Stats and Figures

Statistical Consultancy

Report Title:	**Children Challenging Industry** **Analysis of children's & teachers' data from the Bradford region, 2002-2003.**
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Report Date:	17 March 2005
Version:	1.0

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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

83 children completed questionnaires from the year 2002 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, hot and dark with many people working on dangerous 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 as well as being less likely to say it was noisy, smelly, dirty, hot or dark.

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 were asked to draw someone in industry and give this person a job title. After the project, the children were twice as 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, decreased sharply. When asked to list other jobs carried out on industrial sites, children were nearly twice as likely to list scientist or engineer as jobs carried out in industry. After the project, the children were less likely to choose to be a 'materials handler'.

Many of the children learned 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 learned about the importance of science in industry shown by the fact that nearly all the children said scientific testing was important.

These results demonstrate how much the children learned about industry and the types of jobs in industry during the CCI project. By the end of the project, the image of scientists was more positive. A third of all the children were able to state that scientists and engineers worked in industry.

1.2 Teachers' data

23 teachers returned questionnaires from the year 2002 to 2003, before and after the CCI project. A third 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.

Less than half of the teachers had links with industry or had used any resources developed by industry. Teachers were more likely to teach about industry in the context of geography, than science.

The feedback from the training was overwhelmingly positive. The sessions 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.

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, 80% of teachers said they had learned 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.

The change in attitudes towards industrial resources that occurred during the project was impressive. All the teachers thought that industrial visits would be useful in future and 93% of teachers wanted to use resources developed by the industry after the training. This was a vast improvement when compared with the approximately half of teachers who wanted links with industry, or 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 Bradford region. The majority of the schools (eighteen) were from the academic year 2002-3 with three schools involved in the previous academic year, 2001-2.

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 Bradford 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 19 teachers and 83 children from 21 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.

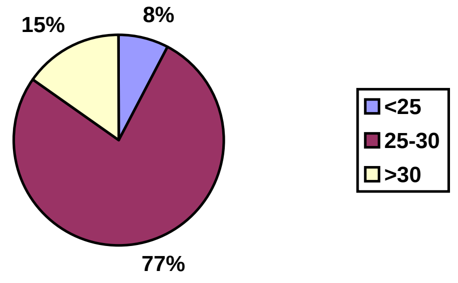
3 Background information on children

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 Number of children in the class

Teachers were asked how many children were in their class. The results are shown in Figure 3-1.

Figure 3-1: Number of children in the class

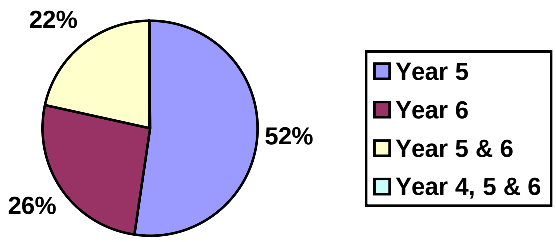


These figures are broadly similar to those seen in the previous study. However, there were more classes with 25-30 children, and slightly fewer classes with small and large numbers of children. This is a larger sample where you would expect the trend to move towards having more classes nearer the average number. In this study, the mean number of children in the class was 28. The minimum was 19 and the maximum was 32.

3.2 Year groups and gender

Teachers were asked which year groups they were teaching. The results are shown in Figure 3-2.

Figure 3-2: Year groups taught



Slightly more than half the pupils were from year 5 with the remainder made up of year 6 pupils or mixed classes of year 5 and 6 children. There were no classes with year 4, 5 and 6 children. 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.

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 (22%). 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 55 (66%) female and 28 (34%) male. This is significantly different from equal groups and could have an effect on the results. The reason both groups are dissimilar is not clear.

3.3 Ethnic profile

The teachers were asked about the ethnic profile of their school. More than half the teachers did not answer this question, maybe because they did not feel able to.

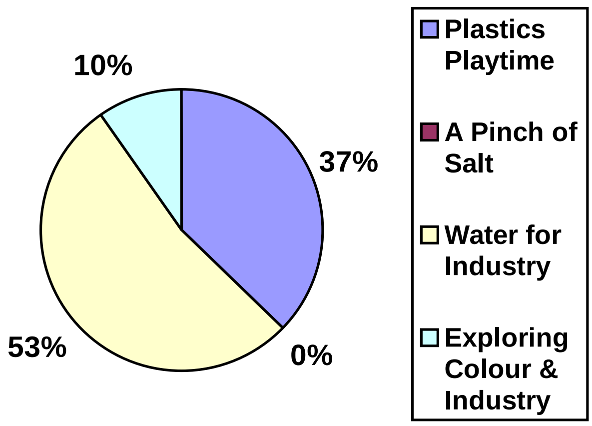
Table 3-1: Ethnic profile

Ethnic profile	Frequency
Mainly white	7
5-15% ethnic	1
Multiracial	1

3.4 Topic

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

Figure 3-3: Topic



The most popular topic was *Water for Industry* with half the teachers choosing this topic. Approximately a third chose *Plastics Playtime*. A smaller percentage chose *Exploring Colour and Industry* but none of the teachers chose *A Pinch of Salt.* The topic on colour was a new topic introduced in autumn 2002.

3.5 Industrial sites visited

The sites visited by schools in the Bradford region who returned their questionnaires are shown in Table 3-2.

Table 3-2: Site visits in the Bradford region

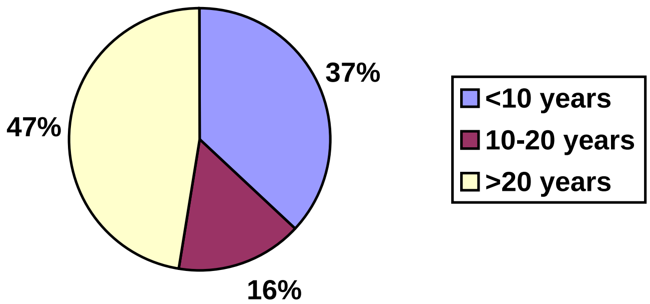
Site Visited	Number of pupils
Avecia Huddersfield	8
Robert McBrides	8
Ciba	4
BSN Medical	4
Coca Cola	4
Total	**28**

In this region, there was only a small number of companies involved in the CCI project. This inevitably meant that some companies were not be able to offer visits to all the schools that needed them. Only a third of the children sampled here went on a site visit compared with percentages of approximately 75% in many of the other regions.

3.6 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 3-4: Years spent teaching



The mean number of years that teachers had been teaching was 16 years in this study. The maximum was 30 years and the minimum was 2 years.

The teachers in this study had been teaching for significantly longer than in Parvin's original study. In this study there were more teachers who had been teaching for longer than 20 years and fewer teachers who had been teaching for 10 to 20 years.

3.7 Teaching science

Ten out of the thirteen teachers who replied to the question on whether they were the only ones to teach science to their class replied in the affirmative. The remaining three teachers had input from other members of staff.

Four of the teachers taught science to other classes. Two teachers said that they taught other classes because they were the science co-ordinator, and two said that they supported other classes mainly for SAT revision.

Teachers were asked about their teaching methods but many teachers 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.

Those that did answer the question were most likely to say ‘QCA scheme’. Two teachers mentioned class and group work. None of the teachers mentioned investigative work.

3.8 Chapter summary

The CCI project sought the views of science and industry from 83 children in primary years 4 to 6 and 23 teachers. The average number of children in a class was 28 in this study, higher than in the previous study. 78% 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 limited range of industrial sites for the children to visit, and many of the children did not visit industry.

The mean number of years teachers had been teaching was 16. A small number of teachers said they were not the only teacher to teach science to their class and a few teachers said they taught science to other classes.

4 Children's views of industrial settings

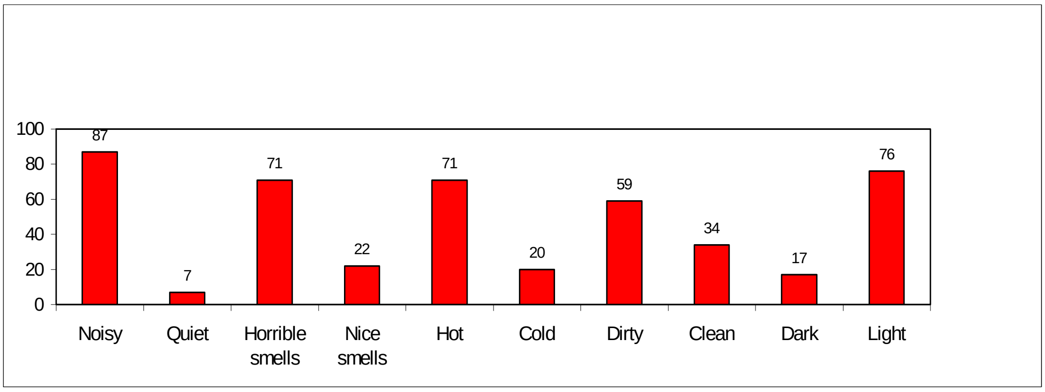
This section discusses the children's views of industry in two parts. The first part involves questions on words that describe industrial sites and the second part involves analysis of the children's drawings of the inside and outside of an industrial site.

