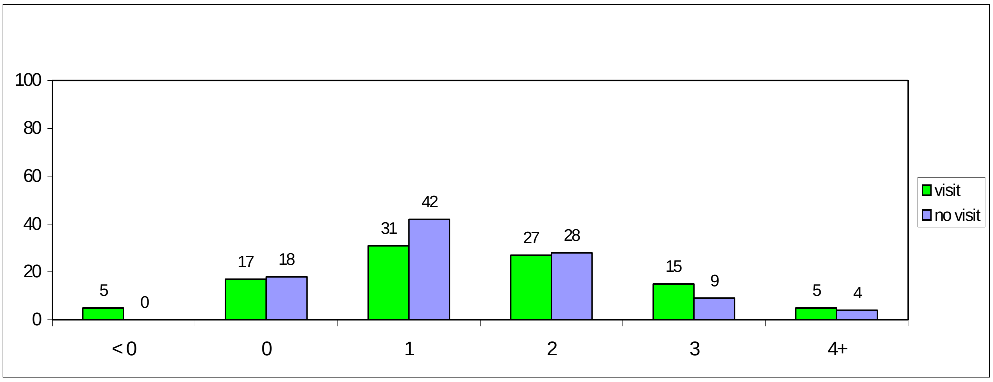
The results of the scores of external and internal pictures are shown in Figure 4-5 and Figure 4-6.

Figure 4-5: Scores of drawings of external view of industrial sites



The scores were significantly greater than zero for both groups. In other words, children, regardless of whether they had a visit or not drew pictures that were more detailed at the end of the project, compared with the beginning. For the external drawings, there was a significant difference in the results of children who had been on a site visit compared with those who had not ($p=0.002$). The mean score was 1.7 for the children who had been on a site visit and 1.0 for the children who had not had a site visit. Children who had a visit were more likely to have a score of two or more, whereas those without a visit were more likely to have a score of zero.

Figure 4-6: Scores of drawings of internal view of industrial sites



The scores were significantly greater than zero for both groups. In other words, children, regardless of whether they had a site visit or not, drew more detailed pictures of internal images of industry at the end of the project, compared with the beginning. For the internal drawings, the average scores for those who had been on a site visit and had not been on a site visit were 1.5 and 1.4 respectively. Whether a child had been on a site visit or not had no affect on the score.

In the next section, examples of drawings have been provided to illustrate the differences between high, medium and zero scores. 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 first asked to draw what they thought the outside of an industrial site would look like. Some of the children drew pictures depicting an 'historical' view of industry before the project, and some drew pictures with very little detail. The pictures drawn after the project tended to be more modern images of industry, and included more detail.

The following before and after pictures are an example of a high positive score obtained by a child who carried out the topic *Water for Industry*. In addition, this child had an industrial visit to Rockwood.

Figure 4-7: Child 1, external picture of industry before the CCI project

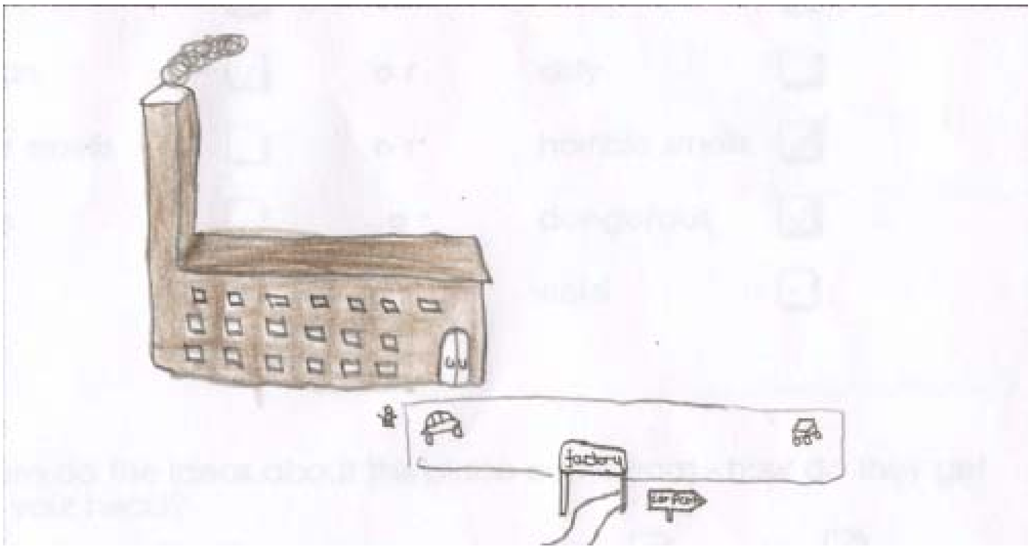
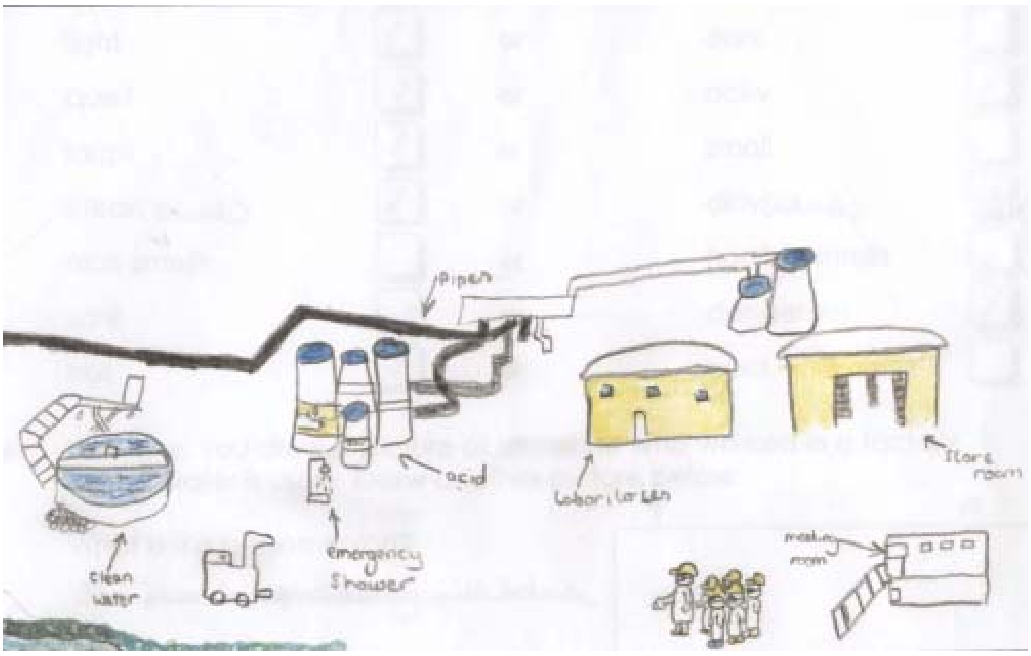


Figure 4-8: Child 1, external picture of industry after the CCI project



Before the project, the child portrayed quite an old fashioned image of industry that was typical of many of the children's pictures. The building drawn was dark and sombre with a huge smoking chimney and many small windows. Afterwards the child's drawing was much more detailed and less stereotypical. The chimney disappeared, and modern low level buildings took its place. Storage containers and closed pipe-work, connecting different areas of the site were included in the second picture. The child also labelled different areas of the site such as laboratories, meeting room and pipes.

The following before and after pictures are an example of a high positive score obtained by a child who was involved in the topic *Plastics Playtime*. This child had an industrial visit to BPI.

Figure 4-9: Child 2, external picture of industry before the CCI project

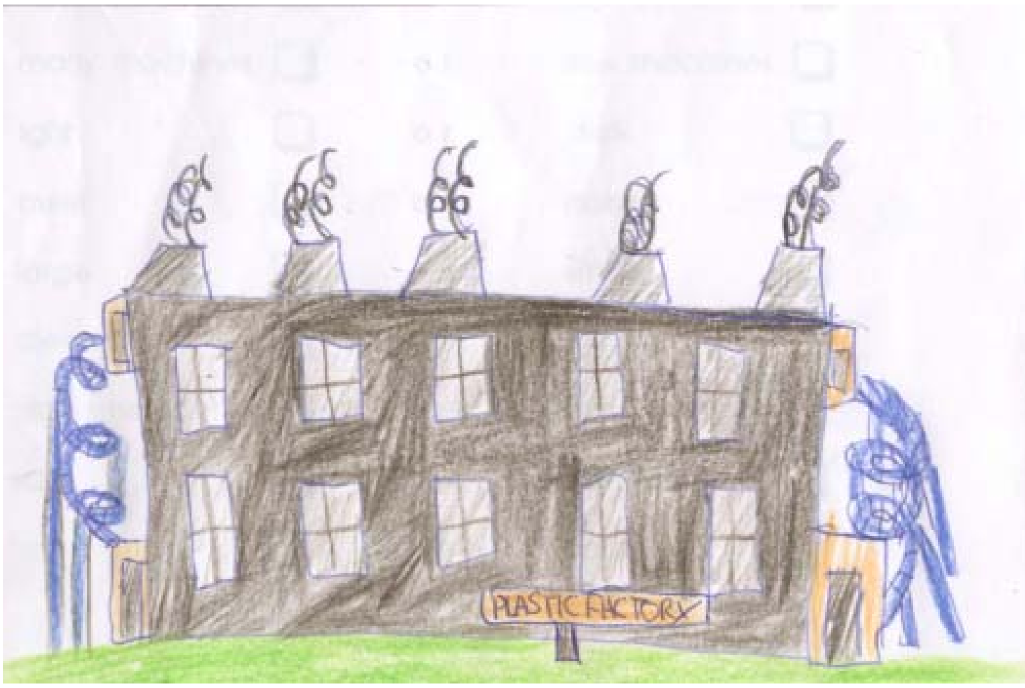
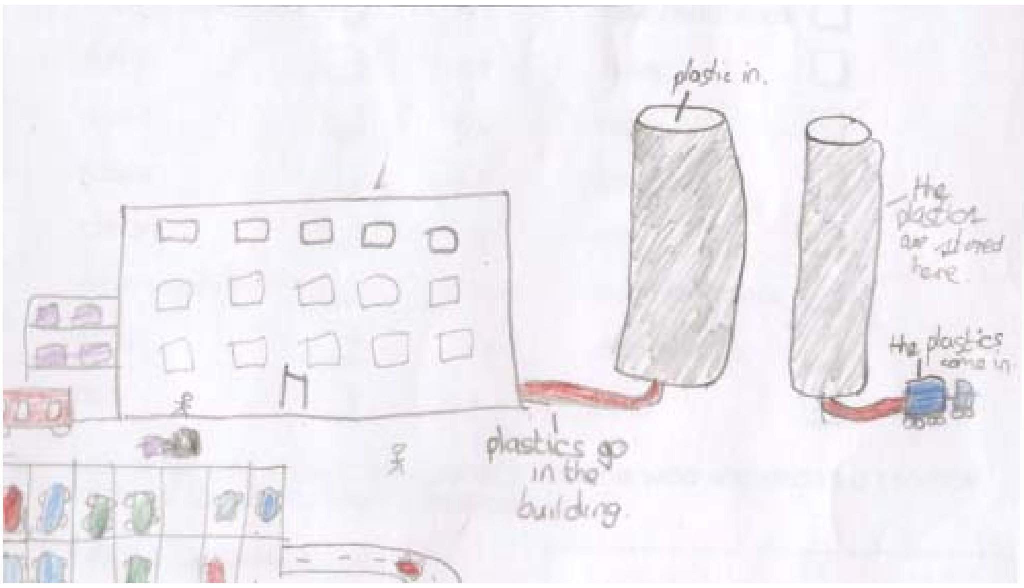


Figure 4-10: Child 2, external picture of industry after the CCI project



Child 2 also depicted a dark sombre building with many smoking chimneys in their first picture. There did appear to be some pipes but they seemed to come out of the ground rather than connecting different parts of the site. In their post project picture they have drawn a modern building and included storage containers and enclosed pipe work, connecting different parts of the site. The drawing is far more detailed and various parts of the site have been labelled.

The following before and after pictures are an example of a medium positive score obtained by a child who did the topic *A Pinch of Salt*. This child did not go on industrial visit.

Figure 4-11 : Child 3, external picture of industry before the CCI project

Figure 4-12 : Child 3, external picture of industry after the CCI project

Many of the children who carried out the topic on salt drew pictures of the sea or buildings beside the sea as they thought that salt came from salt water. Very few children knew about 'solution mining' or salt quarrying before the project started, however during the project, it was covered in detail and these children drew very different pictures after the CCI project. This child actually drew a picture of a windmill like structure but it's difficult to imagine how a windmill could produce salt. The second picture is clearly more accurate and depicts a salt mine or quarry with a person removing rock containing salt.

The next two pictures are from another child who obtained a medium positive score after completing the topic *Colour and Industry*, and had an industrial visit to Colloids.

Figure 4-13 : Child 4, external picture of industry before the CCI project

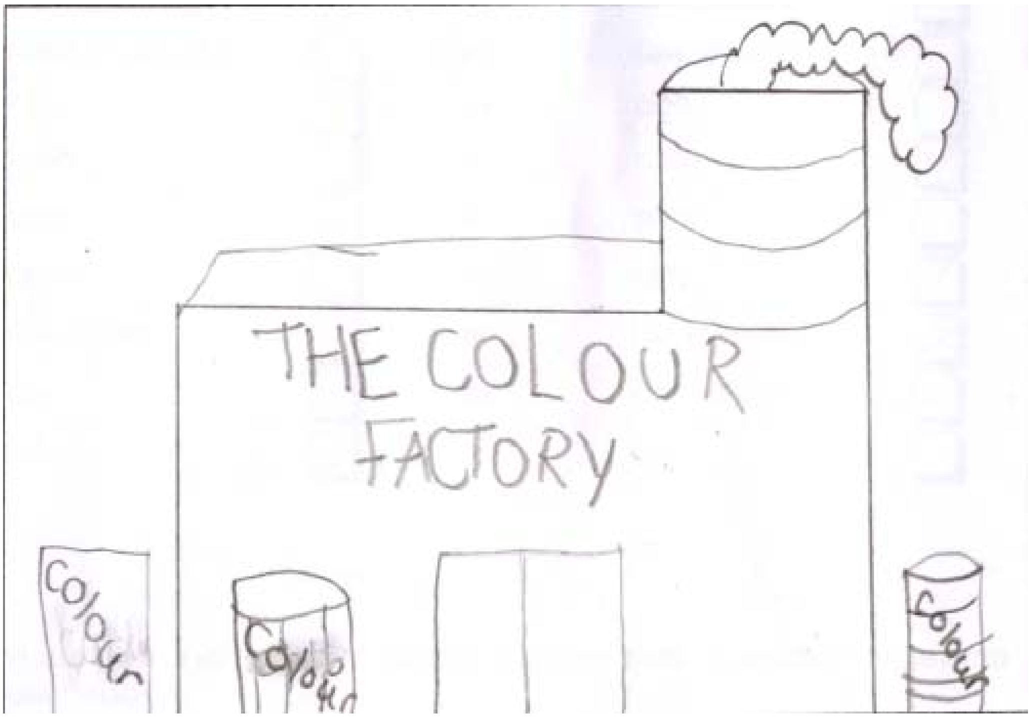


Figure 4-14 : Child 4, external picture of industry after the CCI project

The post-intervention drawing contains a more modern image of a building and the smoking chimney has been removed. However, the picture is not as detailed as previous post-intervention drawings in this report. The child has, none the less, improved their knowledge of the external image of industry as a result of the CCI project.

The following before and after pictures are an example of a zero score obtained by a child who did the topic *Water for Industry*. This child did not go on an industrial visit.

Figure 4-15 : Child 5, external picture of industry before the CCI project

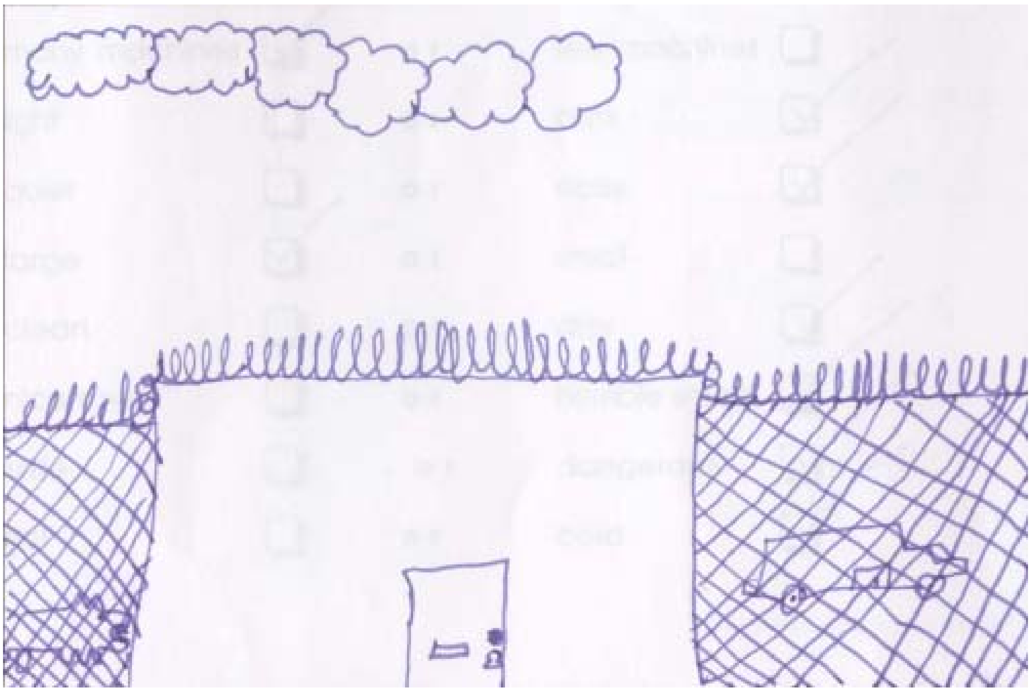
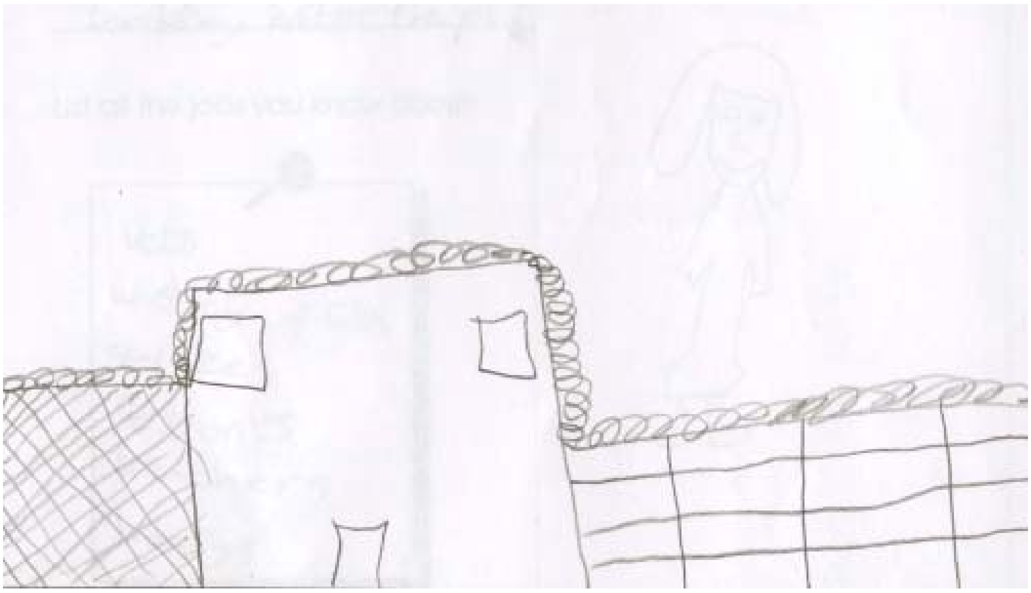


Figure 4-16 : Child 5, external picture of industry after the CCI project



This child's views are fundamentally the same, both before and after the project. The child has drawn a simple building with a door and surrounded by a fence, in both drawings. Despite a site visit, this child was unable to draw a different scene to portray the outside of an industrial workplace. There may be many reasons why the post- intervention drawing is poor. Perhaps time was short and this was all the child could complete or perhaps they did not feel able to add any more detail. This child's post-intervention drawing of the inside of the same place was similarly sparse.