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

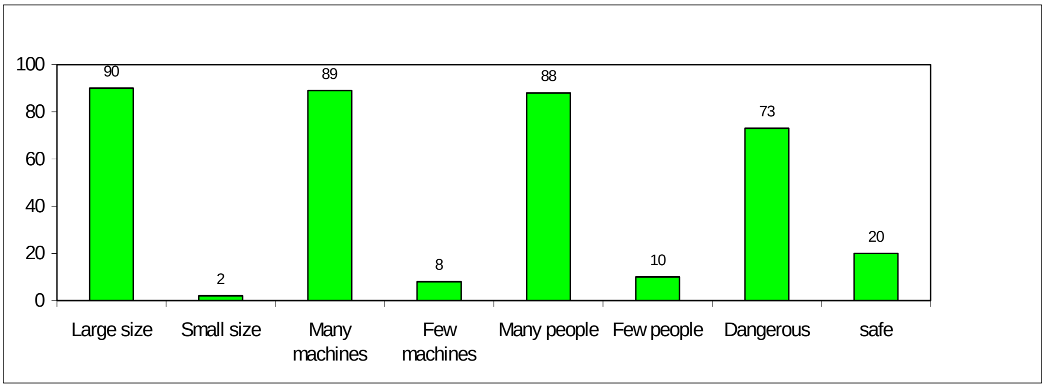


Before the project, the predominant view of industry was that it was noisy, smelly, dirty and hot. The results are similar to those obtained by Parvin (1999). She found that 80% of children thought an industrial site would be noisy and 75% thought it would have horrible smells. She also found that 55% of children thought that it would be hot and 50% thought it would be dark.

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

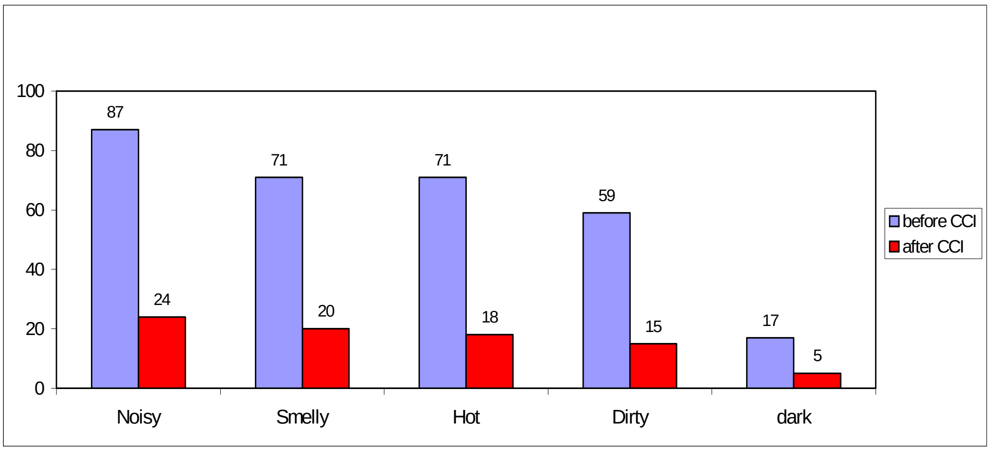


Again, the overall picture is one of a large site with lots of people and noisy machines. Many children also saw it as a very dangerous atmosphere. Parvin's study produced very similar results with the number of children stating a site would be large, with many machines and/or people between 75 and 85%.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

The changes in the views of children were analysed to see if there were any differences in the answers given after the project. The results are shown in Figure 4-3.

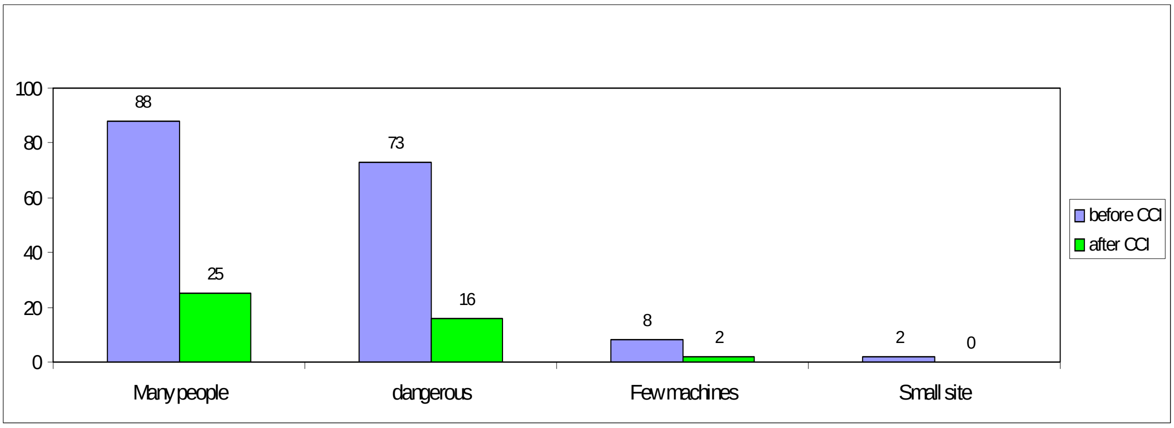
Figure 4-3: Industrial views of children



After the CCI project the children were significantly less likely to say that a site was noisy, smelly, hot, dirty and dark. There was no significant difference between children who had been on a site visit compared with those who did not have a visit. It appears that the 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



After the CCI project the children were particularly less likely to say that industry is dangerous. They were also much less likely to say that there were generally many people working on an industrial site. Both of these results were statistically significant. This accurately reflects the situation in many sites where fewer people work than children would expect and safety on the site is extremely important. 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

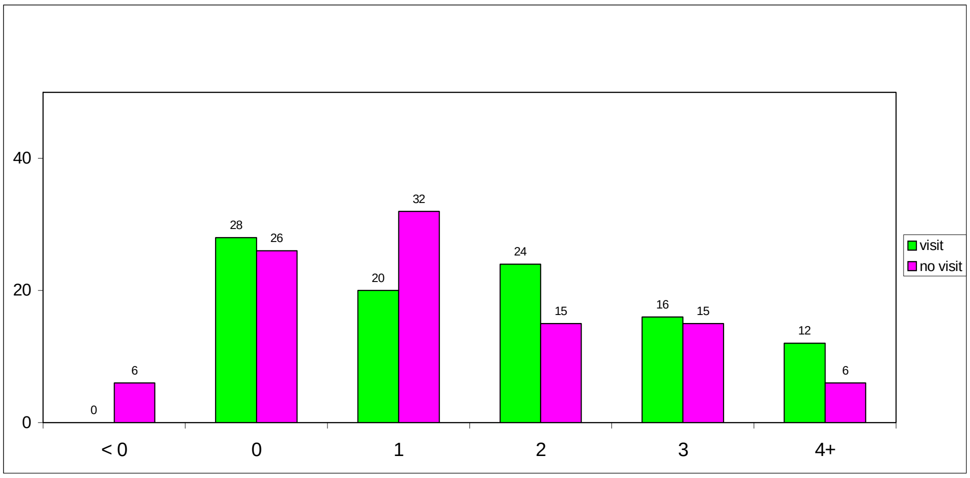
The children were asked to draw pictures of their impressions of an industrial site (inside and outside), before and after the CCI project. The pictures were compared and given a score based on the difference between the pre and post-intervention pictures.

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.

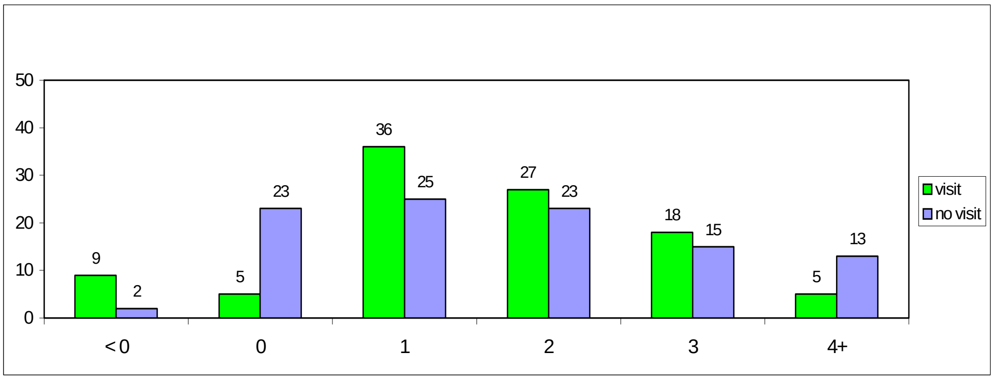
The results of the scores of external and internal pictures are shown in Figure 4-5 and Figure 4-6.

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. The mean score was 1.7 for the children who had been on a site visit and 1.2 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 one. However, this was not significantly different with a sample of this size.

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 very similar at 1.5 and 1.7 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 (a score of 3 or more), medium (a score of 2) 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 of 4 obtained by a child who carried out the topic *Water for Industry*. This child did not have an industrial visit.

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

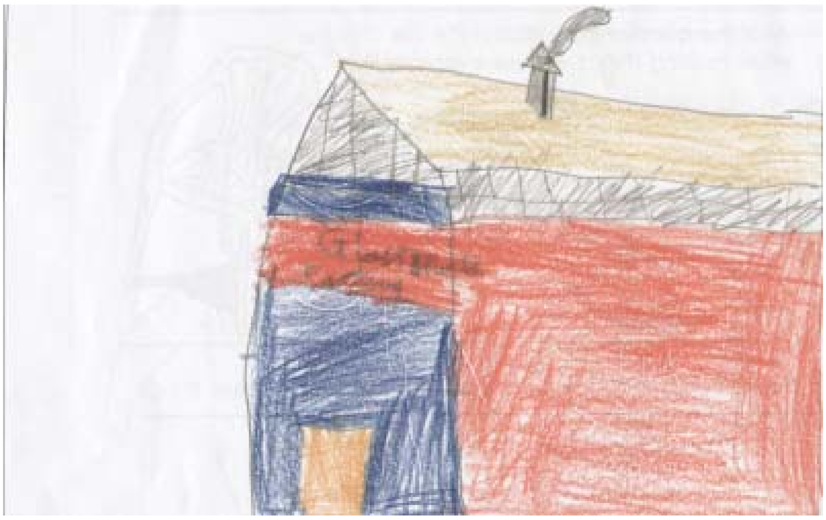


Figure 4-8: Child 1, external picture of industry after the CCI project

Before the project, the child portrayed quite a simple image of industry that was typical of many of the children's pictures. One building has been drawn with a smoking chimney. Afterwards the child's drawing was more detailed and less stereotypical. There is still a chimney, however there is also a cooling tower. In addition, a storage container has been included with closed pipe-work, connecting different areas of the site, in the second picture.

The following before and after pictures are an example of a high positive score of 3 obtained by a child who was involved in the topic *Water for industry*. This child did not have an industrial visit.

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

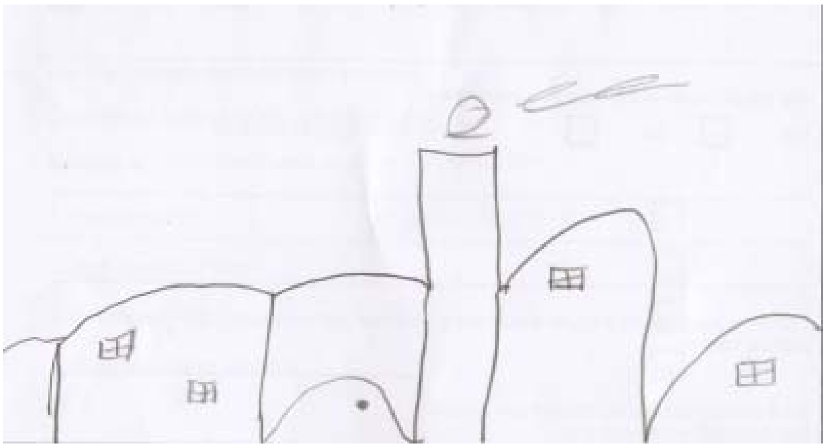
This child depicted a dark sombre image of industry in their first picture, with a building that included many smoking chimneys and a many windows. In their post project picture they have depicted a more detailed and more modern image which included storage containers and enclosed pipe work, connecting different parts of the site. The chimneys have been replaced by a cooling tower.

The following before and after pictures are an example of a medium positive score of 2 obtained by a child who completed *Water for Industry*. This child visited Avecia in Huddersfield.

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

Need to get picture from Heather – single building with 2 chimneys.

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

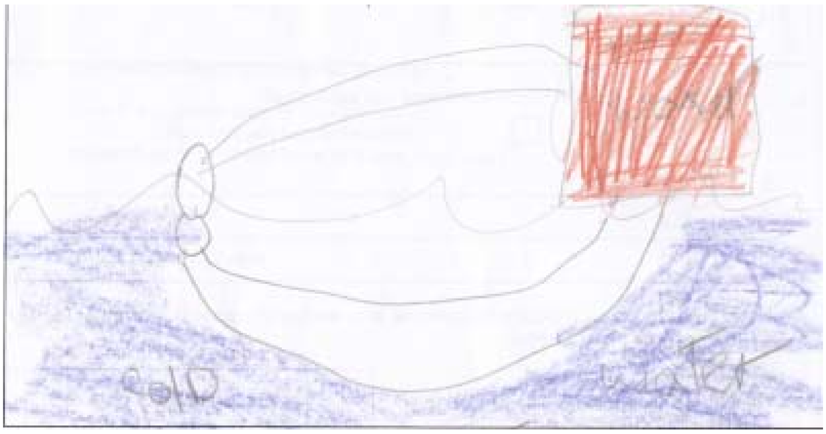


At the beginning of the project, this child drew a very simple picture of a single building which included two smoking chimneys. The second picture is more detailed and depicts a group of buildings with one chimney or cooling tower. In comparison with the previous two children, the improvements in the drawings are less dramatic. 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 4-13 : Child 4, external picture of industry before the CCI project

Figure 4-14 : Child 4, 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 in the pre-project drawing. This child drew a different scene to portray the outside of an industrial workplace but it was no more accurate or detailed. It is not exactly clear what the post-project drawing is depicting. It is possible that it is something they have seen during the project on a video but it does not add to the information portrayed in the first drawing.

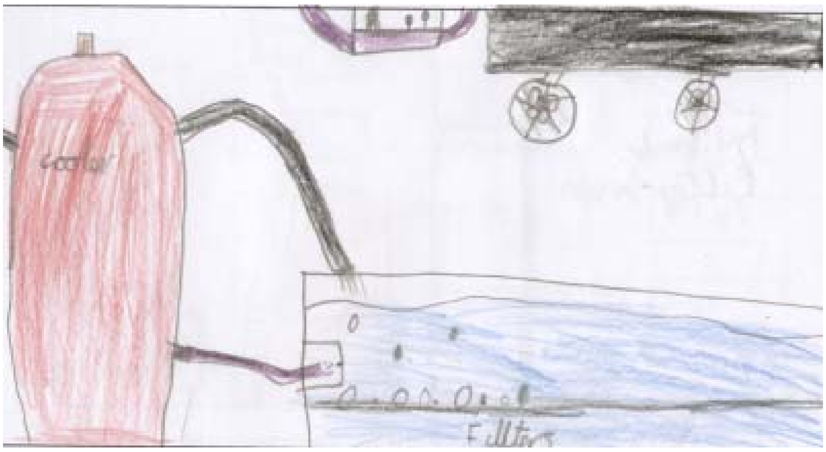
DRAWINGS OF THE INTERNAL IMAGE OF INDUSTRY

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 of 6 obtained by child 1 who did not have an industrial visit.

Figure 4-15 : Child 1, internal picture of industry before the CCI project

Figure 4-16 : Child 1, internal picture of industry after the CCI project



The inside of the building was depicted as old fashioned with an open furnace and substances in open top vessels. There were also what appeared to be tools used in the flames such as you might find in a steel works. After the project, the picture portrays a much more modern image with enclosed tanks and pipe work linking different areas on site. There is also labelled scientific equipment such as filters which were not present in the previous drawing. This demonstrates how much the child has learned about the scientific processes involved in modern industry.

The following before and after pictures are an example of a high positive score of 5 obtained by child 2 who did not have an industrial visit.