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 containing 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 before and after pictures are an example of a high positive score obtained by child 1 who had an industrial visit.

Figure 4-17 : Child 1, internal picture of industry before the CCI project

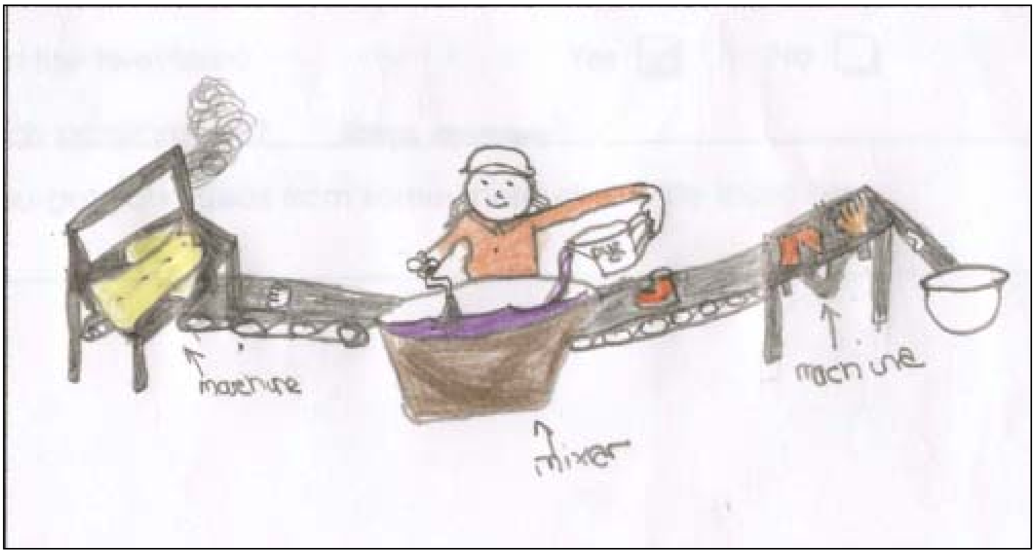
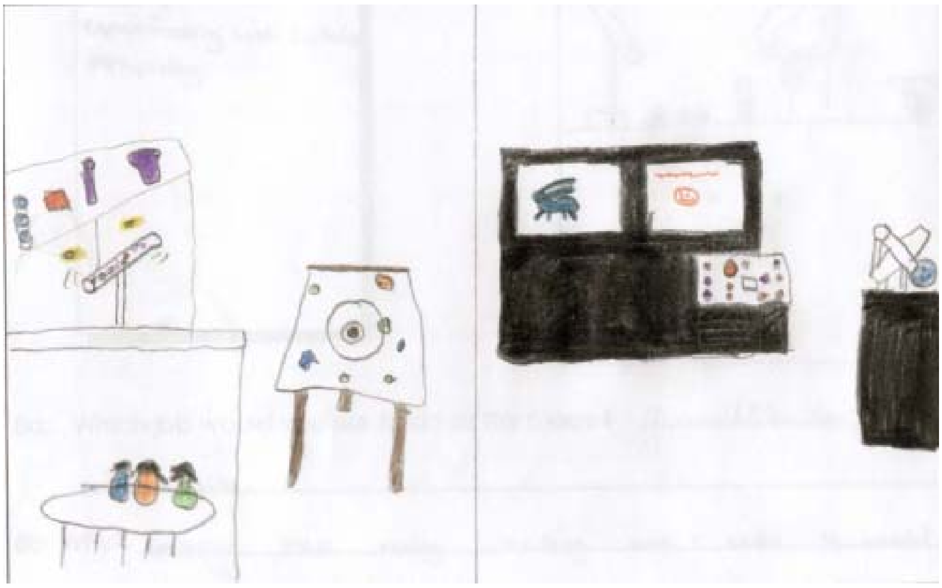


Figure 4-18 : Child 1, internal picture of industry after the CCI project



The inside of the building was depicted as old fashioned with a conveyer belt and a person pouring liquid into an open vessel. After the project, the picture portrays a more modern image with a large range of laboratory and scientific equipment, as well as demarcation of different areas for different uses. This demonstrates how much the child has learned about the scientific processes involved.

The following before and after pictures are an example of a high positive score obtained by child 2 who had an industrial visit.

Figure 4-19 : Child 2, internal picture of industry before the CCI project

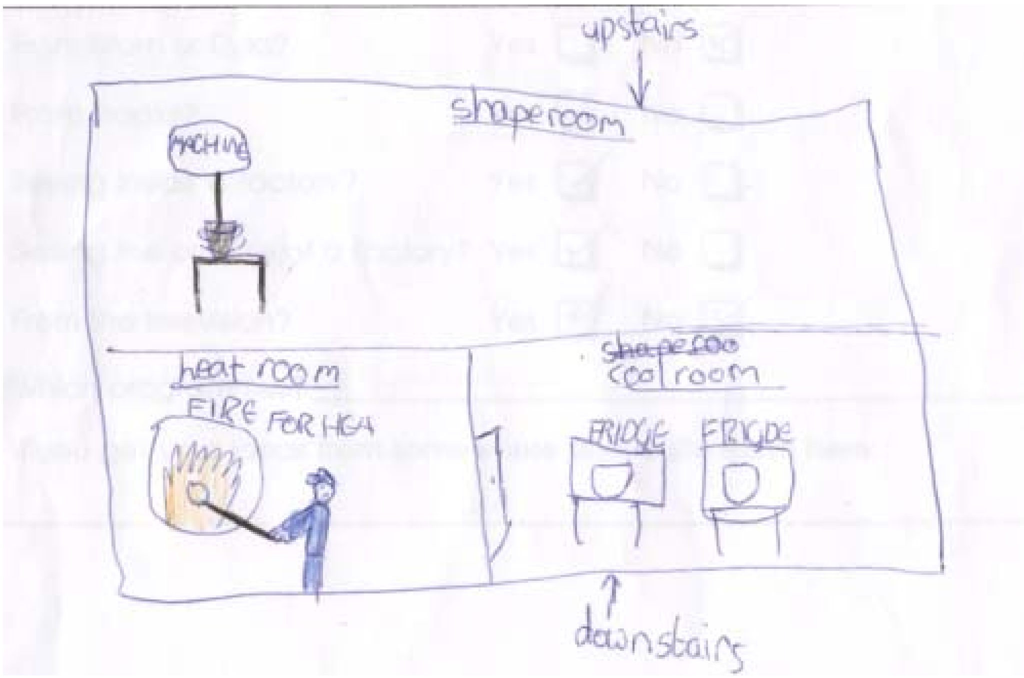
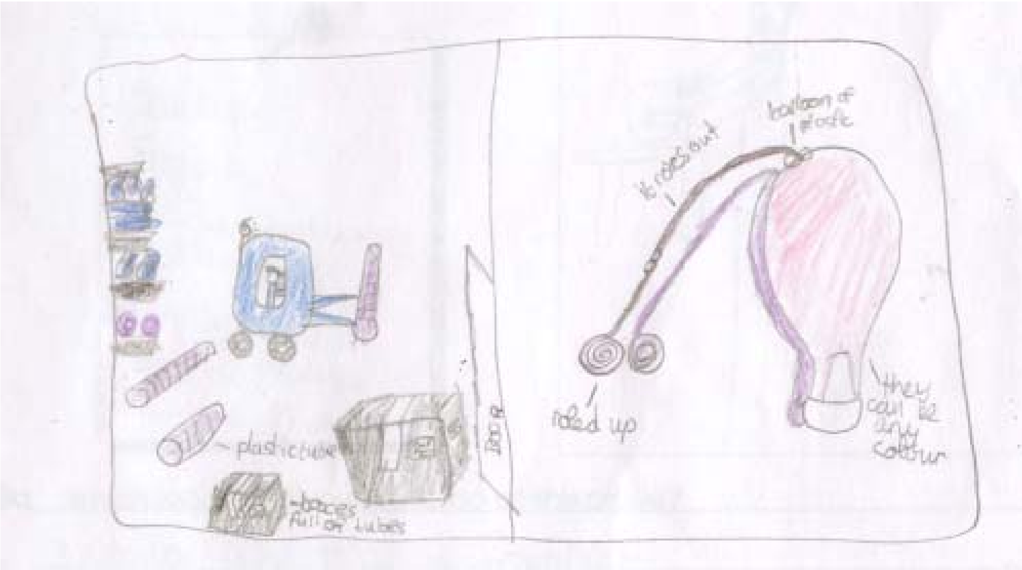


Figure 4-20 : Child 2, internal picture of industry after the CCI project



When asked to draw the inside of an industrial site, this child included open vessels and moulds, which depicted a non-automated vision of industry. In addition, they depicted a person working in a furnace room with a huge roaring fire. In the second drawing, the child has depicted a different scene with enclosed pipes and a more modern environment. Many children also included computers in their second drawing and were far less likely to include conveyer belts.

The following before and after pictures are an example of a medium positive score obtained by child 3 who did not have an industrial visit.

Figure 4-21 : Child 3, internal picture of industry before the CCI project

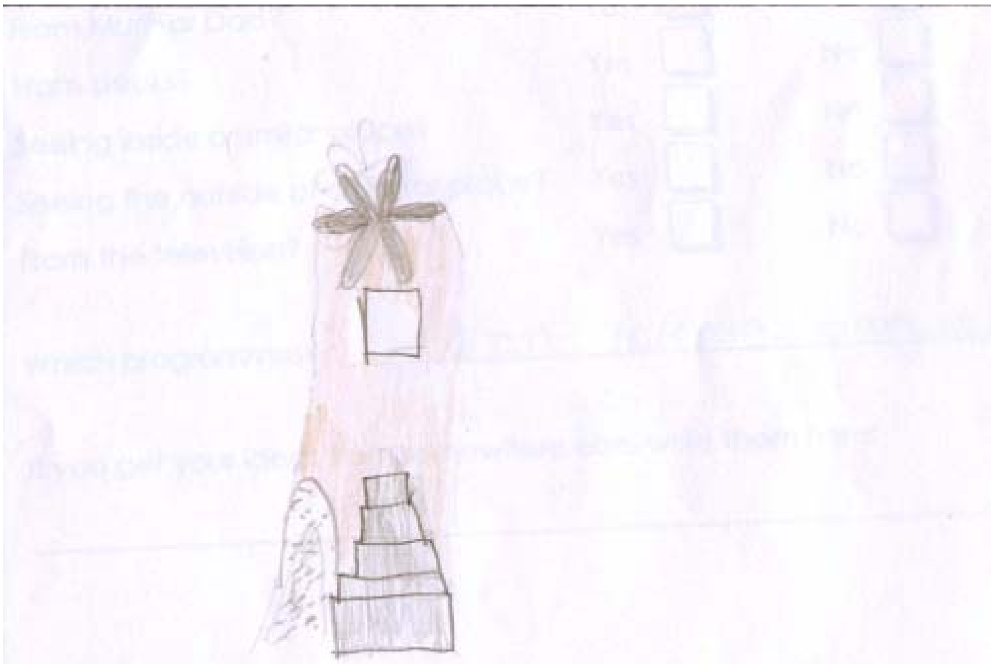
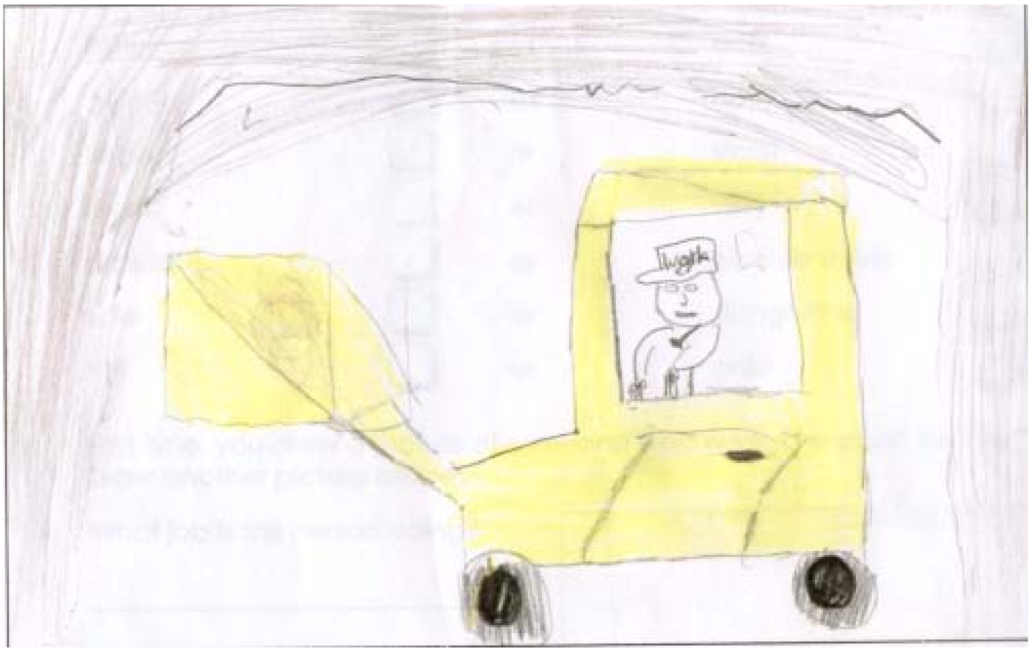


Figure 4-22 : Child 3, internal picture of industry after the CCI project

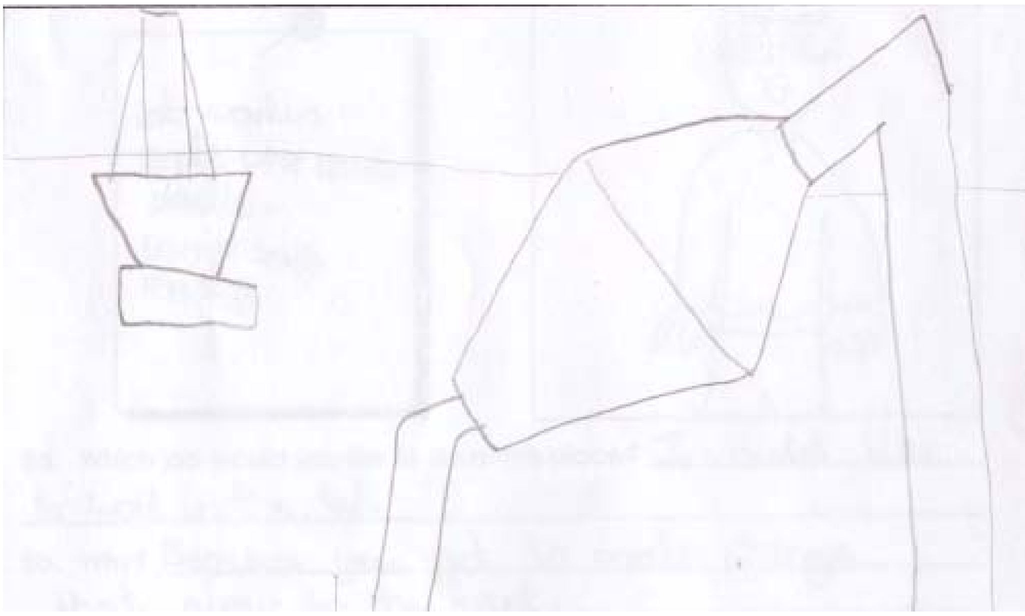


This child has drawn similar pictures for the internal views of industry as for the external views The pre-project drawing again looks like a windmill. The post-project drawing is a more close up picture of a salt mine with a driver clearly seen working the machine to mine the rock salt.

The next set of drawings is also from a child who obtained a medium score. They also visited industry.

Figure 4-23 : Child 4, internal picture of industry before the CCI project

Figure 4-24 : Child 4, internal picture of industry after the CCI project



Comparison of these two drawings gives a positive score. There has been a move away from open vessels handled by machine operators on a conveyor belt. Also included in the first drawing was a vessel being heated on an open fire. After the project, this child has drawn a picture of enclosed vessels and pipe work which is a more modern image of industry, and the open fire has gone.

The following before and after pictures are from child 5 who obtained a zero score, and did not visit industry.

Figure 4-25 : Child 5, internal picture of industry before the CCI project

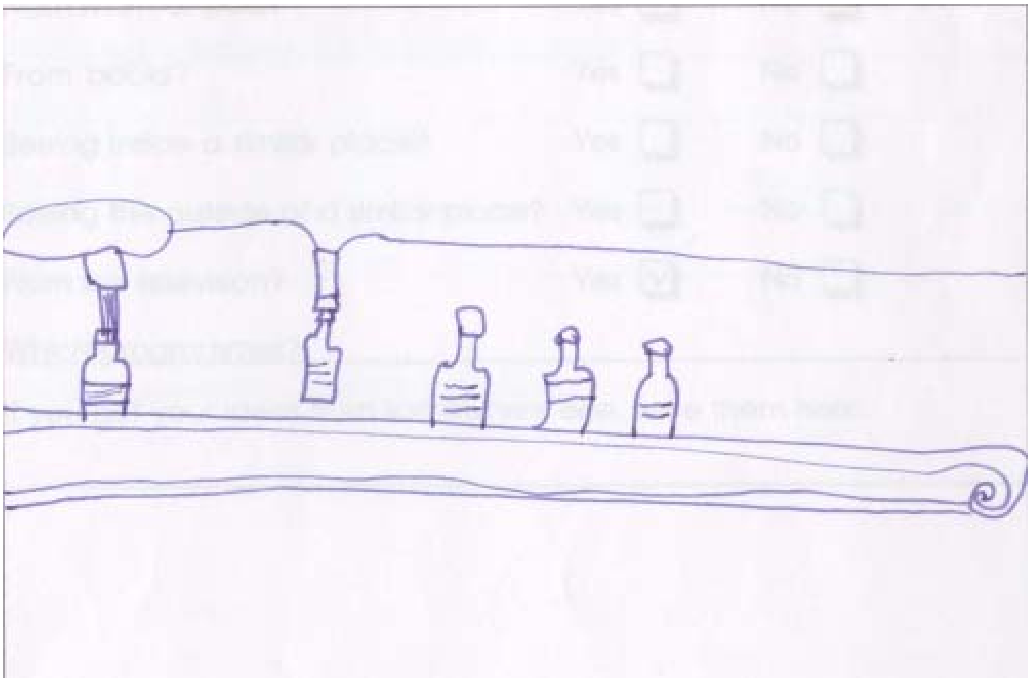
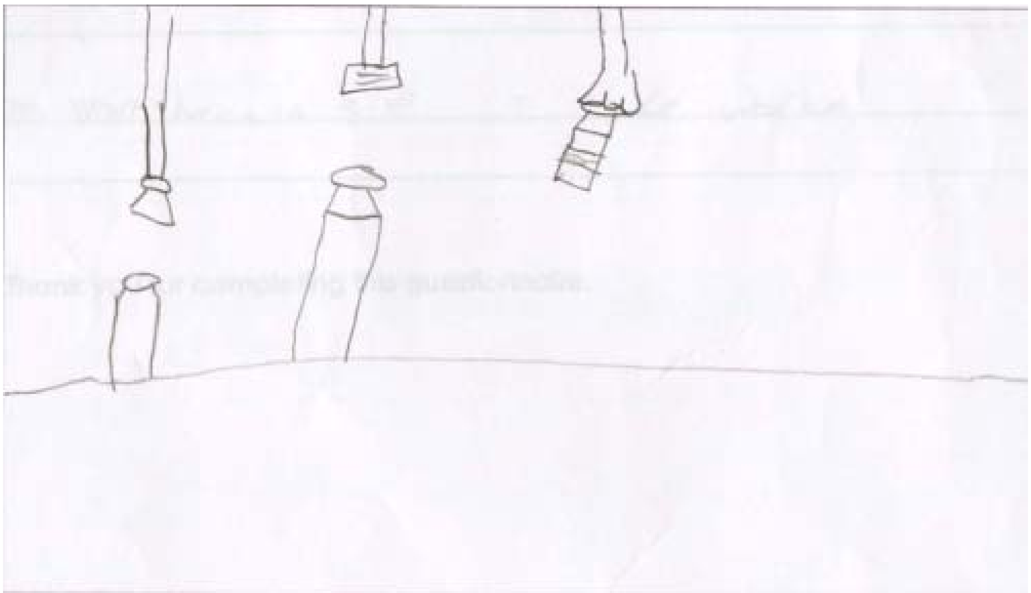


Figure 4-26 : Child 5, internal picture of industry after the CCI project



This child’s views of industry are fundamentally the same here. Although the drawings are simplistic both before and after the project, the pre-intervention drawing did reflect the fact that vessels are enclosed and there also seems to be pipe work. However, the post-intervention drawing added nothing compared to the previous drawing. This could have been because of time constraints or because they did not feel able to draw anything more intricate.

4.3 Chapter summary

Children who had been on a site visit were significantly less likely to say that industrial sites are noisy, smelly, hot, dirty and dark. Children who had not been on a site visit were less likely to say an industrial site was noisy or hot. Both groups of children were significantly more likely to think that industrial sites were safe, and had fewer people than expected. Both groups of children gave a more balanced view of what an industrial site is actually like compared to their views before the project.

These results provide good evidence of the usefulness of the site visit and classroom lessons in educating primary school children on the environment of industrial sites.

After the project, the children were more likely to draw detailed external and internal images of industry, whether they had been on a visit or not. This indicated that they were more aware of the appearance and processes involved in industry after the project. However, the children visiting an industrial site were significantly better at depicting a more accurate picture of the external image of industry than those who did not have a visit. The visit did not seem to improve these children’s internal images of industry. Children who had not had a visit were shown images of industry using video and photographs which was sufficient to learn about internal industrial environments. Parvin concluded that the best way to improve children’s knowledge of industry is to follow up their classroom activities with a well-planned visit to an appropriate company and these results confirm this view.

5 Children's views of industrial jobs

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

- Jobs depicted in drawings
- Other jobs cited by children that occur in industry
- Jobs the children thought they would choose to do in industry.

5.1 Drawing of a person who works in industry

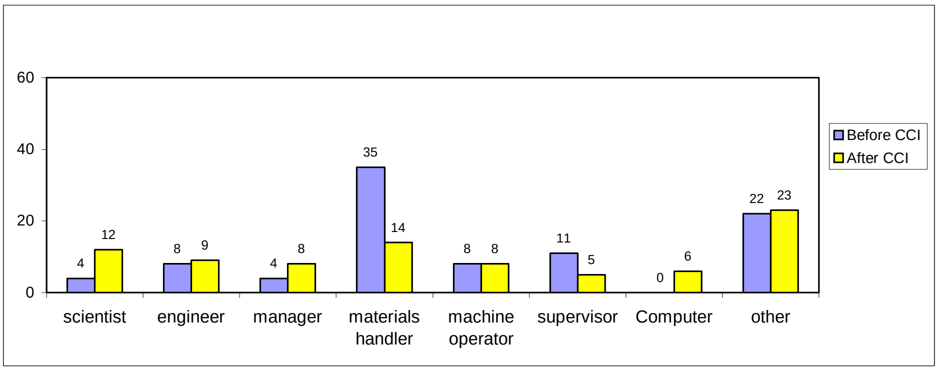
The children were asked to draw a picture of a person who works on an industrial site. They were then asked to write down the job of the person they had drawn. The types of jobs listed were analysed to see if there were any significant differences after the children had experienced the CCI project compared with their answers before the project.

Many different jobs were listed, and those listed less than 5% of the time were amalgamated to form the category 'other'. This group included, packer, driver, office worker, computer operator, cleaner, miner, worker, teacher, cook, security, tour guide and first aid person.

Some children did not draw a picture or state the person's job and these were categorised as 'No response' but were not included on the graph.

The results are shown in Figure 5-1.

Figure 5-1: Industrial jobs depicted in children's drawings



Before the project many of the jobs of people drawn were categorised as 'materials handler', where children quoted jobs relating to processes such as mixing, heating and moulding. They were less able to suggest specific jobs and usually described their drawing by describing what the person was doing rather than giving a job title. The number of children drawing a materials handler or machine operator decreased dramatically from 35% to 14%. These results were statistically significant.

Before the project took place, the children were very unlikely to say that they had drawn a scientist or an engineer. In her original study, Parvin found that children do not associate scientists with industry. They 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 or offices.

The situation after the project had improved. The number of children drawing a scientist increased from 4% to 12% after intervention. However, the number of children listing engineer or manager only increased slightly. The number of children who mentioned that they had drawn a computer operator increased significantly from 1 child (0.3%) to 18 children (6%). The number of children drawing an engineer showed a more marked increase in the Humber region.

When the children were separated into two groups, those who had a visit and those who did not, the group of children who had been on an industrial site visit were significantly more likely to state engineer as the person's job. Like the results in this study, Parvin (1999) found that the site visit had an impact on the children's awareness of the variety of jobs required in industry. However since her original study, more role-play has been introduced into the classroom sessions. This role-play highlights the different roles of people working in industry. For example the job of engineer is described as one of design and building of systems that can produce a product or achieve a result. This may explain why the site visit did not have as large an impact on the awareness of scientists in this study.

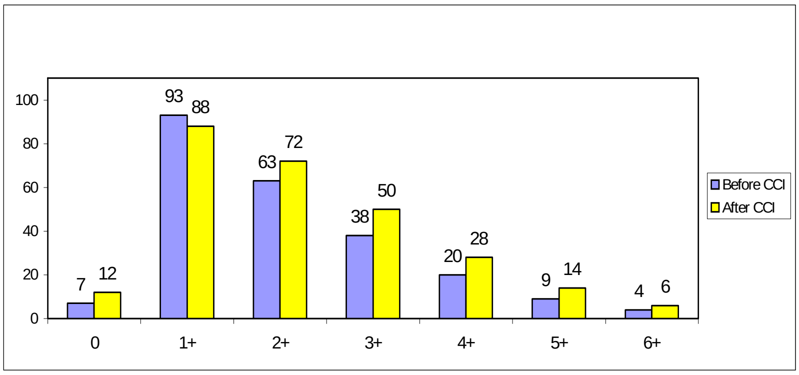
The children were more likely to omit drawing a picture after intervention (15% compared with 6%), and this may be because they felt they were repeating what they had done just a few weeks previously. The number of children drawing people who were categorised as 'other' did not change significantly.

These positive results provide strong evidence that the children learn about the importance of scientists and their roles on industrial sites. After the project, the children were significantly more likely to draw a scientist and significantly less likely to draw a materials handler.

5.2 Other jobs done in industry

The children were asked to list other jobs that they believed were done on industrial sites. The children listed up to nine different jobs before and after the project. The results are shown in Figure 5-2.

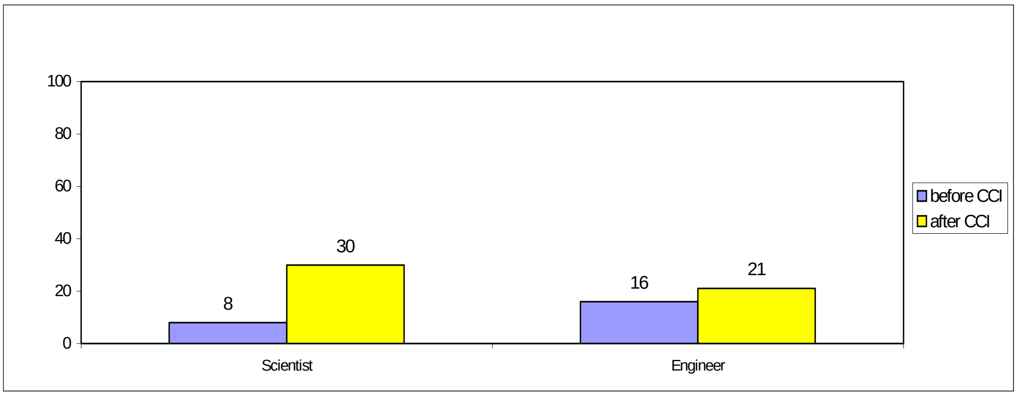
Figure 5-2: Number of jobs listed by children before and after CCI



The number of children listing two or more jobs was significantly higher after the CCI project compared to before the project. The project raised the children's awareness of the variety of jobs held in industry.

The number of children who listed scientist or engineer was investigated. The children who quoted scientist or engineer as the job of the person they had drawn were added to those who listed scientist or engineer in the list of other jobs. This then gave the total number of children who mentioned scientist or engineer in the questionnaire. The results are shown in Figure 5-3.

Figure 5-3: Proportion of children citing industrial scientists or engineers



The proportion of children who listed scientist as a job on industrial sites increased nearly four times from 8% to 30%. However, the proportion of children who listed engineer as a job on an industrial site did not increase as dramatically. The percentage of children who mentioned a scientist or engineer was 41%.

There was a huge increase in the children's awareness of scientists. This demonstrated that, before the project, many children were not aware of the roles of scientists in industry. After the project, nearly half of all the children mentioned that scientists or engineers worked in industry.

Other jobs were listed more frequently after the project, such as manager. In addition, the children were more specific about job titles, for example manager was expanded to give personnel manager, control manager and warehouse manager, which did not happen before the project. This is due to the role-play included recently in classroom sessions as well as the site visit. Conversely, jobs such as materials handler were listed far less frequently.

5.3 Chosen Job

The children were asked which job they would like to do on an industrial site, and give reasons. The complete list of jobs chosen is shown in Table 5-1. This demonstrates the variety of jobs that children had in mind.

Table 5-1: Industrial jobs chosen by children

Which job would you choose	Percent before	Percent after
Scientist	6	20
Engineer	2	7
Materials handler	23	11
Manager	16	15
None	8	5
Machine operator	5	5
Packing	5	3
Supervisor	5	1
Don't know	4	1
No response	4	4
Driver	3	4
Cleaner	2	2
Office	2	3
Computer	2	7

Miner	0	2
Other - technician, worker, cook, tour guide. First aid, security	11	10

Before the project, the most popular job chosen was 'materials handler'. Twenty-three percent of the children wrote down words describing this type of job such as 'moulding the plastic into shape' and 'mix the salt'. The only other job mentioned by more than 5% of the children was manager. The jobs that children were less likely to choose after the CCI project (i.e. a decrease of 4% or more) were 'materials handler', which decreased from 23% to 11%, and supervisor, which decreased from 5% to 1%.

There were three jobs that the children were significantly more likely to choose after the CCI project, and these were scientist, engineer and computer operator. An increase of 4% or more was statistically significant. The proportion of children saying they would like to be a scientist increased more than three fold from 6% to 20% after the project. The proportion of children saying they would like to be an engineer also tripled from 2% to 7%. The proportion of children who wanted to work on a computer also increased from 2% to 7%.

When asked about job preferences before the CCI project, in this study 4% left the question blank and 12% put 'none' or 'don't know'. After the project the same number of children left the question blank but significantly fewer put 'none' or 'don't know' (6%).

These results are similar to those seen by Parvin (1999). She also found that materials handler was by far the most common job chosen before intervention followed by manager, machine operator, packer and driver. She too found a dramatic decrease in the number who chose 'materials handler' and a rise in the number of children who chose 'scientist' after the project.

The results are extremely positive. The classroom sessions and the site visits increased the children's knowledge of the role of scientists in industry. The classroom sessions were designed specifically to link the science done in the classroom with that done by professional scientists on a site. These results provide clear evidence that the advisory teacher successfully conveyed the message, resulting in many children adding to their knowledge of scientists. After the project there was only a tiny minority of children that could not choose a job that they would like to do in industry.

The children were asked why they had chosen that job and the answers were extremely varied. The responses before the project were generally more simplistic. After the project the children had a better appreciation of the occupations in industry, and gave specific reasons for choosing them.

The use of the phrase 'get to' was used frequently, e.g. 'you get to drive forklifts'. It was taken to mean that the child would like to do that particular activity and therefore was classified under 'enjoy'. This quote illustrates the point:

"Scientist, you get to discover things and do a lot of things."

More children said they would like to do a job because it was fun or interesting after the project and fewer chose a job because it was easy. This is evidence that the children had a better appreciation of the jobs available in industry.

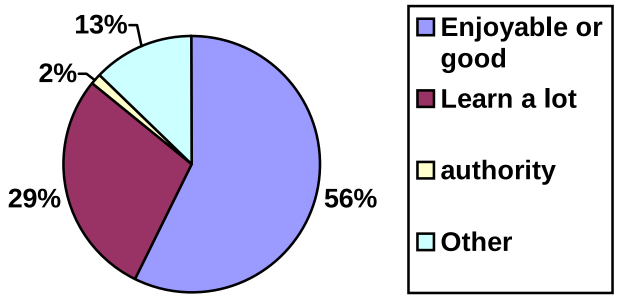
The reasons why scientist and engineer were their chosen jobs were investigated in more detail.

Before the project 19 children chose scientist as a job they would like to do. When asked why, the most common response was that they would enjoy it (7 children).

Other words used were fun, exciting or good. Other children said they would learn something (5 children). The remaining seven children each gave a reason such as they had previous experience, they would make money or they thought it would be easy.

After the project, 64 children chose scientist as a job they would like to do. The reasons why, are shown in Figure 5-4.

Figure 5-4: Reasons why scientist was a job preference



The reasons for choosing scientist were wonderfully positive ones with the most common one being that a scientist's job was enjoyable, fun interesting or good. Some quotes are provided below;

> *"Scientist, because it's exciting and fun and you get to try out new experiments."*
>
> *"Scientist, because it would be very interesting mixing chemicals."*
>
> *"Scientist, because it would be fun to help in industry."*

A large proportion of the children stated that as a scientist they would learn a lot. Examples are;

> *"Scientist, because you would be able to test everything and find out stuff and I just love science."*
>
> *"Scientist because I would get to find out about things and I've already done some experiments that scientists do."*

The 'other' category included wanting to be a scientist because it was safe or easy.

Before the project, 8 children chose engineer as a job they would like to do. When asked why, the most common responses were that they thought it would be enjoyable or fun (3 children), or they had previous experience (3 children).

After the project, 23 children chose engineer as a job they would like to do. The reason for 14 of the children was that it would be enjoyable. Three children said that it was because they would learn something. The remaining six children gave a range of answers such as money, helping people, previous experience and it being easy.

The image of scientists and engineers was an immensely positive one after the children had experience of the CCI project. After the CCI project, there was a huge increase in the number of children who wanted to be scientists, and a more moderate increase in the number of children who wanted to be engineers. The main reason was that it would be enjoyable, fun interesting or exciting.

5.4 Chapter summary

The children learned about the importance of scientists and engineers and their roles on industrial sites. After the CCI project the children were 3 times more likely to draw a scientist (12% compared with 4%). In addition, they were far less likely to draw a materials handler when asked to depict a person who works on an industrial site (14% compared with 35%).

The proportion of children listing scientist as an industrial job increased nearly four times from 8% to 30% which was highly significant. The number of children listing engineer as an industrial job significantly increased from 16% to 21%. Nearly half of the children (41%) stated that scientists and/or engineers worked in industry.

The proportion of children saying they would like to be a scientist increased three-fold from 6% to 20% after the project. The proportion of children saying they would like to be an engineer also increased three-fold from 2% to 7%. The children were much less likely to choose to be a 'materials handler' after the project. This reduced from 23% to 11%.

The project raised the children's awareness of the variety of jobs held in industry.

Jobs such as materials handler were listed much less frequently than before. After the project, the children were more knowledgeable about the variety of jobs carried out in industry and were much more likely to choose to be a scientist or engineer.