Figure 4-17 : Child 2, internal picture of industry before the CCI project

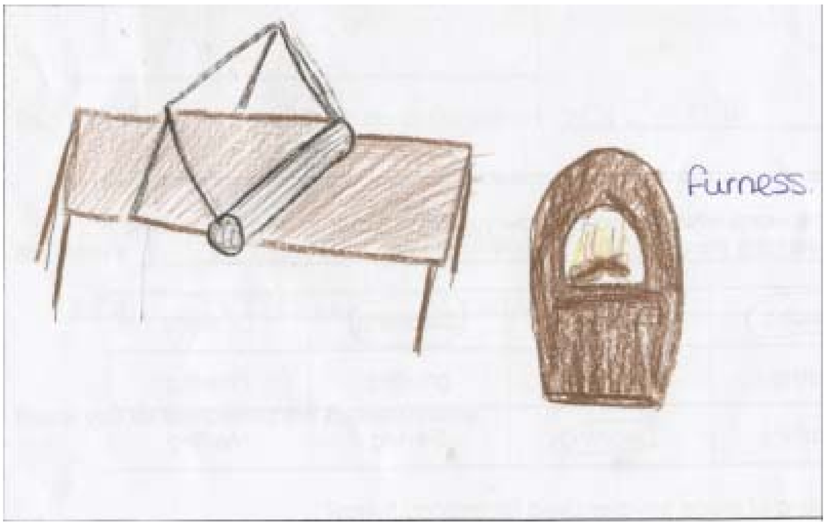
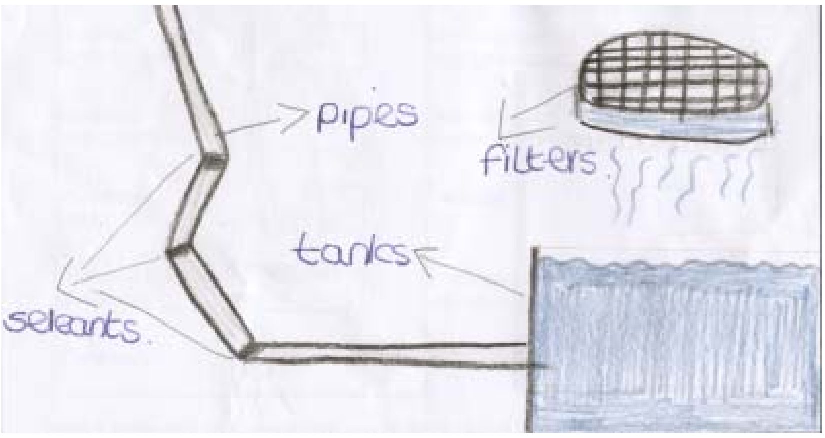


Figure 4-18 : Child 2, internal picture of industry after the CCI project



When asked to draw the inside of an industrial site, this child again included an open furnace and a table with some simple equipment, which depicted a non-automated vision of industry. In the second drawing, the child has depicted a different scene with enclosed pipes and a more modern environment. They have included scientific equipment such as filters. They have also labelled many parts of their drawing, including sealants on the pipes.

The following before and after pictures are an example of a medium positive score of 2 obtained by child 5 who did *Water for Industry* and did not have an industrial visit.

Figure 4-19 : Child 5, internal picture of industry before the CCI project

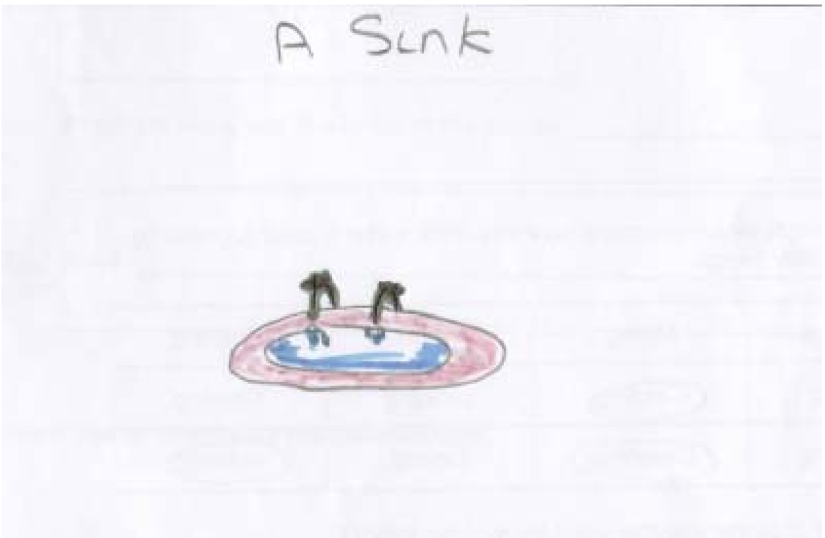
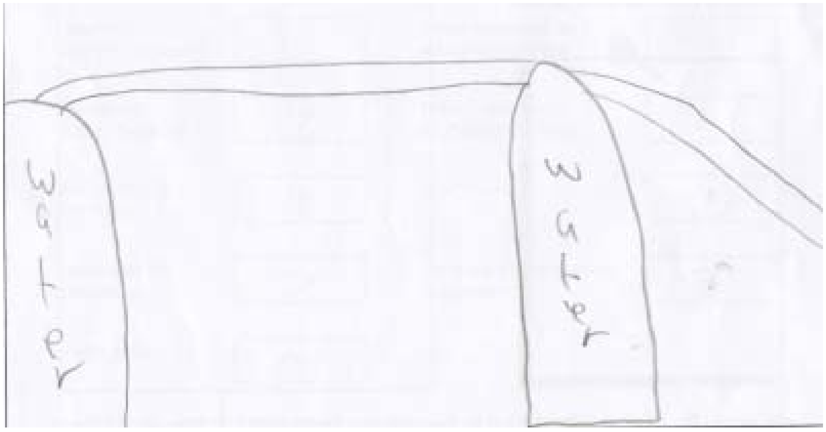


Figure 4-20 : Child 5, internal picture of industry after the CCI project



This child has drawn a domestic view of water usage, i.e. a sink, in their pre-project drawing. There post-project drawing is a more appropriate to an industrial setting with enclosed storage tanks and enclosed pipe work. The improvement in the drawings is more modest than for children 1 and 2 who had more dramatic improvements in their drawings. However, there has been a positive move towards a more accurate view of industry.

The following before and after pictures are from child 4 who obtained a zero score, and did not visit industry.

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

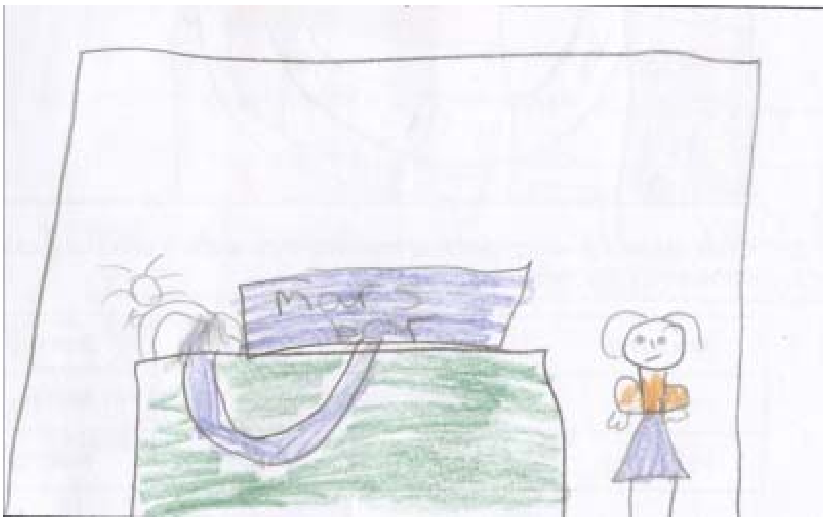
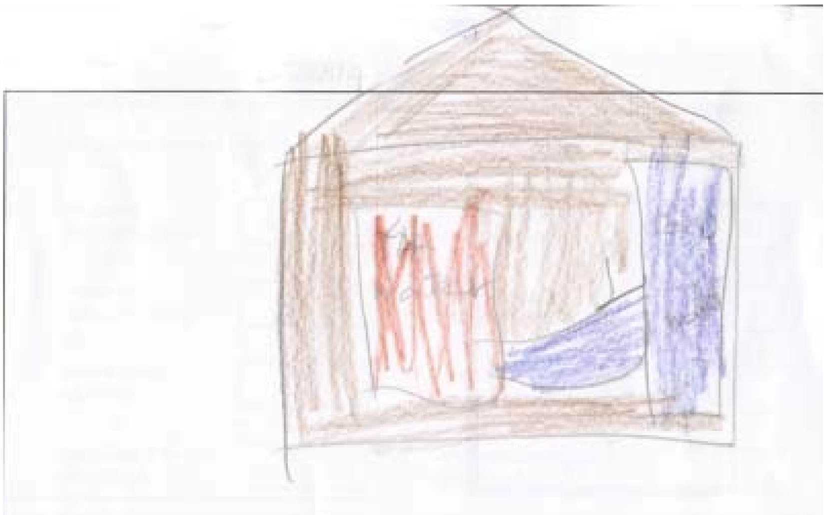


Figure 4-22 : Child 4, internal picture of industry after the CCI project



This child's views of industry seem to be 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. Again, there seem to be different areas with hot and cold water that are enclosed but on further detail.