6 Children's views of science and industry

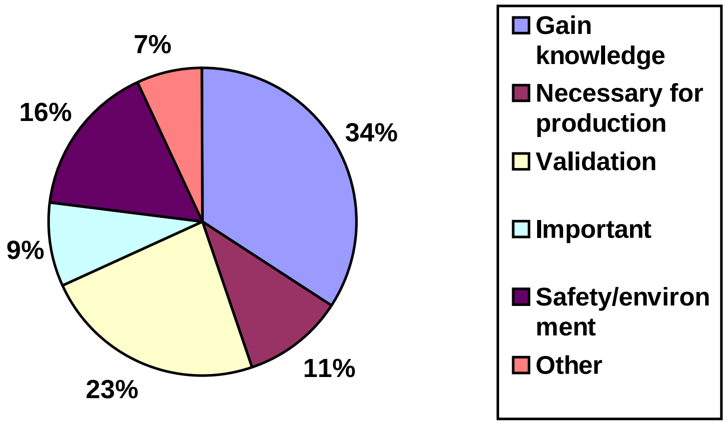
This section discusses the children's views of the importance of science and its relevance to industry.

6.1 Science tests

After they had completed the CCI project, the children were asked whether they thought that their school science tests had any relevance to the companies that manufacture the products they have been studying. 98% of the children said that they thought the tests were important. Only four children did not think the tests were important.

The children were asked why they felt the tests were important. The children gave many different reasons for their views. These are shown in Figure 6-1.

Figure 6-1: Reasons why children think science tests important to industry



A third of the children felt the tests were important for gaining new knowledge to make improvements to products or processes. For example, one response referred to new uses for plastic and another to identifying different types of plastic:

> *"They need to find out what plastics can be used for different things."*

> *"I think it's important because you need new ideas and when we did the investigations we provided them."*

A quarter of children mentioned testing of a product or process, which was categorised as 'validation'. For example:

> "To get an easier, quicker and more efficient way to get the salt."

> *"Because if something is not tested it might not be useful or suitable for the job."*

A significant proportion of children mentioned safety or the environment. For example:

> *"If the pipes get too hot they will burst."*

> *"Because it goes into streams where fish are living and it will spoil the river and the fish will die."*

Five percent of children said it was important but gave no further details.

Parvin obtained similar results. She found that knowledge of the product was the most important reason for carrying out science tests, in terms of how the product is made and its properties, uses and quality.

Nearly all of the children were able to formulate an opinion as to why scientific tests were important. It appears that the classroom lessons, which involved carrying out scientific tests, taught them the importance of science and it's links with industry. However, the fact that the question was not asked before the project means that no firm links to the project can be made. One recommendation, that has already been implemented, is to determine the children's views before the project, to provide stronger evidence of the project's effect on the children's views.

6.2 Chemicals (ingredients) and products

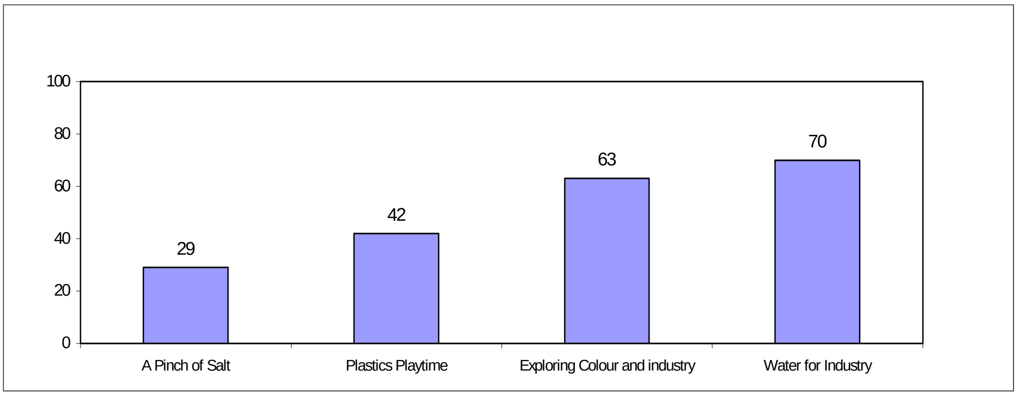
The children were asked whether they had learned anything about the way ingredients were used to make products. Due to the diversity of subject matter covered by each topic, the question was worded differently according to which topic had been completed. See Table 6-1.

Table 6-1: Questions asked for each topic

Topic	Question
Plastics Playtime	Are plastics made with the ingredients you expected?
Exploring Colour and Industry	Is dye made with the ingredients you expected?
Water for Industry	Is water used in industry in the way you expected?
A Pinch of Salt	Is salt made in the way you expected?

The answers varied by topic, which was statistically significant (Chi squared <0.001). When all the topics were analysed together, the proportion of children who said that it was not as they expected was 47%. The answers were evenly split between those that said it was not as they had expected and they had learned a lot about the process, and those that said it was as they expected and therefore they knew a fair amount already. The results were analysed by topic as shown in Figure 6-2.

Figure 6-2: Product made in the way expected, by topic



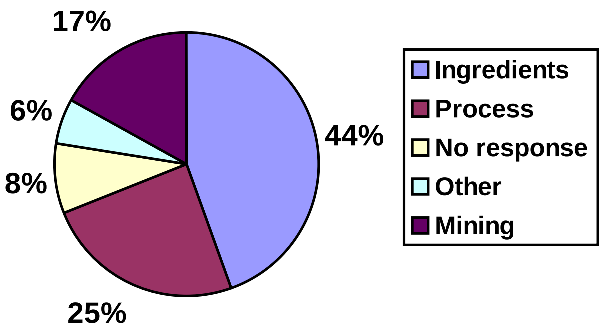
The children who had completed *Plastics Playtime* and *A Pinch of Salt*, were least likely to say that the product was made and used in the way expected. In these groups, less than half of the children said it was as they expected. This result is not surprising. The fact that plastic derives from oil is not well known by children.

In addition, many of the children thought salt came from seawater. In fact, this figure should have been smaller as many children stated that salt came from the sea in the pre-project questionnaire. When asked if it was as they expected after the project many said it was as they expected even when they had put the wrong answer originally. This may be because they felt they should have known and they did not want to admit that they did not know where salt came from. Many adults would probably feel the same! Alternatively, they might have forgotten what they originally thought.

Two thirds of the children who had completed *Water for Industry* and *Exploring Colour and Industry* (note that only 19 children completed *Exploring Colour and Industry*) said it was as they expected. These results reflect the fact that the process of how water is used is more familiar to children than how plastic is made and where salt is extracted.

When asked to elaborate on their answers, the children again, gave significantly different responses according to the topic covered. The responses for all the children regardless of topic are shown in Figure 6-3.

Figure 6-3: What the children had learned about industry



The most common responses from the children was that the ingredients used to make the product were not what they had expected at the beginning of the project. A large number of children also mentioned that the process was not as they expected. The remaining children mentioned mining, referring to salt, or other miscellaneous ideas such as ‘it was busy’ or ‘there was electricity’.

A child commented on *Plastics Playtime*:

> *“I learned that little bits of expanded polystyrene can turn into a shape by heating it up.”*

A child who had been involved in *A Pinch of Salt* said:

> *“I found out that salt comes from fragments of rock and how and what it is used for.”*

Two children who had been involved in the *Water for Industry* topic said:

> *“I found out that really useful chemicals went into a useful cleaning product.”*

> *“They used a lot of different ingredients than I thought.”*

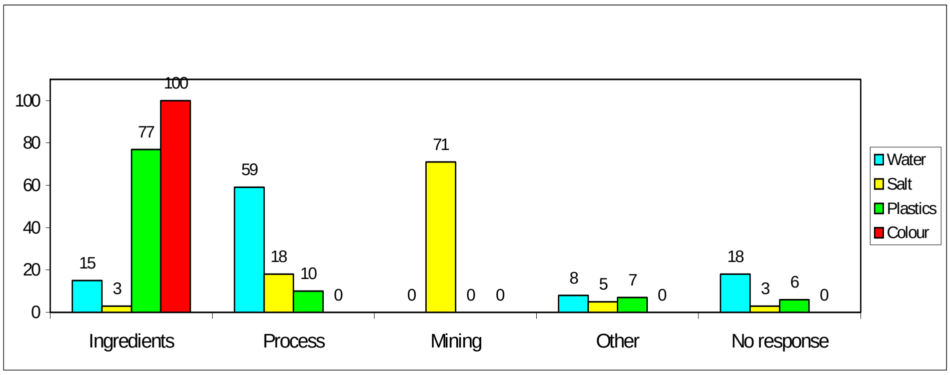
With mining and processing combined, more than half of the children said they had learned about different processes used. This was related to their topic, so if they had been learning about salt they mentioned the process involved in making salt. One child said:

> *"You don't just dig plastics out of the ground."*
>
> *"I found out that you had to crunch the rock salt and they had lots of big machines."*

Mining is discussed in more detail in the next section.

The results of the answers were separated by topic and are shown in Figure 6-4.

Figure 6-4: What the children said they learned by topic



As the graph shows, there are significant differences between the topics. The children involved in *Plastics Playtime* and *Exploring Colour and Industry* were most likely to say that it was the ingredients that were different from what they had expected. Only a minority mentioned that it was the process that was different.

The children involved in *A Pinch of Salt* and *Water for Industry* were more likely to say that it was the process involved, including mining, that was different from expected. The children found the ingredients familiar but admitted that they were not familiar with how salt was extracted, or water used in the processing of materials. Most of the children involved in *A Pinch of Salt* who mentioned that the process was different from expected, specifically mentioned the mining of salt. Many of the children thought that salt was extracted from seawater and learned that salt is extracted from rocks in the UK.

Half the children admitted that they had learned a substantial amount about how chemicals were changed into products, as they stated that it was not what they had expected before the project started.

6.3 Chapter summary

Nearly all of the children (98%) felt that scientific testing was important and relevant. There were many reasons why they held this opinion, the most common one being, new knowledge was gained for quality control or product development.

Just over half (53%) of the children felt that products were made from the ingredients they expected. Children who had completed the *Plastics Playtime* topic and *A Pinch of Salt* were less likely to agree with this statement than children who had completed the other topics. The children who claimed that it was not as they expected, expanded to say that it was either because the ingredients or the processes used to make the product were different from expected.

7 Children's reaction to the CCI project

In the post-project questionnaire, the children were asked to tick activities that interested them a lot, and cross activities that did not interest them. They were told they did not need to tick or cross every box. They were also asked whether they found the site visit interesting. The questions varied according to the topic so this section is separated into topic headings.

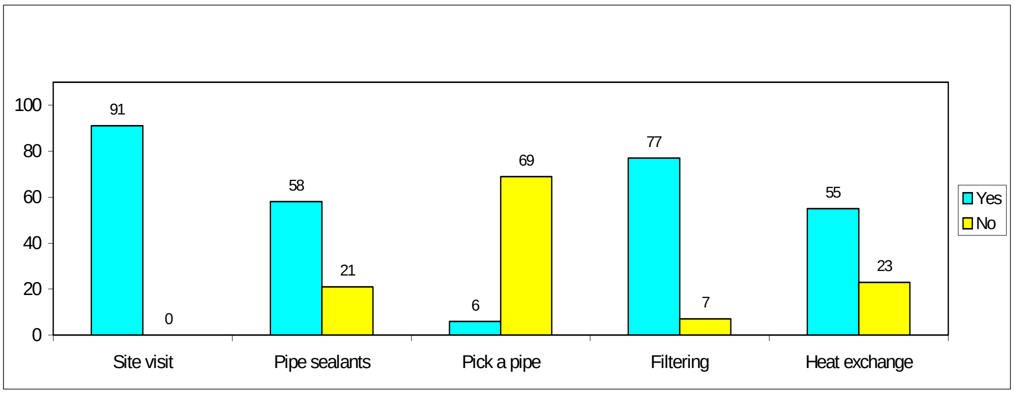
7.1 Water for Industry

The children were asked if they found the following activities interesting:

- Site visit
- Pipe sealants
- Pick a piece of pipe
- Filter fun
- Cool it (heat exchange).

The results are shown in Figure 7-1.

Figure 7-1: Children's interest in each *Water for Industry* activity



The vast majority of the children enjoyed the site visit and the remainder felt neutral rather than negative about the visit.

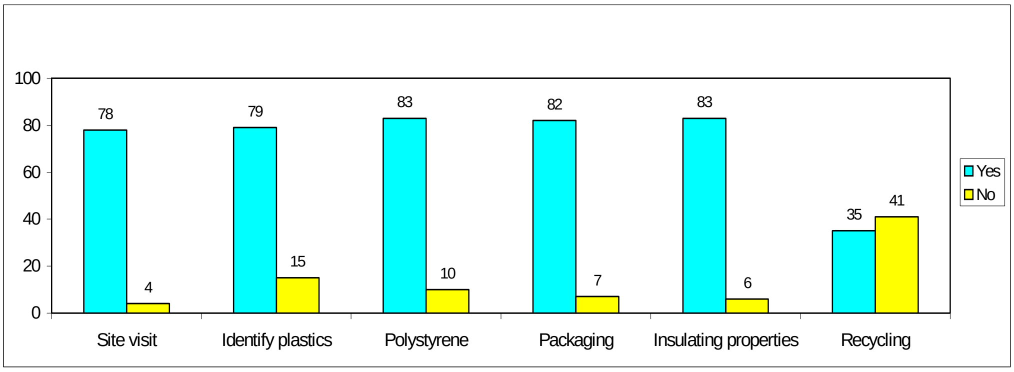
The children's favourite activity in the classroom was the activity on filtering. The children's least favourite activity for this topic was 'pick a pipe'. This may be because the activity involves observing metal and plastic pipes over a period of time rather than more hands-on practical.

7.2 Plastics Playtime

The children were asked if they found the following activities interesting:

- Site visit
- Identify four plastics
- Expanding polystyrene
- Materials for packaging investigation
- Insulating properties of plastics
- Recycling information.

Figure 7-2: Children's interest in each *Plastics Playtime* activity



The majority of the children enjoyed the site visit.

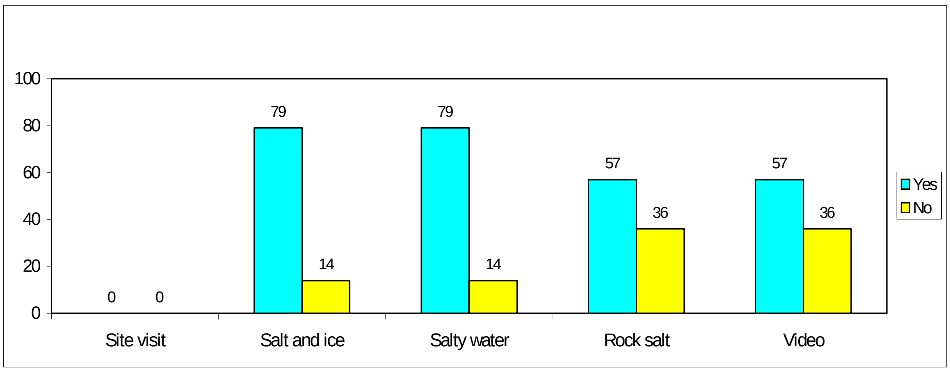
The vast majority of children enjoyed all the activities except receiving information on recycling of plastics. This may have been because many of them knew about it already. It is also one of the least practical activities.

7.3 A Pinch of Salt

The children were asked if they found the following activities interesting:

- Site visit
- Salt and ice investigation
- Salt from salty water
- Rock salt to table salt
- Salt industry video.

Figure 7-3: Children's interest in each *A Pinch of Salt* activity



There were only fourteen children who had done *A Pinch of Salt*, and none of them had been on a site visit.

The children's favourite activities were 'Salt and ice' and 'Salty water'. The children's least favourite activities were 'Rock salt' and watching the video on industry.

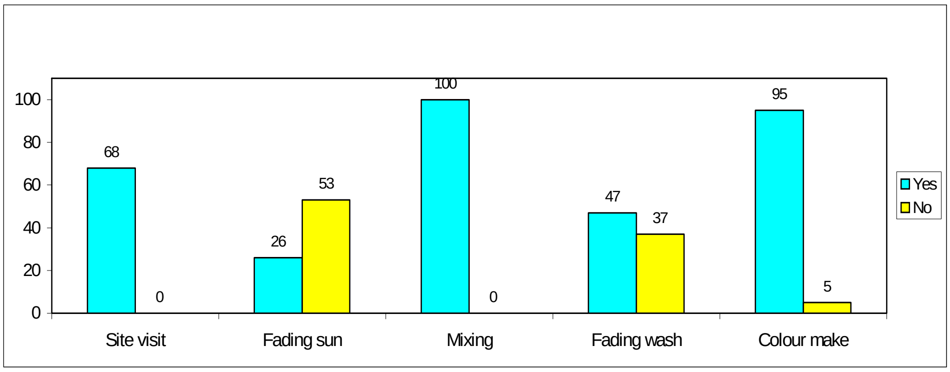
7.4 Exploring Colour and Industry

The children were asked if they found the following activities interesting:

- Site visit
- Fading in sunlight test

- Mixing and separating coloured inks
- Fading with washing test
- Colour making process
- Mixing powder paints.

Figure 7-4: Children's interest, in each *Exploring Colour and Industry* activity



There was feedback from nineteen children. The majority of the children enjoyed the site visit.

The most popular part of the topic was the colour making process and the mixing, both highly practical activities which virtually all the children said they enjoyed.

7.5 Chapter summary

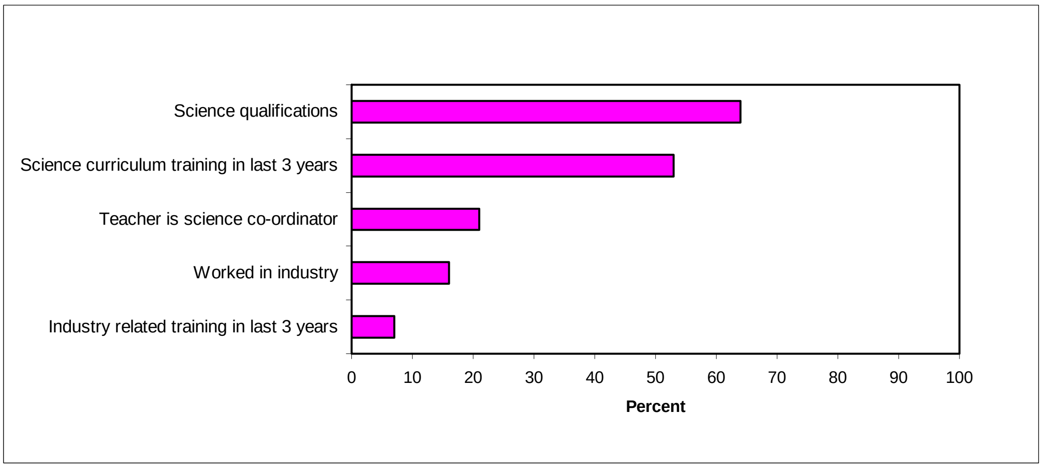
All the topics contained activities that were interesting to the vast majority of children. The most popular activities tended to be those that met one or more of the following criteria. They were practically-based, contained information that was new to the children or enabled results to be obtained quickly. Those requiring observations over time were less popular. These are: Pick a pipe (water), fading in sunlight (colour) and fading with washing (colour).