4.3 Chapter summary

After the CCI project the children were significantly less likely to say that industrial sites are dangerous, noisy, smelly, hot, dirty, dark and employ many people. The 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. The children visiting an industrial site were slightly better at depicting a more accurate picture of the external image of industry than those who did not have a visit but the difference was not statistically significant. 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

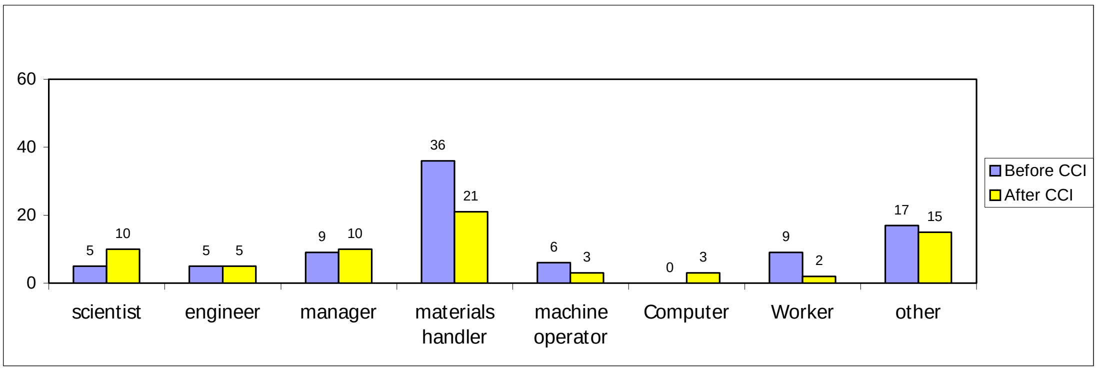
The children were asked to draw a picture of a person who works on an industrial site. They were then asked to write down the job of the person they had drawn. The types of jobs listed were analysed to see if there were any significant differences after the children had experienced the CCI project compared 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 from 36% to 21%. In addition, the number of children who said they had drawn a worker, a vague term, decreased from 9% to 2%. Both 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 5% to 10% after intervention. However, the number of children listing engineer did not change. The number of children drawing an engineer showed a more marked increase in the Humber region. The number of children who were more specific about the job being depicted increased with fewer children using the general term, worker.

The children were more likely to omit drawing a picture after intervention (30% compared with 10%), and this may be because they felt they were repeating what they had just done a few weeks previously. The number of children drawing people who were categorised as 'other' did not change significantly.

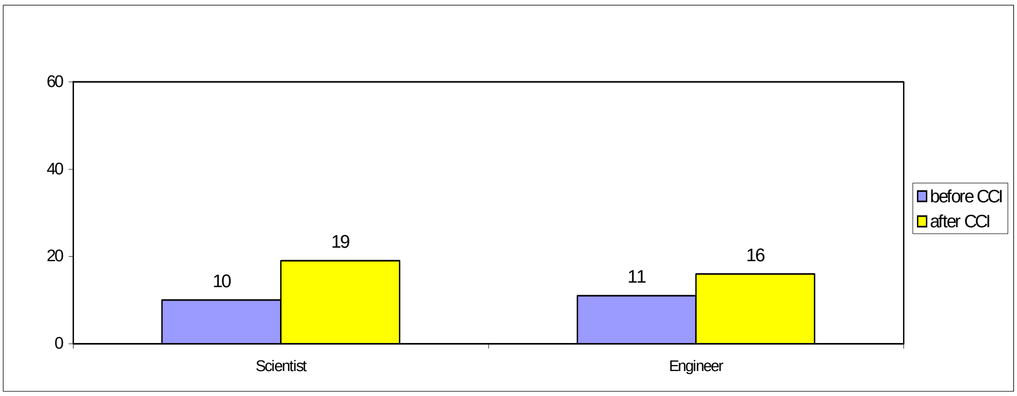
These positive results provide some evidence that the children learn about the importance of scientists and their roles on industrial sites. After the project, the children were more likely to draw a scientist and less likely to draw a materials handler.

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 seven different jobs before and after the project.

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 5-2.

Figure 5-2: Proportion of children citing industrial scientists or engineers



The proportion of children who listed scientist as a job on industrial sites doubled from 9% to 19%. The proportion of children who listed engineer as a job on an industrial site increased from 11% to 16%. These were both significant increases. The percentage of children who mentioned a scientist or engineer was 30%.

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

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	4	8
Engineer	5	4
Materials handler	31	10
Manager	9	4
Machine operator	6	1
Packing	6	1
Driver	5	3
None	4	1
Worker	4	3
Office	3	0
Supervisor	3	0
Don't know	1	0
Cleaner	1	0
Computer	0	1
Other - technician, cook, tour guide. First aid, security, teacher	4	5
No response	15	59

Before the project, the most popular job chosen was 'materials handler'. Thirty-one percent of the children wrote down words describing this type of job such as 'moulding the plastic into shape' and 'mix the salt'. The other jobs mentioned by more than 5% of the children were manager, machine operator and packer. After the project the children were significantly less likely to choose to be a materials handler. The number decreased by two-thirds from down to 10%.

The number of children who chose scientist as the job they would like to do doubled from 3 to 6 children. However the number of children choosing engineer did not change.

After the project, fewer children said they did not know what they would choose or that they did not know. However, there was a huge increase from 15% to 59% in the proportion of children who gave no response to this question. It is not clear why this should be the case as only a small increase in blank responses was seen in the other four regions.

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 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 quite positive. The classroom sessions and the site visits increased the children's knowledge of the role of scientists in industry. However, the results would probably have been more positive if fewer children had left this answer blank.

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 twice as likely to draw a scientist. In addition, they were far less likely to draw a materials handler when asked to depict a person who works on an industrial site (21% compared with 36%).

The proportion of children listing scientist as an industrial job doubled from 10% to 19%. The number of children listing engineer as an industrial job increased from 11% to 16%. A third of the children (30%) stated that scientists and/or engineers worked in industry.

The proportion of children saying they would choose to be a scientist increased slightly from 4 to 8% however, the proportion of children saying they would like to be an engineer did not change. The children were much less likely to choose to be a ‘materials handler’ after the project. This reduced from 31% to 10%.

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.

6 Children's views of science and industry

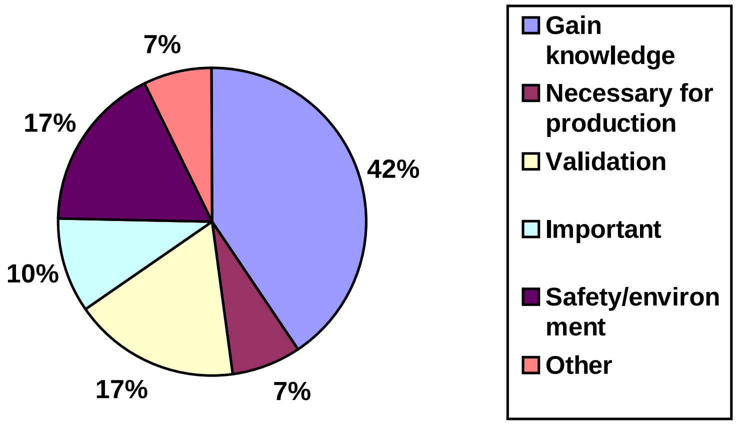
This section discusses the children's views of the importance of science and its relevance to industry.

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. 91% of the children said that they thought the tests were important. Only seven 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



Nearly half of the children felt the tests were important for gaining new knowledge to make improvements to products or processes. For example,

"Because they have to know how to make the water cool enough and safe enough to use."

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

"Because you might have to do these experiments to test if something works."

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

"Because if you didn't know what to do it might be a safety hazard."

Ten 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

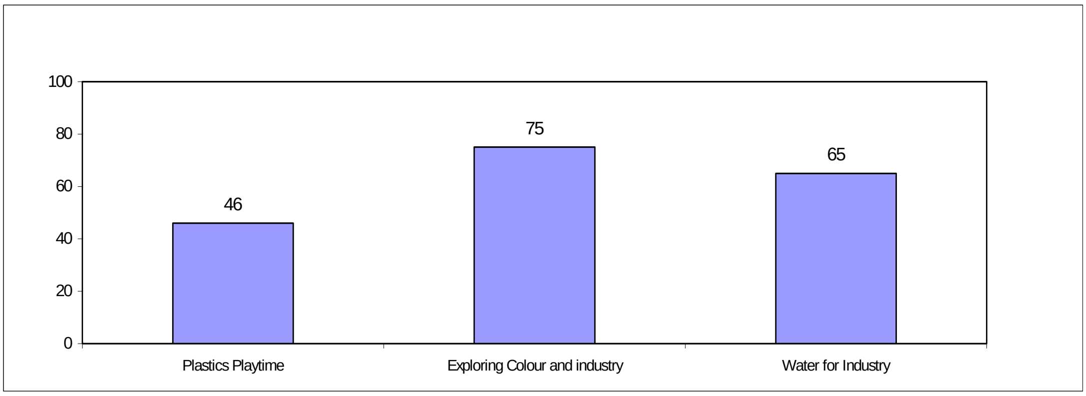
The children were asked whether they had learned anything about the way ingredients were used to make products. Due to the diversity of subject matter covered by each topic, the question was worded differently according to which topic had been completed. See Table 6-1.

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?

The answers varied by topic. When all the topics were analysed together, the proportion of children who said that it was not as they expected was 41%. 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

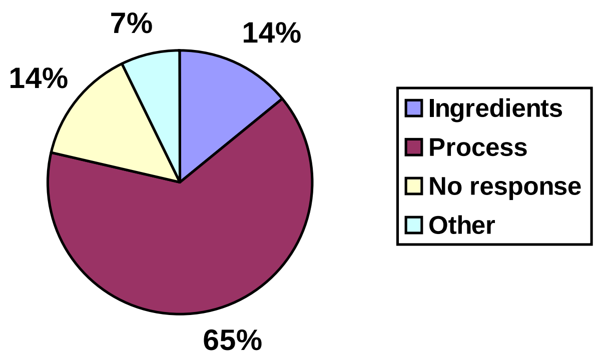


The children who had completed *Plastics Playtime* were least likely to say that the product was made and used in the way expected. In this group, less than half of the children said it was as they expected. This result is not surprising. The fact that plastic derives from oil is not well known by children.

Two thirds of the children who had completed *Water for Industry* and *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 process used to make the product were not what they had expected at the beginning of the project. The children also mentioned that the ingredients were not as they expected. The remaining children mentioned other miscellaneous ideas such as 'it was busy' or that they did not know.

6.3 Chapter summary

Nearly all of the children (91%) 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.

Nearly 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.

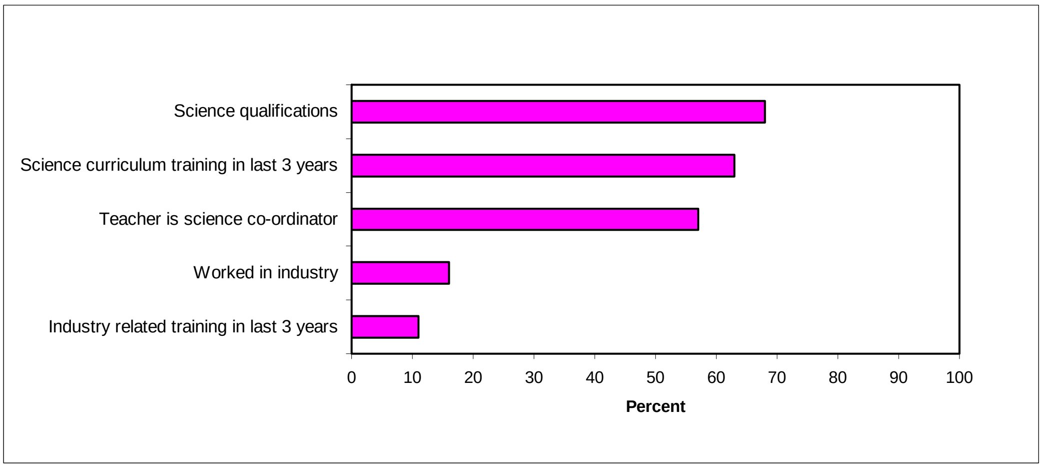
Just over half (59%) of the children felt that products were made from the ingredients they expected. Children who had completed the *Plastics Playtime* topic were less likely to agree with this statement than children who had completed the other topics. The children who claimed that it was not as they expected, expanded to say that it was usually because the processes used to make the product were different from expected.

7 Evidence to support the provision of training

7.1 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 7-1: Training and qualifications



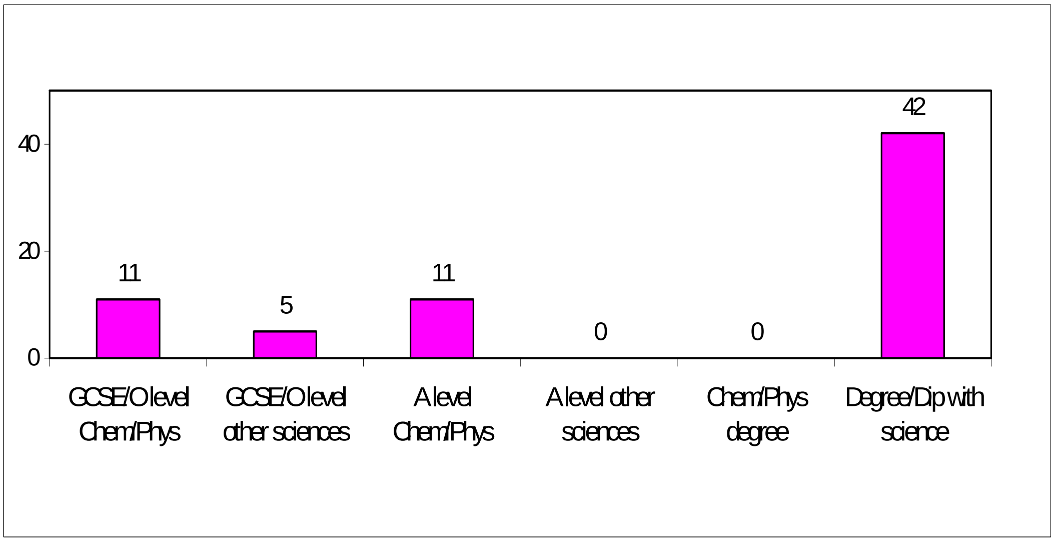
Compare with other regions when all regions complete.

7.2 Qualifications

Approximately a third of teachers (32%) 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 7-2. 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 7-2: 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.

7.3 Work experience

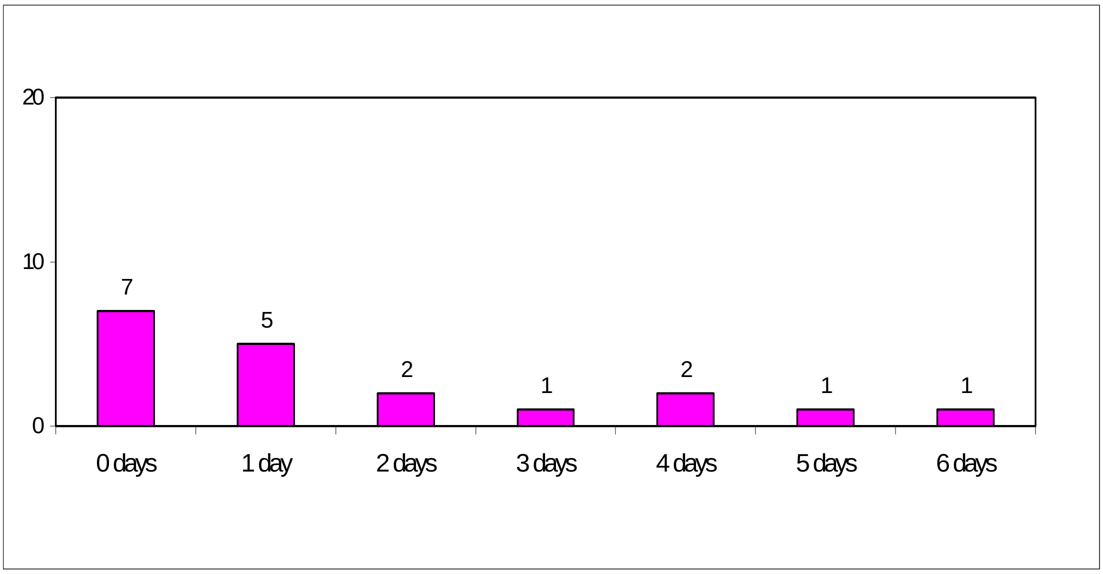
The three teachers who had worked in industry were asked how many years they had worked there. One had worked in industry for 12 years while the remaining two teachers had worked in industry for one year.

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. However the small sample of teachers data collected in this region means that it is not possible to explore the issue any further.

7.4 Training

Teachers were asked how many days of science training they had undergone in the last 3 years. The results are shown below and are in frequencies not percentages.