8 Evidence to support the provision of training

8.1 Summary of training and qualifications

The teachers were asked about their science qualifications and what training they had undergone in the past three years. The graph below summarises the results.

Figure 8-1: Training and qualifications



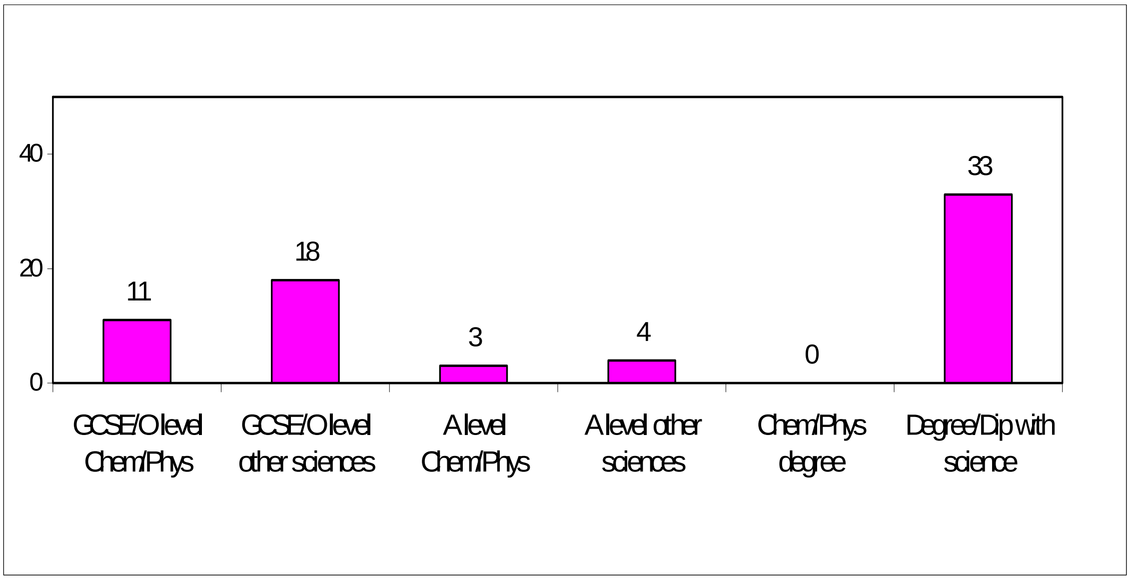
Compare with other regions.

8.2 Qualifications

Approximately a third of teachers (36%) did not have a GCSE/O level in Science, the minimum qualification considered to be needed to teach primary school science.

Those that said they did have a science qualification gave the answers shown in Figure 8-2. If a teacher stated that they had experience of chemistry or physics this was coded as 'Chem/Phys', if a teacher mentioned biology or general science this was coded as 'other science'. Some teachers gave more than one answer so they might have said that they had A level science and a science degree.

Figure 8-2: Science qualifications



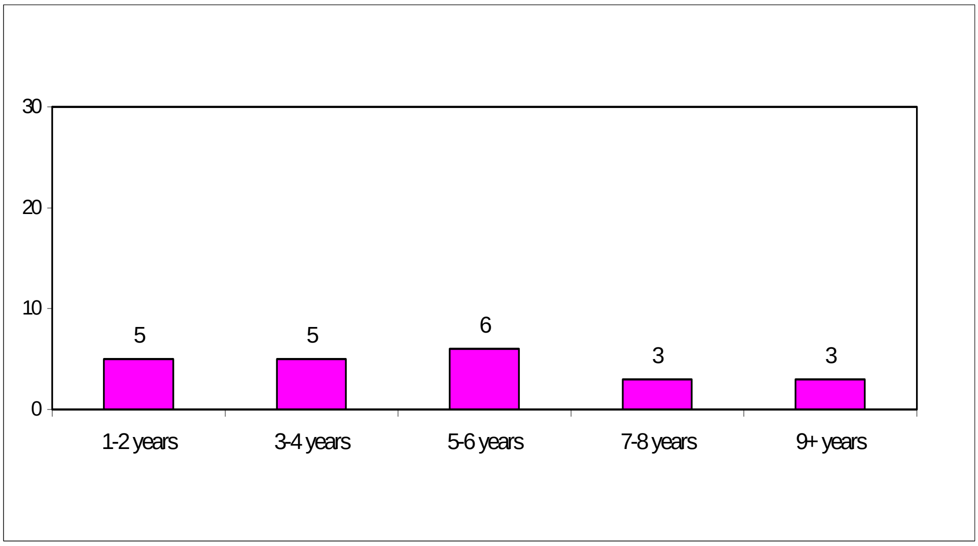
In the previous study, 57% of the teachers did not have any science qualifications. That was considerably higher than in this study and may be because there were proportionally more teachers who had been teaching for more than ten years in the previous study. Therefore, more teachers in this study may have trained with a science specialism, as part of their degree in education. However, there is concern that the question may be too open-ended on the questionnaire and so this is being re-phrased for future data collection.

This study has not shown that having a degree leads to an increase in knowledge or improved attitudes towards industry. Teachers who have been teaching a long time are less likely to have a degree and more likely to have a teacher's certificate. However, there is no evidence that these older (and more experienced) teachers are less knowledgeable or more negative about the chemical industry.

8.3 Work experience

Teachers were asked how many years they had worked in industry. The results are shown in Figure 8-3.

Figure 8-3: Number of years in industry



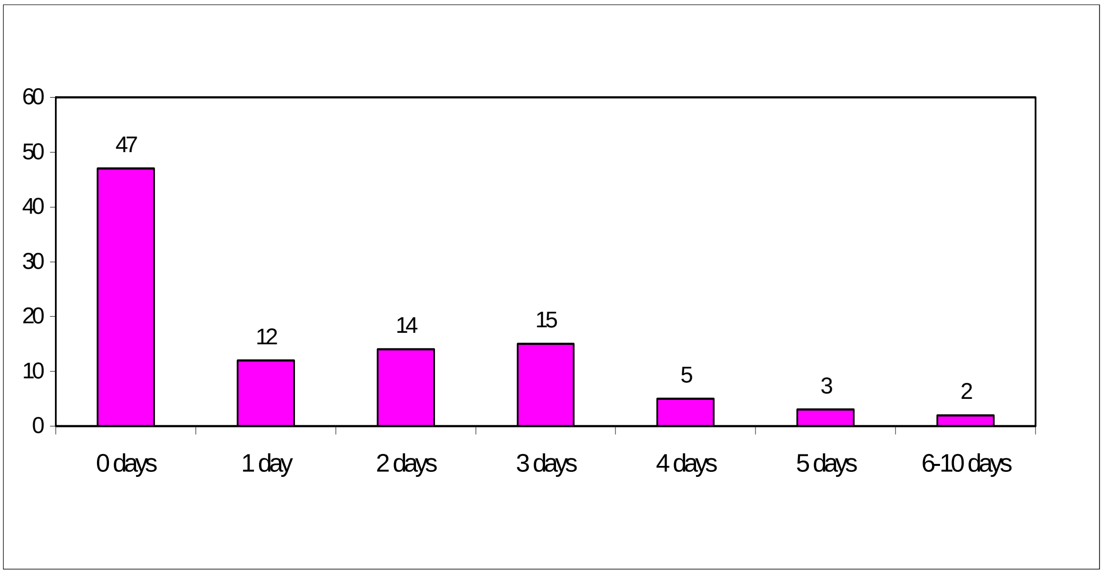
In this study, 16% of the teachers had experience of working in industry, ranging from one to seventeen years.

This figure is similar to the results of the previous study where 14% of teachers had worked in industry. Teachers with industrial experience would be expected to have more knowledge and more positive attitudes towards industry and this is explored in later sections of the report.

8.4 Training

Teachers were asked how many days of science training they had undergone in the last 3 years. The results are shown below.

Figure 8-4: Number of days of science training



Half the teachers had undergone some science training in the last three years. The following table compares this study with the previous study, (Parvin, 1999).

Table 8-1: Number of days of training

Number of days	Percent this study	Percent Previous study
0	47	45
Total 1-3	41	20
Total 4-6	9	18
Total 7-30 days	2	18

The most common response was one, two or three days training over the last three years. Most teachers had odd days of training except for two lucky teachers who had two weeks of training! All teachers have five training days per year where they must cover all aspects of the primary curriculum. It may seem surprising that half of the schools are 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.

In the previous study there was quite a large group of teachers who had completed a DfEE course lasting more than 8 days, which explains the high figure of 18%. In the 1990s there were government funded science-training courses which were 20, 10 or 5 days which explains why a smaller number of teachers had two or more weeks of training in this study.

Only 6 (7%) of the teachers had undergone industry-related training. This result was the same as the one obtained in the previous study. Industry training is much less common than science training. Three teachers had a day's training, and one teacher each had 2, 3 and 7 days training respectively. There are probably far fewer courses available in industry training to teachers. Many teachers may not know of anything available. Providing this information to teachers may increase the proportion of teachers taking this type of training or make them more aware of organisations such as Educational Business Partnerships (EBPs) that offer work placements to teachers.

Science co-ordinators are much more likely to have science training experience but only 18 (21%) teachers stated they were a science co-ordinator. The number of years that each teacher had been a science co-ordinator is shown in the table below.

Table 8-2: Number of years as science co-ordinator

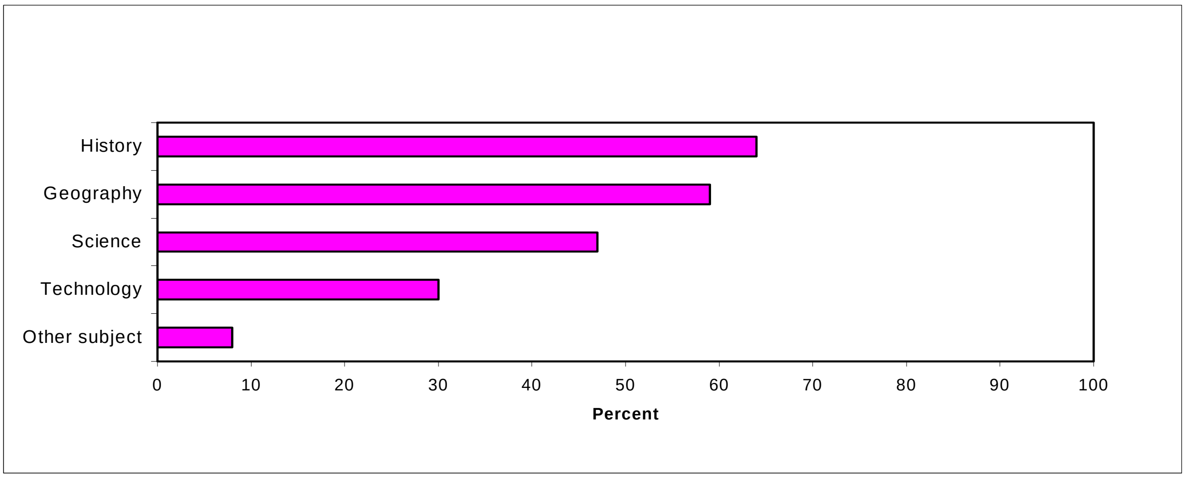
Number of years	Percentage
0	83
1-2	9
3-5	3
6+	6

Some teachers may keep the role of science co-ordinator for several years rather than rotating it round the school so that training may always fall to the same few teachers every year.

8.5 Teaching of industry within the curriculum

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

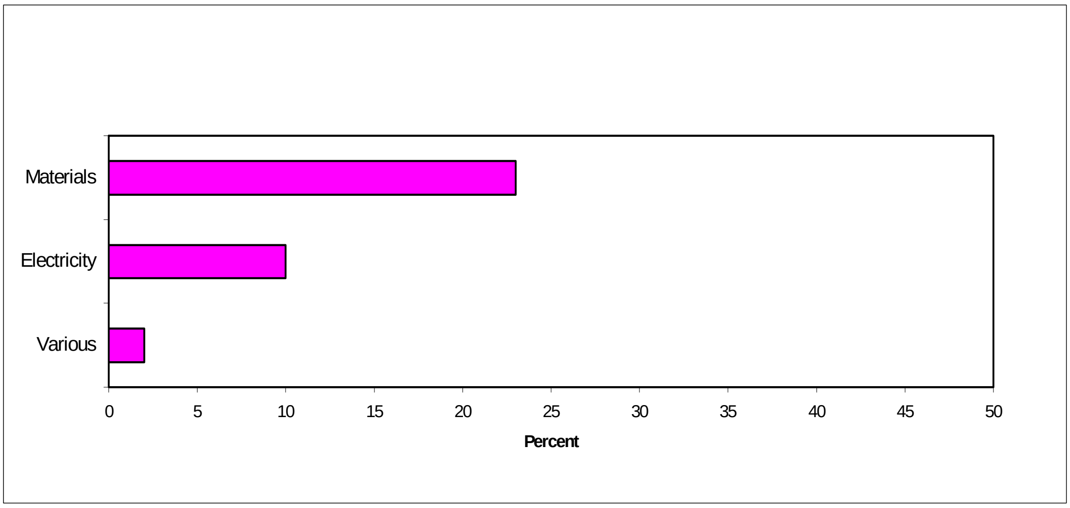
Figure 8-5: Subjects covering industry in the curriculum



It is gratifying to know that approximately half of the teachers covered industry in the science curriculum compared with 12% from the original study. However this still left 53% of teachers sampled who did not cover aspects of industry in their science curriculum.

The most common place to cover industry was in history. A closer look at the subjects covered within science, history and geography is taken next.

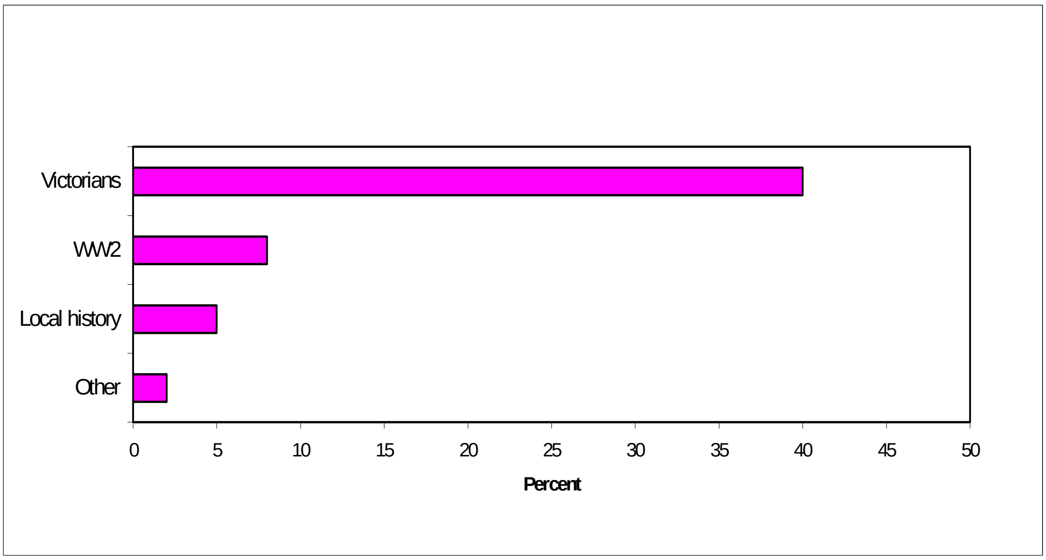
Figure 8-6: Science



Industry was most often mentioned when covering the 'materials' topic in science. The range of science topics was very limited. However, this was an improvement in the number of teachers from the previous study covering industry in the science curriculum. Teachers who mentioned pollution were categorised under the topic in geography to obtain a total of the number of teachers discussing industry and pollution.

Industry was included in a variety of history topics.

Figure 8-7: History

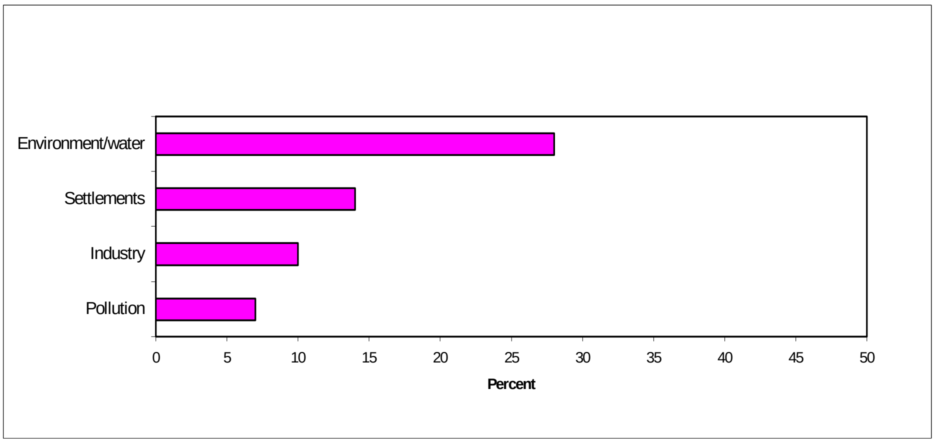


The Victorian era was the most commonly cited topic where industry was covered. This gives a view of industry as it was a hundred years ago if not balanced with more modern views, taught in science and technology. Teachers may feel more knowledgeable and confident teaching about industry as it was in the Victorian era rather than as it is now.

In the previous study the most common link with industry was through local history rather than the Victorian era, but the question was asked in a slightly different way so it is difficult to compare the two groups of teachers. A small number of teachers listed additional subjects under history, including mining, electricity, transport and explorers. These were coded 'other' in Figure 8-7.

Geography is a wide-ranging subject with many topics. Some of the topics were grouped together. Pollution was kept separate, but environment and water were amalgamated as the difference between them was quite blurred.

Figure 8-8: Geography



The number of teachers who listed pollution as a topic was quite small, however teachers who listed environment or water may have also discussed pollution. Water or the environment were included in the geography curriculum by a third of all teachers.