Figure 7-3: Number of days of science training



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

Table 7-1: Number of days of training

Number of days	Percent this study	Percent Previous study
0	37	45
Total 1-3	42	20
Total 4-6	21	18
Total 7-30 days	0	18

The most common response was one or two days training over the last three years. Most teachers had odd days of training with only two teachers having a week or more 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 two of the teachers had undergone industry-related training. This result was similar to the one obtained in the previous study. Industry training is much less common than science training. One teacher had one day's training and one teacher had two days training. 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 more likely to have science training experience and eight 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 7-2: Number of years as science co-ordinator

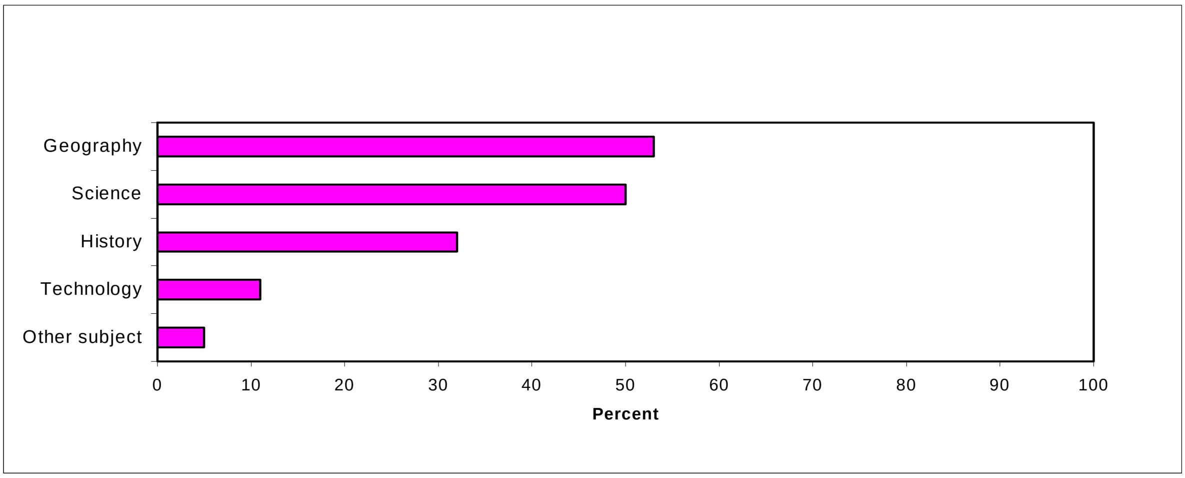
Number of years	Frequency
0	6
1-2	4
3-5	3
6+	0

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.

7.5 Teaching of industry within the curriculum

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

Figure 7-4: Subjects covering industry in the curriculum



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

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

Industry was most often mentioned when covering the 'materials' topic in science. This was mentioned by 4 out of the 9 teachers who said they taught industry as part of the science curriculum. The range of science topics was very limited. Three of the teachers did not give a topic. One mentioned teaching about industry when covering electricity and another mentioned habitats which could be categorised under geography. However, this was an improvement in the number of teachers from the previous study covering industry in the science curriculum. Any 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 covered in a number of geography topics. 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.

Only one teacher listed pollution as a topic, however teachers who listed environment or water may have also discussed pollution. Water or the environment were included in the geography curriculum by all the remaining teachers who included geography when discussing industry (9 teachers).

Industry was also included in a number of history topics. The Victorian era was the most commonly cited topic where industry was covered and mentioned by five teachers. 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.

One teacher mentioned that they taught about industry when discussing local history. In the previous study this was the most common link with industry, 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. One teacher mentioned World War 2.

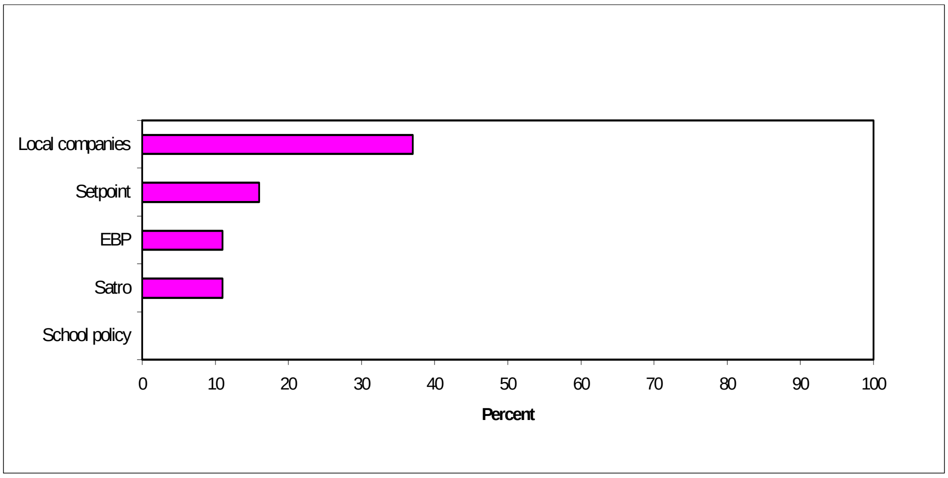
One teacher listed personal, social and health education (PSHE) as a subject where they taught about industry.

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.

7.6 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 7-5: Schools with industrial links



None of the schools had a policy on industry links. This was not the case in other regions where approximately 1 in 7 schools had a policy on links with industry. Schools could be involved with a number of organisations such as Education Business Partnership (EBP), SATRO and Setnet that promote links with industry. However, links with industry were the most common links that schools had in this region with seven teachers stating they had such a link. The most common companies that they had links with were CIBA and Yorkshire Water which two teachers mentioned for each. The three remaining teachers mentioned Radiators Denso Marston, Warburtons and Yorkshire building society. One teacher said that she had a link with another company (not a local one) and this was EAZ links.

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 links of this nature.

7.7 Use of resources by teachers

The teachers were asked whether they had used any resources from industrial sources. Eight out of the nineteen teachers (42%) said that they had used resources sponsored by or developed by the chemical and allied industries. Four of these teachers listed one resource and four listed two different resources. The most common resources used were from companies producing washing powder (e.g. Persil and Ariel) listed by four teachers. BP was the next most popular listed by 3 teachers. The following companies were mentioned by one teacher each: Flora, Yorkshire Water, British Gas, CIBA and Oral B.

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.

7.8 Chapter summary

Approximately a third of the teachers had not had recent training in science and a third had no science qualifications, yet they were expected to teach science in the primary curriculum.

Training in industry was even less common (11%). 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 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 1 in 7 had a school policy on industrial links. 58% of the teachers had not used any resources developed by industry. Many teachers may be unaware of the relevance of teaching science through industrial context.

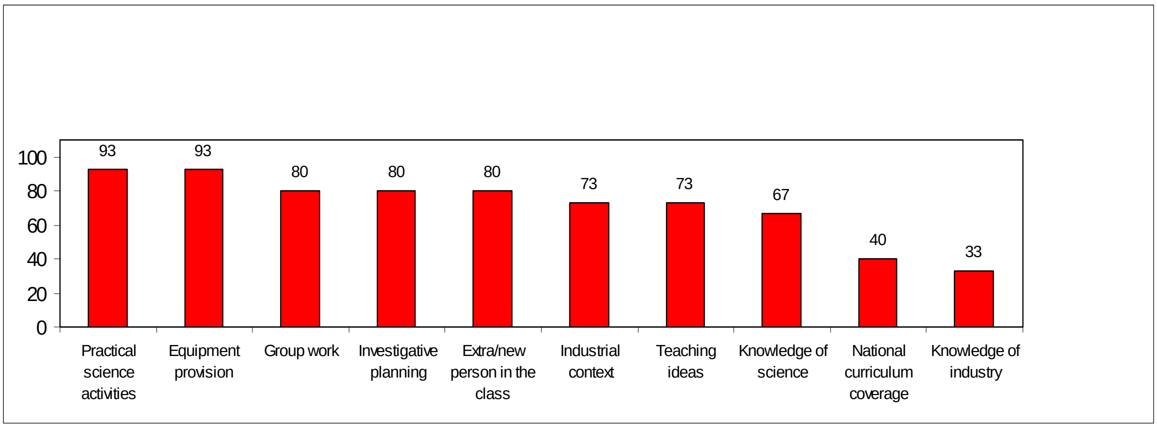
In summary, this training was very much needed by primary teachers to increase their confidence, knowledge and motivation of teaching science using industrial contexts.

8 Teacher's reaction to the CCI project

8.1 Strengths

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

Figure 8-1: Strengths of the CCI project



Virtually all the teachers indicated that the practical science activities and equipment provision were strengths of the sessions. Investigative planning, group work and having a new person in the class were also rated very highly by 80% of teachers.

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.

The categories least likely to be indicated as strengths of the project, were National Curriculum coverage and the advisory teacher's knowledge of industry.

Another interesting factor was that knowledge of industry was rated as a strength 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.

Of concern was the fact that less than half the teachers rated National Curriculum coverage as a strength of the project. The investigative part of the science curriculum has recently been given more importance and is a core element of the science curriculum. The project therefore fulfils many of the teaching requirements for the science curriculum. The reasons for these results are being investigated with the advisory teachers from all the regions.

Two teachers also included other strengths. Both quotes are included below:

"Energy and enthusiasm of the teacher."

"Excellent management of pupils, they really enjoyed it."

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.