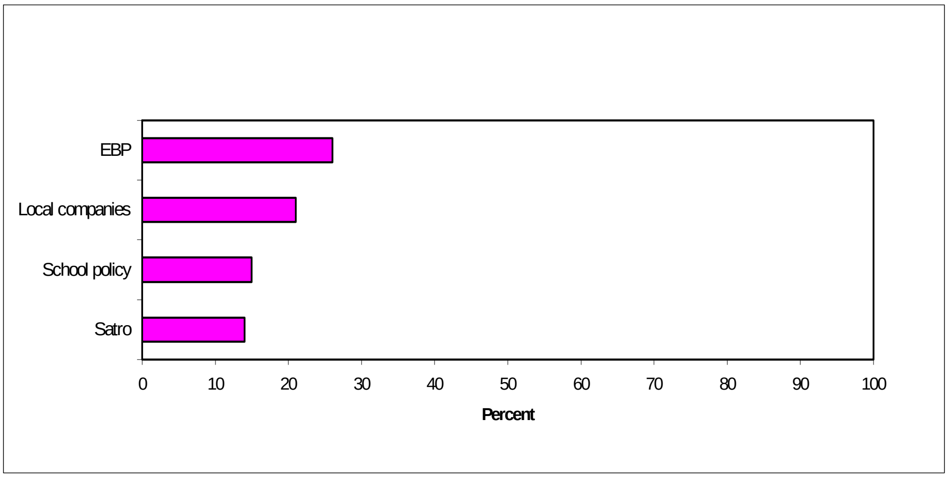
Topics in technology included a variety of topics such as marketing, packaging, communication and moving parts but no obvious large group. 70% of teachers said they did not teach about industry in technology. Six teachers listed other subjects in which they covered industry. These were personal health and social education, literacy and maths.

One of the 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 how it is relevant to the science curriculum taught in schools now.

8.6 Industrial links

Teachers were asked about their links with industry and the results are shown below. It should be noted that SATROs no longer exist and Setpoints are relatively new, having started in late 2001.

Figure 8-9: Schools with industrial links



One in seven (15%) schools had a policy on industry links. Schools could be involved with a number of organisations such as Education Business Partnership (EBP), SATRO and Setnet that promote links with industry. Of the links available EBP was the most common, with a quarter of schools stating they had links of this type. In another region, local companies were the most common link. The EBP might have been the most common in this region because the advisory teacher had an office in Liverpool.

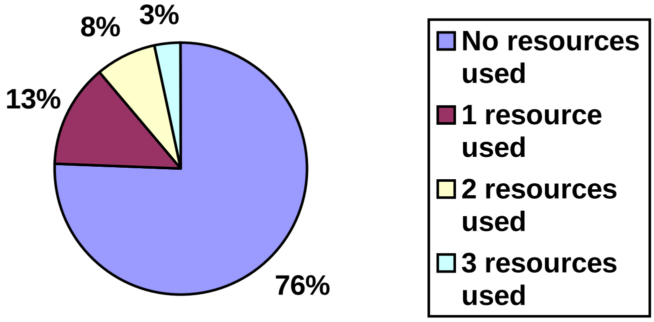
There were eight teachers who said their school had links with other companies and these included Nethervalley partnership and BNFL. The majority of schools did not have existing links with industrial companies.

One of the aims of the training was to encourage teachers to forge links with companies and perhaps learn about the benefits to the school of having these links.

8.7 Use of resources by teachers

The teachers were asked whether they had used any resources from industrial sources. The results are shown in Figure 8-10.

Figure 8-10: Use of resources



Three-quarters of the teachers did not use any resources sponsored by or developed by the chemical and allied industries. The most common reason given for not using resources was that teachers did not know about them. More than half of the teachers said they had not seen any resources. Only 2 teachers said that they did not use the resources because of company propaganda. Attitudes towards resources are discussed further in chapter 11.

Teachers seemed to be more likely to know about resources if they had any industrial links, which was confirmed by the data. If they had no links, only 15% of teachers had used resources, compared with 37% if they had any of the links mentioned. This was statistically significant using a Chi squared test (p=0.019).

The industrial resources that the teachers had used were wide ranging. There were very few resources that more than a few teachers had used. The most common resources were Energy Matters by Shell and educational materials from BP and ICI.

8.8 Chapter summary

Nearly half of all the teachers had not had recent training in science and 36% had no science qualifications, yet they were expected to teach science in the primary curriculum.

Training in industry was even less common (7%). It's no surprise that teachers did not feel confident to teach this subject.

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

A few teachers had links with industry and 15% had a school policy on industrial links. Three-quarters of all the teachers had not used any resources developed by industry. Teachers who had links with industry were more likely to use industrial resources to teach primary science. Many teachers may be unaware of the relevance of teaching science through industrial context.

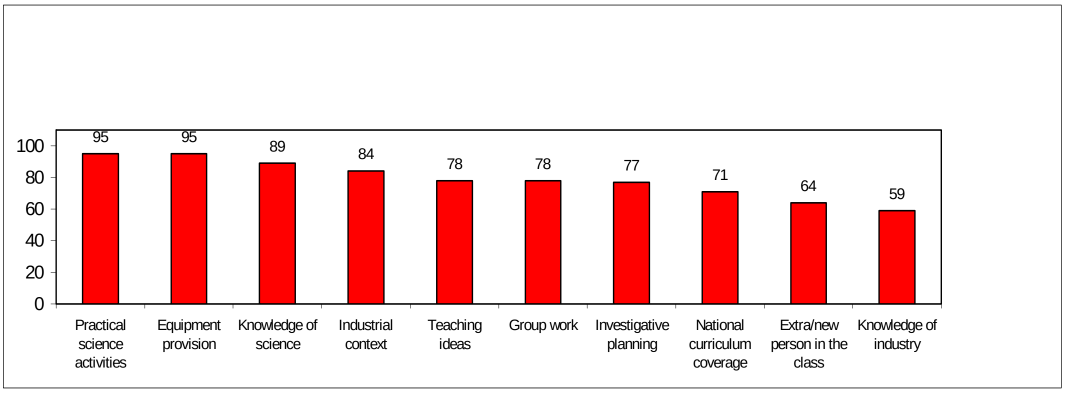
In summary, this training was very much needed by primary teachers to increase their confidence, knowledge and motivation of teaching science using industrial contexts.

9 Teacher's reaction to the CCI project

9.1 Strengths

Teachers were asked to indicate which of the following categories were strengths of the session

Figure 9-1: Strengths of the CCI project



Virtually all the teachers indicated that the practical science activities and equipment provision were strengths of the sessions. Knowledge of science and industrial context were also rated very highly by over 80% of teachers.

The categories least likely to be indicated as strengths of the project, were knowledge of industry and extra/new person in the class.

It was interesting that teachers were more likely to mention the provision of equipment and practical science activities as strengths. Teachers obviously feel they need more equipment and support in this area. It is possible that other aspects of science are easier to learn from books about the science curriculum but the practical investigations that compliment this are more difficult to master.

Another interesting factor was that knowledge of industry was rated as a strength much less often than knowledge of science. Many teachers may have seen the visit as the industry side of the training and the classroom activities as the science side of the training. Yet 'industry context' is very high and the advisory teacher's knowledge of industry has an impact on the success and use of industry context.

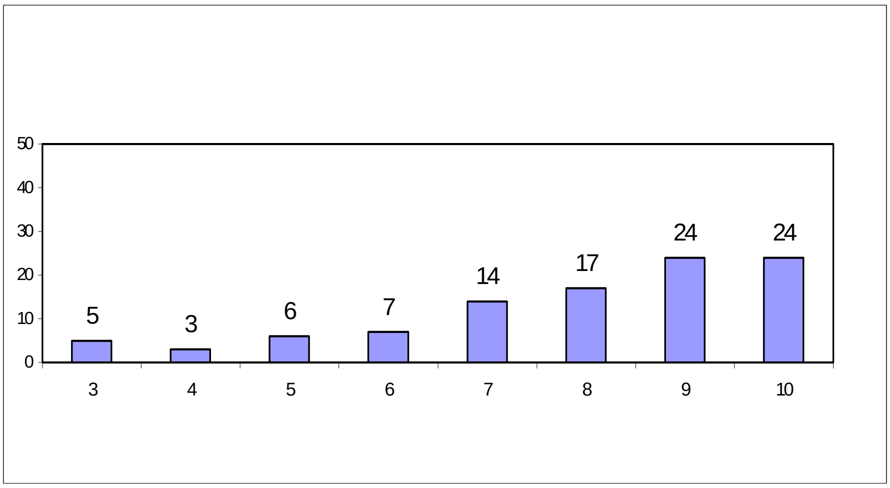
Eight teachers also included other strengths. These included well planned and well presented sessions, good assessment ideas and likeable and child friendly teacher. Some teaches gave more than one strength.

In the previous study, the wording was different for the question on strengths of the project. Teachers were asked to list the strengths of the session rather than tick the relevant boxes. The list of strengths on the new questionnaire is based on the responses to this open-ended question in the previous study.

The two main strengths in the previous study were industrial context and expert knowledge. Given a list, the teachers would tend to tick more categories than if they had to write them down spontaneously so it is difficult to compare the results of the two studies. Practical science was third on the list in the previous study so is rated even higher in the current study.

The mean number of strengths selected was 8 out of 10. A quarter of all the teachers ticked all 10 strengths. Three-quarters of the teachers ticked seven or more categories as strengths. See Figure 9-2 for a breakdown of the results

Figure 9-2: Number of strengths out of ten



This is a strong indication of how highly the training was regarded. Teachers were extremely enthusiastic about the project and felt it had been a valuable use of their time.

A few quotes are included below as examples of how the teachers received the sessions:

"I was very impressed with the amount the children were able to learn and the way it was taught. The different resources were great and the experiments and investigations made the children very enthusiastic."

"An excellent project, from which the children gained a lot. Extreme enthusiasm was created and a sense of learning and purpose throughout. The children also had lots of opportunities they would not otherwise have had."

"Expectations were far exceeded, pupils understand a subject they had difficulty with before."

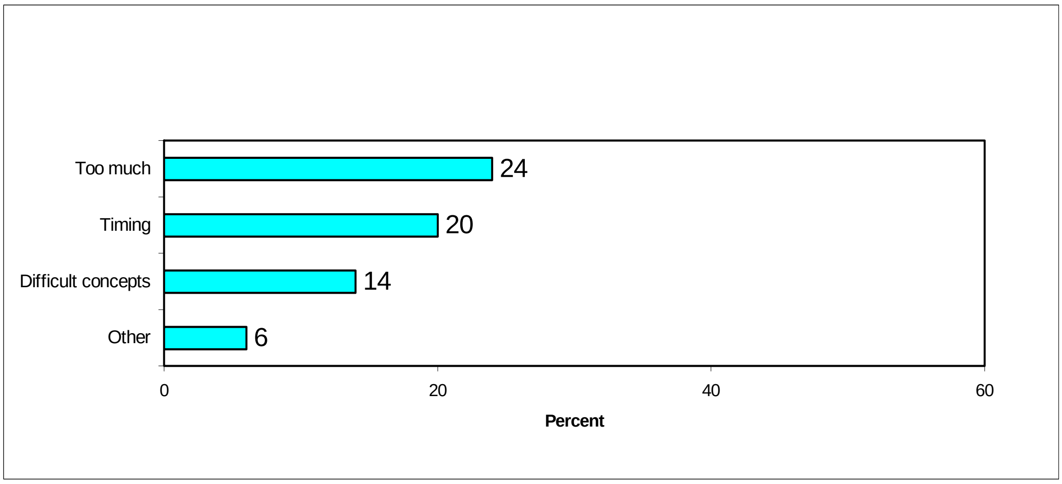
"Project was fantastic, more aware of resources within industrial contexts."

"I have taken part in many varied projects in my ten years of teaching and this project is the only project that hasn't stressed me out because it was so well organised by Sue Andrews that it was foolproof. It provided exciting and challenging opportunities for my class. They were always eager to take part in the classroom sessions and raved on about the site visit – a very enjoyable experience all round."

9.2 Weaknesses

The teachers were asked whether they thought there were any weaknesses to the sessions. The results are shown in Figure 9-3.

Figure 9-3: Weaknesses of training



The number of teachers who indicated there were weaknesses was quite small. The most common weakness was that too much was included in the project. In the previous study, 33% had said there was too much to cover so this figure has been reduced. The sessions had been changed to reflect this but a significant number of teachers still thought there was too much in the sessions. This is already being considered by the team of advisory teachers and strategies to deal with it put in place.

A smaller number of 14% cited that some of the concepts covered were difficult to grasp. This is the same as in the previous study where 13% of teachers had said there were aspects that were difficult in the sessions.

The number of teachers in the previous study who said they had problems with timing was very similar to this study, although actions have been taken to offer all schools freedom of choice of when they do the project. It is therefore unlikely that the proportion can be reduced much further as it is due to the unavoidable problem for teachers of shortage of time.

Other weaknesses were as follows. The number of teachers stating each weakness is included in brackets: Too much choppy change (2), too many children (2) and not enough visual sessions (1).

The teachers, who were teaching year 6 only, were significantly less likely to cite 'too much to cover' or 'difficult concepts'. Only 7% of year 6 teachers said that there were difficult concepts, compared with 14% of teachers of younger age groups (Chi squared test, $p=0.014$). In addition, only 18% teachers of year 6 classes thought there was too much to cover compared with 29% of teachers of younger age groups. The latter result was not statistically significant for this region, however when all the regions were amalgamated it was significant.

Newer teachers were also significantly more likely to say there were difficult concepts. The teachers who said they thought there were difficult concepts had been teaching for an average of 8 years, compared with 14 years for teachers who did not think there were difficult concepts (T-test, $p=0.03$). In the previous study, it was found that many teachers thought there were difficult concepts in the science curriculum as a whole.

9.3 Chapter summary

The feedback from the training was overwhelmingly positive. The sessions were of an extremely high standard that was highly rated by all the teachers. It was obvious that the teachers and the children found the whole experience extremely enjoyable and a valuable use of their time.

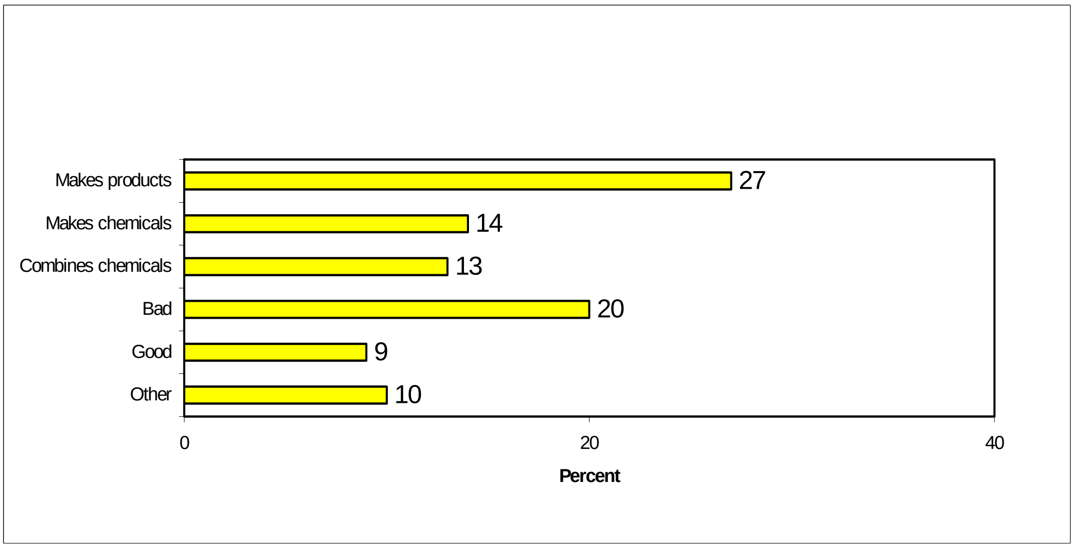
Few weaknesses were mentioned, by a minority (45%) of teachers.

10 Knowledge and skills of teachers

10.1 Knowledge of the chemical industry

An attempt was made to measure the teachers' existing knowledge of the chemical industry. The teachers were asked to describe the chemical industry and the results are shown below

Figure 10-1: How teachers described the chemical industry



The most common response was that the chemical industry made things or chemicals. Only 13% of teachers were able to say that chemicals were combined to produce another product. This was seen as the most informative answer.

Twice as many teachers said negative things about the chemical industry (20%) as said something positive (9%). However, only half the teachers said only negative things and nothing positive about the chemical industry (11%). The remaining 9% who were negative, also said either neutral or positive things about the chemical industry. This is a low figure compared to the 34% obtained in the previous study. The number of teachers who feel there are negative things about the chemical industry is much higher, as will be seen later in the report, when teachers are asked a closed question about pollution.

A few teachers did not answer the question and instead wrote how the chemical industry related to the curriculum, and this was categorised as 'other'.

In the previous study, this question was asked in an interview and half of the teachers did not feel they could answer at all. By asking it in a questionnaire teachers were more willing to say something albeit quite simple statements, such as, makes chemicals or negative statements such as, dirty and smelly. In the previous study, none of the teachers said that chemicals were combined, but in this sample 13% of teachers gave a more comprehensive answer.

Knowledge of the chemical industry was quite poor. Although everyone knew of its existence – no one said they did not know about the chemical industry, only a minority of teachers could provide any detail about the industry.

On the one hand many teachers had no idea what the industry did but on the other hand they were quick to say it was polluting the environment. This points to the fact that any knowledge they have attained has not come from scientific sources likely to give a more balanced view. Parvin found that information was more likely to come from the media and other sources that are far more likely to discuss the negative aspects of the chemical industry, than what the chemical industry actually does.

A few quotes from teachers are provided below in answer to the question ‘Describe the chemical industry’:

“Dirty and smelly.”

“Chemical industry is an essential pre-requisite for modern life, which unfortunately can have serious health effects on some of its workers and contributed greatly to the pollution of our planet.”

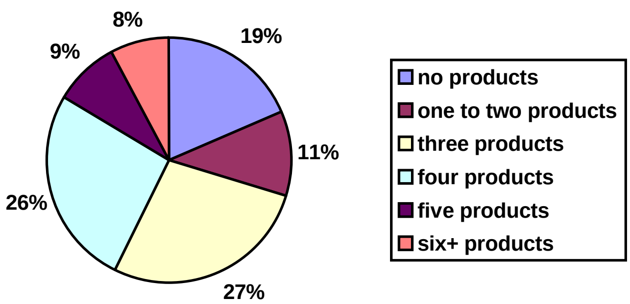
“Living close to places like Stanlow refinery, I consider the chemical industry as essential to our country’s economy and everyday existence.”

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 science. This could be achieved, not just with class-based training, but also with a visit to industry. This would give them an opportunity to experience the chemical industry first hand, which would help them to develop a more accurate view of the chemical industry.

10.2 Products of the chemical industry

Teachers were asked to list products of the chemical industry of which they were aware. The number of products they listed is shown in Figure 10-2.

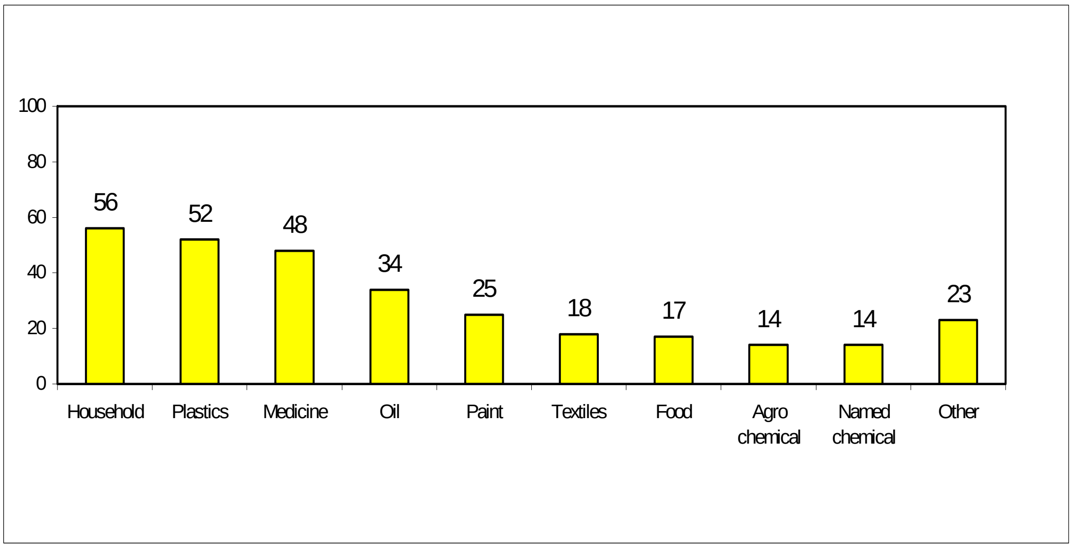
Figure 10-2: Products of the chemical industry



The mean number of products that teachers listed was three but one in five teachers did not list any products at all. Approximately a quarter of the teachers said that the chemical industry produced lots of products or they put a couple of products and then wrote ‘etc.’ Some teachers may have known more products than they listed, but only wrote down three or four of them.

A breakdown of the products that teachers listed is provided in Figure 10-3. The category ‘household’ included cleaning products and cosmetics.

Figure 10-3: Products listed



Household products were the most commonly cited products, closely followed by plastics and medicines, all mentioned by more than 40% of the teachers.

About a third of teachers mentioned oil and a quarter mentioned paint. Fewer than 20% of teachers mentioned textiles, food, agrochemicals or named chemicals.

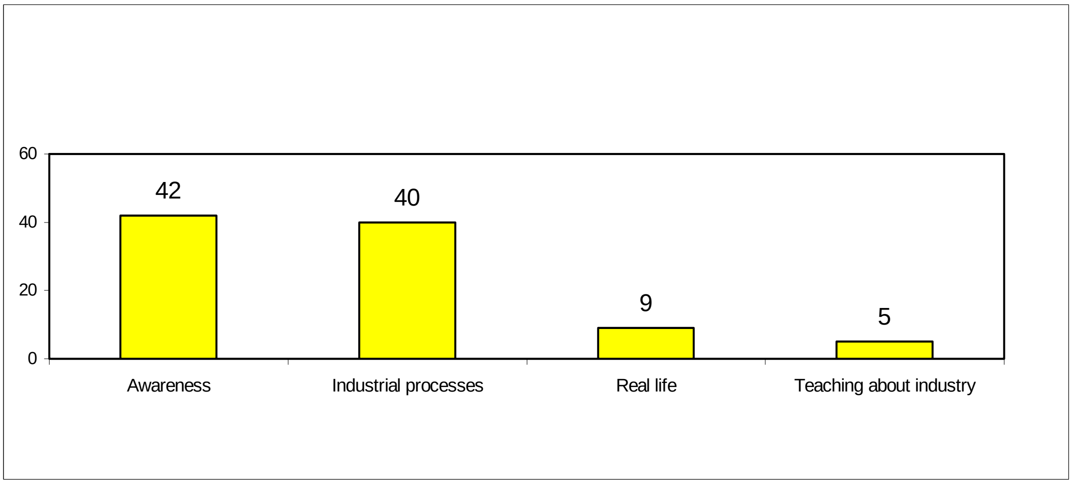
In the previous study, plastics were named most often by teachers, but only by about half the teachers. Oil, paint and medicine were all mentioned in similar numbers in both studies.

Different regions may have different industries, which may mean that teachers have different products uppermost in their minds when answering the question. In regions where there was a lot of industry you would expect teachers to list significantly more products.

10.3 Industrial knowledge gained through the training

Teachers were asked whether they had learned anything about industry, and what they had learned. The results are shown in Figure 10-4.

Figure 10-4: What teachers learned about industry



80% of the teachers stated that they learned something new about industry during the training sessions. The most common response was that they had increased their awareness of industry. The second most common response was learning about industrial processes.

These were overwhelmingly positive aspects of industry with no teachers saying they had learned negative things.

In particular, the visit to industry taught the teachers things about industry, with industrial processes or awareness about industry being the most common things learned. The quotes below are examples of increased awareness of industry:

"The need to work as a team - everyone in the factory has an essential role to play."

"Finance is also a major consideration when making choices."

"Learned that chemical plants are not as dirty, smelly and dangerous as I thought."

"Chemical industry is a cleaner, safer place than factories used to be."

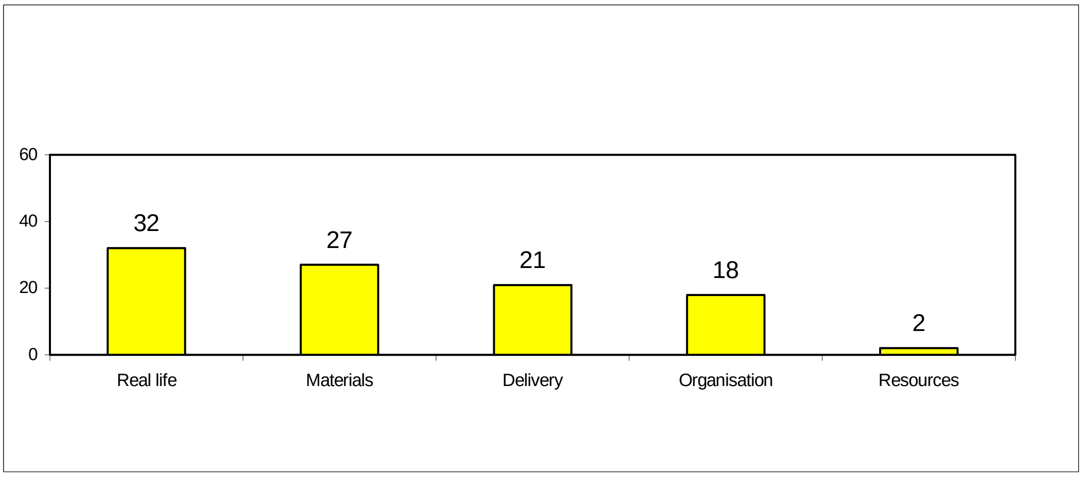
Other teachers learned about the processes. Quotes are provided below which answer the question 'what did you learn about industry?':

> *"Opportunity to view industrial processes."*
>
> *"I had no idea about the processes gone through in order to make the end product."*

It was not possible 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. We only know whether they thought they had learned about aspects of industry.

Teachers were also asked what they had learned about science. The wording in the original questionnaire was what had they learned about *teaching* science. The results are shown in Figure 10-5.

Figure 10-5: What teachers learned about science



67% of teachers stated that they learned something new about, science, or teaching science.

If they were asked about *teaching* science, most of the teachers answered 'materials', 'delivery' or 'organisation', and if teachers were asked about science, they were more likely to put 'real life' or 'materials'. 'Materials' refers to the area of the National Curriculum, Materials and their properties.

More teachers thought they had learned about 'materials and their properties' (Sc3) than any other area of science. The second most popular answer was 'delivery or planning of science lessons'. Many teachers felt that they could use some of the methods used by the advisory teacher to improve their own science classes. A smaller number of teachers also mentioned that they learned how to improve their own use of resources.

Some quotes are included below, but unfortunately, because the wording was changed, it is difficult to draw any firm conclusions from this question:

"Excellent ideas for assessment and group organisation during practical sessions."

"It reinforced how organised and well prepared the teacher needs to be for a successful lesson – the teacher was excellent."

"Having a wealth of resources to use within each group can make a huge difference to their learning."

"New slant on experiments – very difficult to come up with simple enough experiments for some difficult concepts – saw some excellent experiments which used everyday materials and could be easily used in classroom next year."

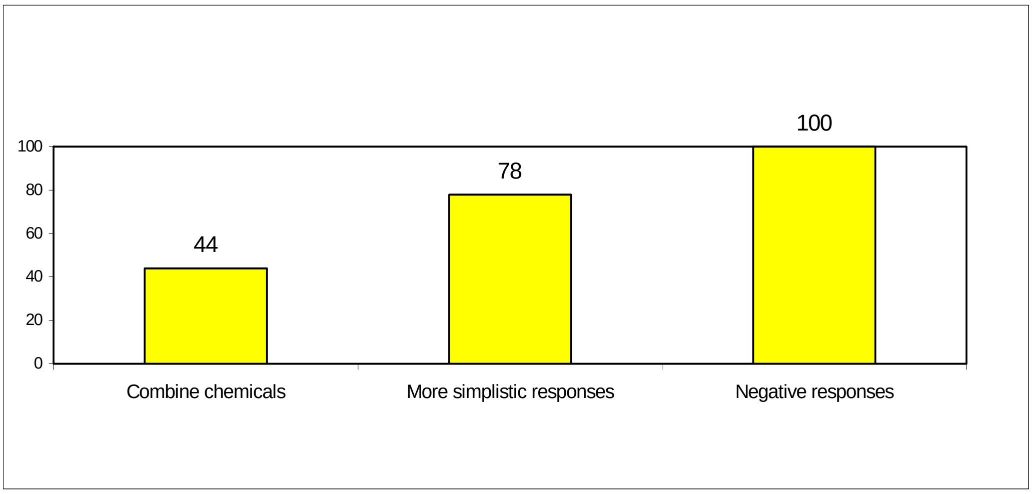
In future, the wording of the question is to be changed in order to help measure the learning outcomes of the teachers. The question on learning about industry is not possible to quantify but it is useful to know what the teachers have learned.

10.4 Differences in industrial knowledge

88% of the teachers said that they learned something about industry or teaching science, or both. We can take this a step further to investigate whether the teachers who did learn something, differ in any way from the teachers who said that they did not learn anything.

An attempt has already been made to assess teachers' knowledge about the chemical industry before the training. This was done by categorising the answers into negative, simplistic or more thorough responses. Using the assumption that those with a good knowledge of the chemical industry were less likely to say they had learned anything about science or industry, the responses from the three categories were compared. Conversely, those with poor knowledge would be expected to say they *had* learned something during the training. The results are shown in Figure 10-6.

Figure 10-6: Teachers who stated they learned something about industry



The results show that teachers who were negative at the start of the project were much more likely to state that they had learned something about industry. All the teachers who had made negative comments about industry at the beginning of the project said that they had learned something about industry during the project. In contrast, less than half of the teachers who gave the most informed response when asked to describe industry said that they learned something about industry by the end of the project. These figures were highly statistically significant with $p=0.009$.

The associations between those teachers learning about science and other factors were explored to see if other factors affected whether teachers felt they had learned something or not. It appeared that recent training in science or industry did have a positive effect. Teachers who had not received training in science or industry over the last 3 years were more likely to say that they had learned something about science or teaching science (97% compared with 81%). This was statistically significant with $p=0.025$.

These results provide some evidence that asking teachers what they know about the chemical industry can be a measure of their knowledge. In addition, asking whether they have learned anything seems to provide an indication of how useful they found the CCI project.

Teachers who have had recent training in science or industry may be more knowledgeable about teaching science than teachers who had had no recent training.

10.5 Chapter summary

A minority of teachers were able to say with any detail what the chemical industry does but most were able to give examples of what the chemical industry produces. This is not a surprising answer. It is a difficult question to answer unless involved directly in the chemical industry.

88% of teachers said they had learned something about industry or science, or both, after the training. Many teachers gained a more balanced view of the chemical industry after completing the training.

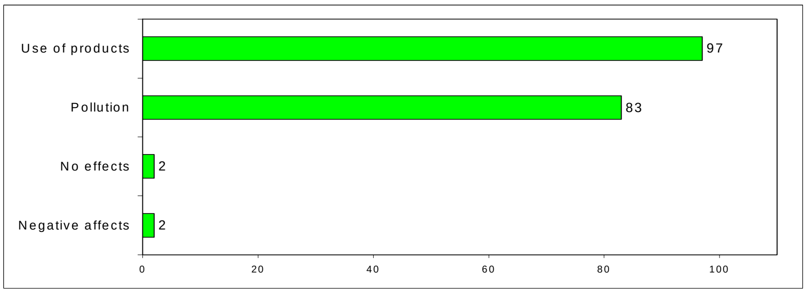
Teachers were more likely to say that they had learned something about industry if they were more negative about the chemical industry at the start of the project. In addition, teachers who had not received recent training in science or industry were more likely to say that they had learned about science or teaching science. These are probably teachers who had less knowledge of industry before the project.

11 Attitudes of teachers

11.1 Attitudes towards industry before the training

Teachers were asked their views on how industry affected their lives.

Figure 11-1: Teachers views on industry



Nearly all the teachers thought that the chemical industry was necessary to produce the ‘every day’ products that we need. Most teachers (83%) also felt that there was a negative aspect of the chemical industry, namely pollution.

Only two teachers said that the chemical industry had no affect on their daily life and two teachers said that the industry had other negative effects (apart from pollution). Five teachers mentioned other positive effects such as production of cars and carrying out of research.

One of the reasons that so many teachers thought that pollution was directly affecting their lives, may be that they did not think that industry is doing enough to reduce pollution. The teachers’ attitudes towards the chemical industry would be expected to be more positive if they thought that a lot was being done to keep pollution to a minimum. The teachers realise that the industry produces essential items so they do not feel that there should not be a chemical industry.

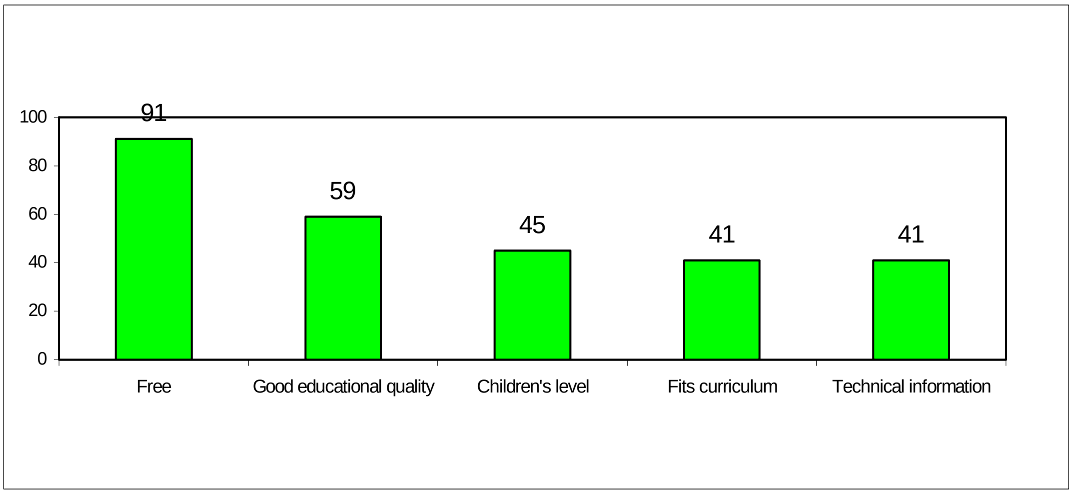
The attitude towards the chemical industry is quite similar to the attitude towards cars. Most people are willing to accept the risk of pollution if it is giving back something very useful. If prompted, most people would say that cars are pollutants but when asked to talk about cars, it’s probable that only a small number would say spontaneously that they are pollutants. This is what can be seen in this study. In the last section on knowledge, only 20% spontaneously cited pollution as a concern in the chemical industry, but when prompted 83% of the teachers said that they are affected by pollution.

In the previous study, this question was asked as part of an interview rather than a closed question as in this study, so the answers cannot be compared. It is interesting that only a small proportion of the teachers in the previous study cited effects such as pollution, giving a profile of answers similar to the earlier question on what they knew about the chemical industry.

11.2 Attitudes towards resources before the training

Teachers were asked whether they had used resources by industry and 22 (24%) said that they had. See Figure 11-2 for reasons why teachers used industrial resources. The results are displayed as a percentage of those that have used such resources.

Figure 11-2: Teachers' reasons for using resources from industry

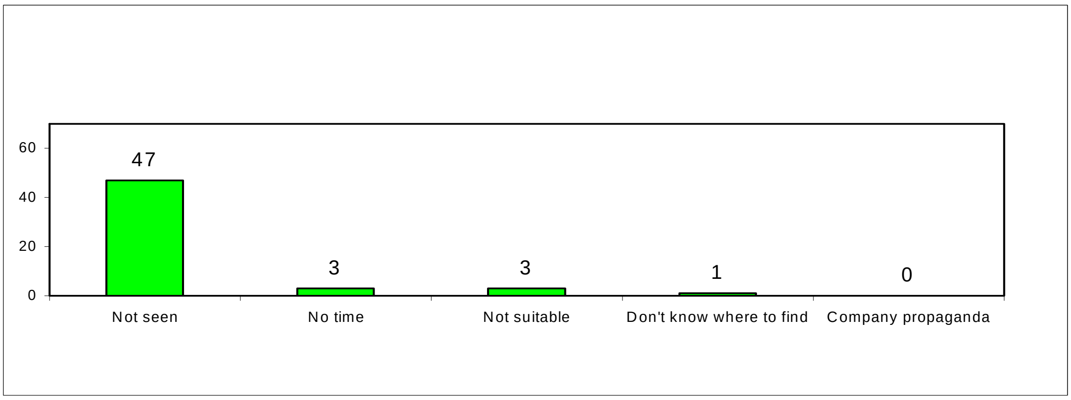


The most common reason for using resources from industry was because they were free, followed by them being of good educational quality. Less than half of the teachers also said they used them because they fitted the curriculum.

In the previous study teachers said they would only use industrial resources if they fitted the teaching programme and they were of good educational quality, and the teachers in this study gave very similar answers.

The 68 teachers (76%) who had not used industrial resources were asked for reasons why they had not used them.

Figure 11-3: Teachers' reasons for not using resources



The reason the majority of teachers had not used resources was because they had not seen any or they did not know where to find any. Only a very small number of teachers had not used them because they did not like them or they were not suitable. These results were very similar for all the regions involved in the study.

Teachers have limited time to assess the suitability of educational materials so it would be very difficult for teachers to search for information when they do not know where to find it.

Some teachers may not have thought that useful information was available from companies for such a young age of children. Other teachers may have decided that there was enough information in the curriculum already. Many teachers may not have known the benefit of these materials in putting the science curriculum into context.

Teachers may be more likely to use industrial resources if another teacher in the school passes them on, or a company sends copies of the resources to the teacher. Another source of information could be science training, either by the teacher or the science co-ordinator in the school

Quotes below are examples of what teachers said about using resources before the training.

"Did do when first teaching but find NC very prescriptive leaving little time to undertake wider ranging topics."

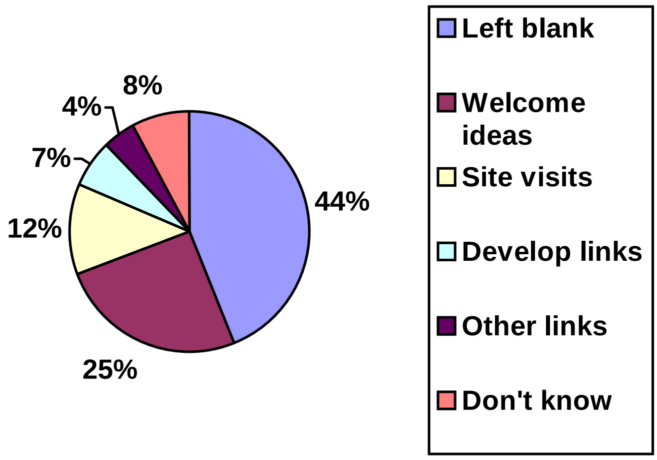
"Although we have been provided with resources, little time for reviewing resources means that most are stored not used."

To summarise this section, many teachers had not used industrial resources but this was usually because they had not seen any rather than because they did not like them. There could be many reasons for this but from the comments made by teachers the most common reason seems to be time restraints.

11.3 Attitudes towards industrial links before the training

Teachers were asked what types of links they would like to have with industry before being involved in the CCI project.

Figure 11-4: Suggested links with industry before the CCI project



Half the teachers either did not answer the question and left it blank or said they didn't know about possible links with industry. Some of the teachers wrote down specific links such as site visits. A further 25% said they would welcome ideas. The other links cited were, visiting speakers, practical experience, and community links such as sponsorship.

Half of teachers said they wished to create a link, which suggests that teachers would like to learn more about how industrial links could be beneficial to them. Some quotes are shown below in response to the question regarding desirable links:

"Things that might influence children's thinking, ideas and perception of science and industry."

"Links which support/extend our curriculum areas."

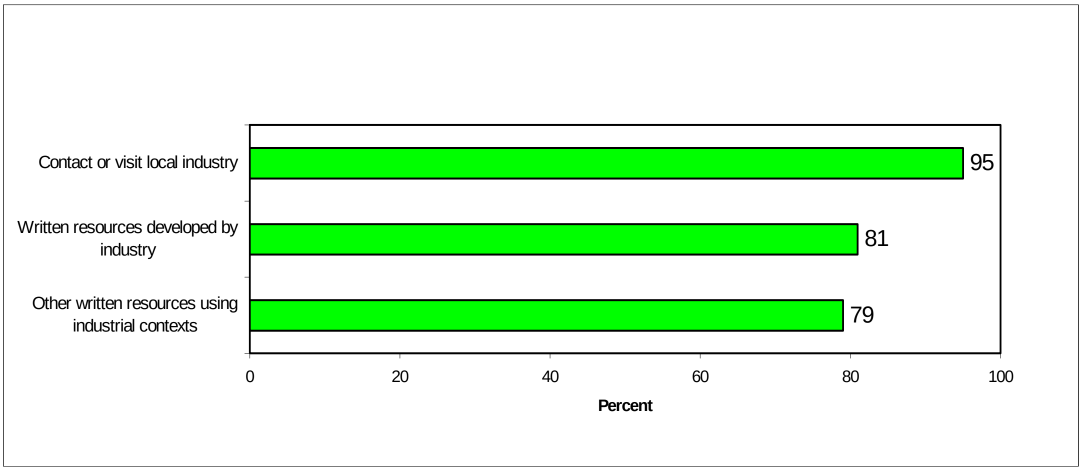
"Regular visits to companies to make scientific notions real for children in KS2. Meeting with 'Work related learning' to create more links."

The attitudes of teachers towards links were quite positive. Many teachers had specific ideas for links and others would be willing to listen to ideas put to them and therefore learn about how industry helps contextualise the science curriculum.

11.4 Attitudes towards resources and links after the training

After the training sessions and visit to industry, teachers were asked about their views on using industrial resources in the future.

Figure 11-5: Use of resources after the CCI project



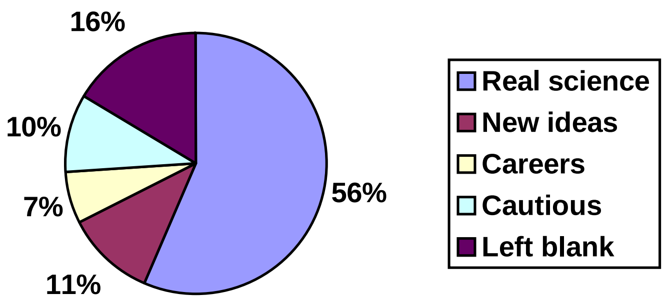
Virtually all the teachers stated that they would like to have contact with local industry and 81% of teachers would consider using resources developed by industry or other sources.

Before the training, the teachers' attitudes towards resources and the chemical industry were quite positive. About a quarter of the teachers had used resources and this was mainly for their good educational quality. The reason teachers had not used industrial resources was mainly because they had not seen them rather than because they had been consciously avoiding them! Most teachers thought there were positive and negative aspects of the chemical industry and about half of the teachers thought they would like links with the chemical industry.

The response of teachers after they had the training sessions was extremely positive compared with the half who said they wanted links before the training. This positive attitude towards industrial resources was likely, therefore, to be due to the project. The number of teachers who wanted links with industry increased by about 30%.

The teachers were also asked why they would or would not consider using industrial resources. The results are shown in Figure 11-6.

Figure 11-6: Reasons for using industrial contexts



More than half of the teachers stated that the reason for using industrial contexts was that it made science real; it brought science to life. The teachers realised that teaching the children science without giving it a context made it more difficult for the children to understand the relevance of science.

An interesting point is that when the teachers were asked for their reasons for using industrial resources, before the training, none of them gave 'real science' as a reason. Maybe, it was because, before the CCI project, the positive aspects of teaching science within an industrial context had never been emphasised.

Before the project, few teachers were aware of the need to relate science to the 'real world'. By the end of the project, the teachers were more likely to say that resources made science more real than any other reason. This indicates a radical change of teachers' views to teaching the science curriculum as a direct result of the CCI project.

A further 11% of teachers gave other reasons for using industrial contexts such as it gave them new ideas for teaching science other than real life context. These reasons included comments like; it made science fun, and, it made science interesting. 7% of teachers also mentioned that using industrial context, especially visiting industry, teaches children about possible career paths.

1 in 6 teachers left this section blank but this was not because they were negative about using resources. Many teachers who answered 'yes' to all the parts of the question still left the section blank. Below are some of the quotes from teachers talking about industrial resources:

"Link to industry makes science come alive."

"Visual resources or especially first hand experience always produce better learning outcomes than just spoken explanation by a teacher."

"Primary school children enjoy science and it is important for them to know that their school work has direct relevance to real life."

"Good contacts made – NEXPRESS have invited us again next year."

"I would like to involve industry once a year linked to topics covered – they were extremely helpful."

"They (the children) actually see the real life applications and begin to see importance of working together in a team."

"Several of the children expressed an interest in working in the factory. The visit was fantastic, not only did the children learn about science and the industry but they were shown positive male and female role models in employment."

"Making the link between classroom practice and industry made the whole project and concepts so much more relevant and real to the children."

"Children were given a positive, more modern and attractive view of industry."

"The manager was friendly and welcoming. The activities available were appropriately matched to the needs of the children."

1 in 10 teachers were more cautious and said they might use industrial contexts in the future. Despite the training sessions, this small group of teachers was still not convinced of the relevance of using industry in teaching primary science. Quotes from teachers are included below:

"Past experiences have generally shown a watered-down version of what is offered to secondary school pupils."

"The materials/visits need to be very carefully planned to the exact needs of the class."

"If the materials were as pupil friendly and as well prepared as those by Mrs Andrews then the teaching preparation for the teacher would be a lot easier."

"Where the content linked to National curriculum recommendation i.e. materials and their properties."

"I would visit industry if visit planned for me yes, but very little time is available for planning visit."

Time is frequently mentioned as an obstacle to using an industrial context. In the previous study the teachers were revisited after a year and many had changed their teaching practices but 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 hard problem 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.

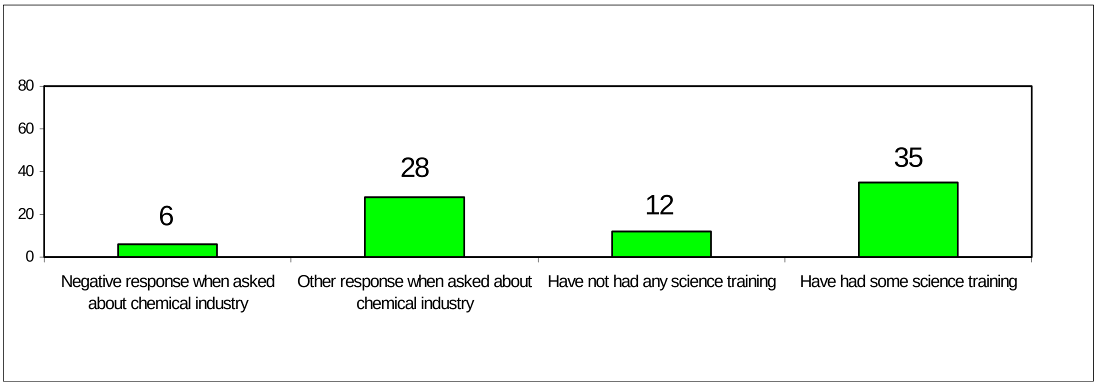
Teachers only make time to forge links with industry if they are very motivated to do so. Such as, if there is a strong link with the national curriculum and/or they have existing interest and knowledge from previous qualifications or training.

11.5 Differences in attitudes towards industry

Further analysis was carried out to explore whether attitudes towards industry were associated with any other factors. The aim was to find out whether some teachers were more likely than others to use industrial resources.

Teachers who had given only negative responses about industry in the pre-questionnaire were compared with teachers who had given other responses. In addition, teachers who had undergone training were compared with teachers who had not had any training. The results are shown Figure 11-7.

Figure 11-7: Teachers who had used industrial resources



The teachers who had recent training, in either science or industry were three times more likely to have used industrial resources. This was statistically significant using a chi squared test. The reason for this may be that teachers who have had recent training learned more about the industrial resources available to them. In addition, the teachers who were more positive about the chemical industry were more than four times more likely to use industrial resources. Science co-ordinators were not significantly more likely to use resources in this study.

It may be that the teachers who are more likely to use resources are also more likely to have training and it's more a measure of personality. These would be teachers who were more positive about industry. Those teachers who were more negative about industry may also be less likely to look out for training courses in science or industry, as well as industrial resources.

11.6 Chapter summary

Before the training, when prompted, nearly all teachers thought there were positive and negative things about the chemical industry. The general view was that the industry is necessary for the things we use but many teachers also referred to pollution as a mandatory by-product of the manufacturing of these products.

Before they had any 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 24% of teachers who had used resources were most likely to say that they did so because they were free and of good educational quality.

Teachers who had undergone recent training in science or industry were more likely to use resources about industry. Teachers who were more positive about industry were also more likely to use resources.

The change in attitudes towards industrial resources that occurred during the training was impressive. 95% of all the teachers thought that visits would be useful and 81% of teachers wanted to use resources developed by the industry. This was very positive when compared with 24% of teachers who had used industrial resources and 48% who had wanted industrial links before the training. The training sessions had helped the teachers realise the relevance and importance of using different resources about industry.

It has been shown that this training has significantly changed the attitudes of teachers. At the beginning, the teachers were mostly neutral about industry with a small group of teachers who were extremely negative about the chemical industry.

After the training, the majority of teachers were extremely positive towards the chemical industry with a small group of teachers that were more sceptical. Some of the initially negative group were also in the sceptical group, but not all. Therefore, the vast majority of teachers had a better attitude towards the chemical industry after the training.

12 Conclusions

12.1 Children's data

The CCI project involved many children from primary years 4 to 6, the majority in year 5. 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. There was a very wide choice of industrial sites for the children to visit in this region.

After participation in CCI, children were able to produce significantly improved and more detailed drawings of the external and internal images of industry. This demonstrates their acquired knowledge of industry, including their increased awareness of the processes involved in making products.

Data showed that after the project, the children were more likely to think that industrial sites were safe, and have fewer people than expected, which is a more accurate reflection of how industry is today. In addition, children were much less likely to say that industrial sites were noisy and hot.

Children who had a site visit were more likely to obtain a balanced view of industry. However, children who had not had a visit were shown images of industry using video and photographs, and for many children, this was enough to learn about and demonstrate positive views of industry.

The classroom and site visits provided ideal environments to learn about the roles of scientists and engineers. Many of the children, whether they had a visit or not, clearly learned about the importance of scientists and engineers and their roles on industrial sites. After the CCI project the children were much more likely to draw a scientist or engineer and significantly less likely to draw a materials handler, or packer.

When given a choice, children chose scientist and engineer as jobs they would like to do in industry much more often after the project. The proportion of children saying they would like to be a scientist was 4% before the project and increased to 12% after the project.

The project raised the children's awareness dramatically, of the variety of jobs held in industry. After the project, nearly half of all the children mentioned that scientists and engineers worked in industry. Jobs such as 'materials handler' were mentioned far less frequently.

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.

The children really enjoyed the project as demonstrated by the proportion of activities the children recorded as interesting. The activities enjoyed the most were those that were practical, contained new information and/or gave quick results.

12.2 Teachers' data

The reaction to the training was extremely positive. Most teachers had nothing but praise for the training received. Most of the teachers had not had recent training in science and a third had no science qualifications. Training related to industry was even less common.

It was also found that teachers were more likely to teach about industry as part of the history or geography curriculum, than the science curriculum. Many teachers were not aware of the relevance of teaching science with an industrial context to make the subject more interesting and relevant. Three quarters of the teachers had not used any resources developed by industry, usually because they did not know about them.

Teachers increased their knowledge of the chemical industry and of science.

Only a small number of teachers were able to say with any detail what the chemical industry does at the beginning of the project. By the end of the training nine out of ten teachers felt they had learned something about industry or science. Many teachers gained a more balanced view of the chemical industry as a result of taking part in the project.

Before the training, when prompted, nearly all teachers thought there were positive and negative things about the chemical industry. The general view was that the industry is necessary for the things we use but many teachers referred to pollution as a mandatory by-product of the manufacturing of these products.

Before they had 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 reason they gave for this was that they had not seen any.

A significant change in attitudes occurred towards industrial resources because of the training. Nearly all teachers thought that visits would be useful compared with 48% of teachers wanting links before the training. After the project, 81% of teachers wanted to use resources developed by the industry compared with 24% of teachers who had used resources before the training. After the project, the majority of teachers were extremely positive towards the chemical industry.

12.3 Summary

The CCI project clearly achieved its main goals. The children and teachers were far more knowledgeable about industry and the role of scientists after the project. Children were able to depict industrial sites more accurately and the processes involved inside industrial sites. Teachers felt they had learned about teaching science and were more likely to use industrial resources. Teachers and children's perceptions of industry, including safety, improved. Far more children were aware of the roles of scientists and engineers, and aspired to working in these professions in the future. Teachers and children had become much more aware of the link between what happens in science lessons in the classroom and what happens on industrial sites. Finally, teachers and children had enjoyed the project immensely.

13 Appendix 1: Questionnaires

- Background
- Pre-questionnaire
- Post-questionnaire

14 Appendix 2: Points system for analysing drawings

The post-intervention drawings were compared to pre-intervention and points awarded or deducted according to pre-determined criteria. The list of criteria for outside drawings are listed first followed by the criteria for inside drawings:

- One point for the outside drawings is awarded for the following:
- Move from one to more buildings
- Reduction to one or less chimneys
- Addition of pipes
- Removal of furnace
- Removal of conveyor belt
- Addition of control panel
- Addition of process or scientific equipment
- Addition of cooling towers
- Addition of vessels/tanks
- Addition of storage drums
- Addition of road tankers
- Addition of forklift trucks
- Addition of specific buildings (e.g. warehouse or laboratory)
- Addition of company name
- Addition of specific features (e.g. barbed wire)
- Addition of company name
- Labelling, which demonstrates particular pieces of new knowledge
- Significant change in the number of windows (e.g. from 1 to 10 or vice versa)
- Addition of people doing jobs specific to the industry (e.g. scientist, forklift driver).

In a similar way, points are deducted for elements that have been removed (or the reverse to the statement above) from the drawing:

- One point for the inside drawings is awarded for the following:
- Move from one to more buildings
- Reduction to one or less chimneys
- Addition of pipes
- Removal of furnace
- Removal of conveyor belt
- Addition of control panel
- Addition of process or scientific equipment
- Addition of cooling towers
- Addition of vessels/tanks
- Addition of storage drums
- Addition of road tankers
- Addition of forklift trucks
- Addition of specific buildings (e.g. warehouse or laboratory)
- Addition of specific features (e.g. security barrier)

- Addition of company name
- Labelling, which demonstrates particular pieces of new knowledge
- Significant change in the number of windows (e.g. from 1 to 10 or vice versa)
- Addition of people doing jobs specific to the industry (e.g. scientist, forklift driver).

In a similar way, points are deducted for elements that have been removed (or the reverse to the statement above) from the drawing.

15 References

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

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

Table 15-1: Sources and results of children's images of industry

Child	Code	Result for outside picture	Result for inside picture	Industrial visit
1	S109/4	5	4	Rockwood
2	S101/1	4	5	BPI
3	S147/1	2	2	No visit
4	S189/1	2	2	Colloids
5	S085/2	0	0	No visit