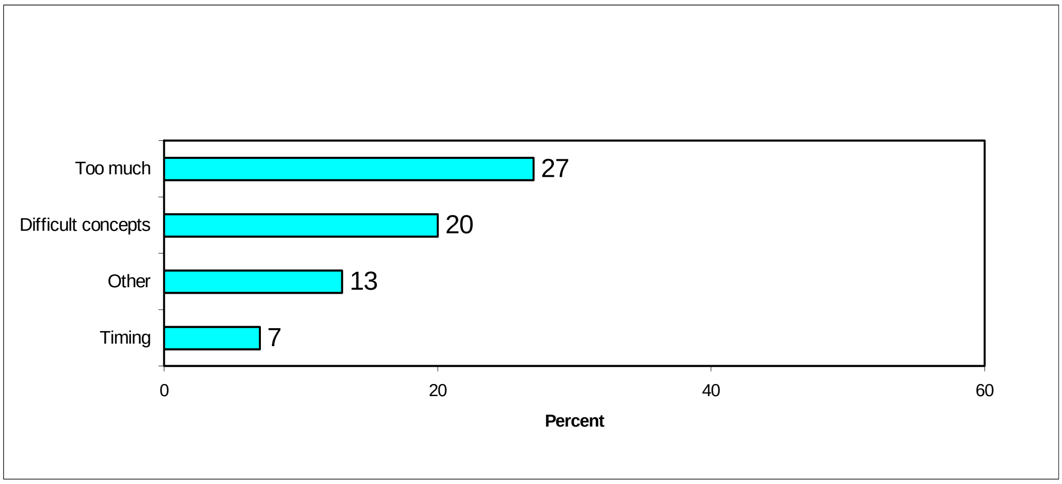
The two main strengths in the previous study were industrial context and expert knowledge. Given a list, the teachers would tend to tick more categories than if they had to write them down spontaneously so it is difficult to compare the results of the two studies. Practical science was third on the list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

The mean number of strengths selected was 7 out of 10. A fifth of the teachers ticked all 10 strengths. The teachers were enthusiastic about the project and felt it had been a valuable use of their time.

8.2 Weaknesses

The teachers were asked whether they thought there were any weaknesses to the sessions. The results are shown in Figure 8-2.

Figure 8-2: Weaknesses of training



The number of teachers who indicated there were weaknesses was small. The most common weakness was that too much was included in the project mentioned by four teachers. 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.

Three teachers cited that some of the concepts covered were difficult to grasp. This is similar as in the previous study where 13% of teachers had said there were aspects that were difficult in the sessions. In other regions where larger samples were taken, the teachers, who were teaching year 6 only, were significantly less likely to cite ‘difficult concepts’.

The number of teachers in this study who said they had problems with timing was less than in the previous study. 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 any further as it is due to the unavoidable problem for teachers of shortage of time.

Both teachers mentioned problems with the questionnaires:

“Poor questionnaires for pupils – generally difficult to do.”

"Worksheets were not stimulating enough and Surveys difficult to answer."

One of these teachers also thought it was not linked closely enough with the national curriculum for science:

"Not linked to NC science topics needed for SATS."

8.3 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.

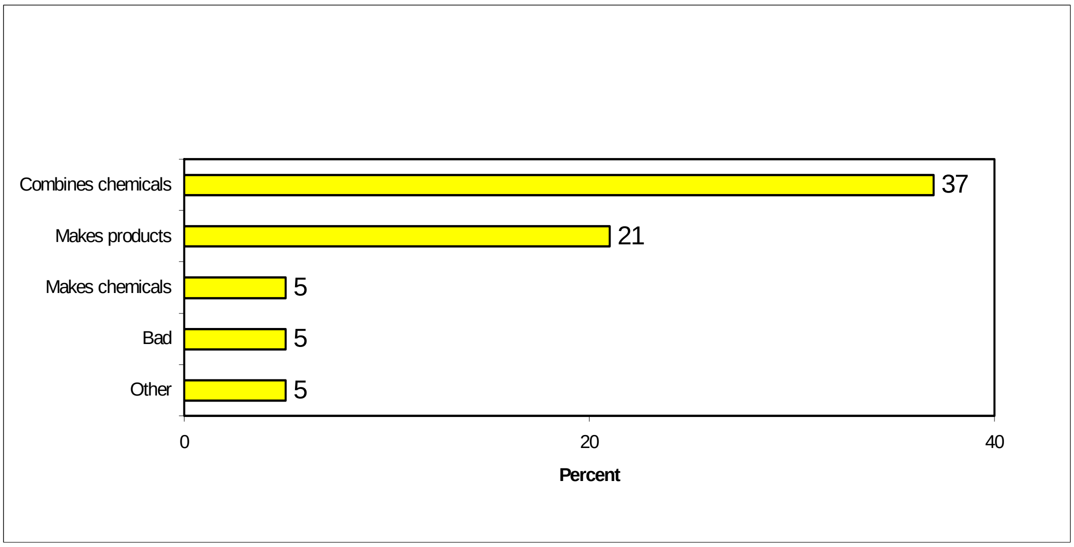
Few weaknesses were mentioned, by a minority (40%) of teachers.

9 Knowledge and skills of teachers

9.1 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 9-1: How teachers described the chemical industry



The most common response was that the chemical industry combined chemicals to produce another product. This was seen as the most informative answer. In the other four regions the most common response was that the chemical industry made products.

Only one out of nineteen teachers said only negative things and nothing positive about the chemical industry (5%). 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.

One teacher 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 in this region was possibly better than in other regions. However this is a very small sample of teachers and further investigations would have to be made to confirm these results.

Knowledge of the chemical industry is rarely attained 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.

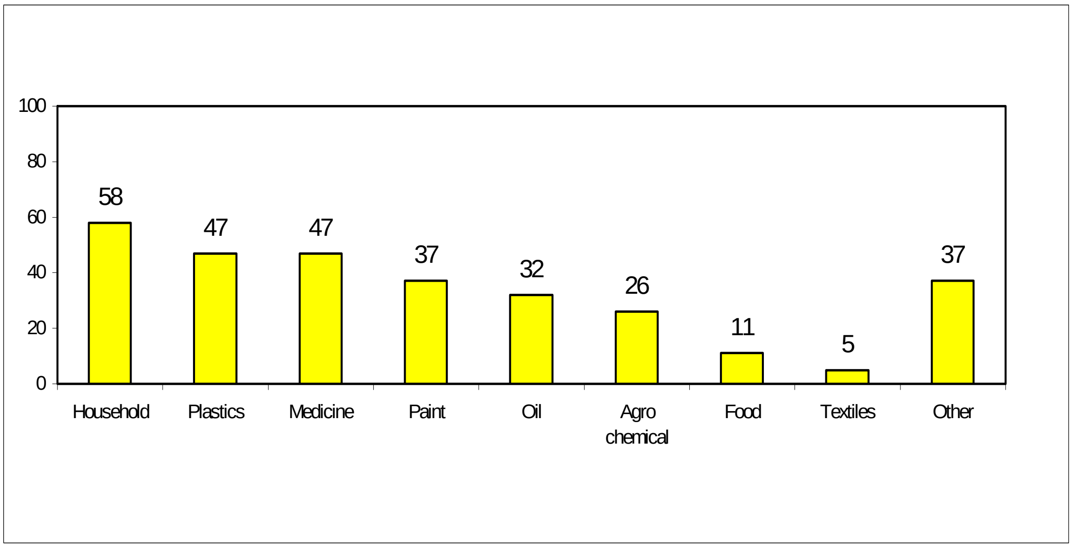
It was hoped that one of the outcomes of the training would be that teachers would learn more about industry, and how it relates to science. This could be achieved, not just with class-based training, but also with a visit to industry. This would give them an opportunity to experience the chemical industry first hand, which would help them to develop a more accurate view of the chemical industry.

9.2 Products of the chemical industry

Teachers were asked to list products of the chemical industry of which they were aware. The mean number of products that teachers listed was three but one in five teachers did not list any products at all. A third 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 9-2. The category 'household' included cleaning products and cosmetics.

Figure 9-2: 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 paint and oil and a quarter mentioned agro-chemicals. Fewer than 20% of teachers mentioned food, textiles or named chemicals (not mentioned at all).

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. Other products listed included iron and steel, man made materials, glue, solvents and paper.

Different regions may have different industries, which could lead to teachers having different products uppermost in their minds when answering the question.

9.3 Industrial knowledge gained through the training

Teachers were asked whether they had learned anything about industry, and what they had learned. Six teachers (40%) 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 (3 teachers). Two teachers said they had learned about industrial processes and one teacher did not give any further details.

These were 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. Some quotes are provided below.

"Focused questioning, how to organise a whole class to pursue investigative science work, the need for more resources in school."

"Making polystyrene, how to classify and test plastics."

"Fascinating!"

"Staff and pupils learnt new concepts."

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. Seven teachers (46%) stated that they learned something new about science.

Three of the teachers said they had learned how to improve delivery mainly through increasing confidence in teaching science. The teachers felt that they could use some of the methods used by the advisory teacher to improve their own science classes.

Some quotes are included below.

"Where to begin! An expert inspired me in a subject unfamiliar with. Took away some of the fear and led me to experiment more confidently."

"Increased confidence."

Another teacher said she had learned how to put science into a real life context.

"Plastics is not an area covered on the NC science topics for year 5. Interesting and relevant to everyday life."

One teacher was pleased at how well the children carried out investigative tasks.

"Was surprised by the level of investigative skills the children showed."

9.4 Chapter summary

A third of the teachers were able to say with detail what the chemical industry does and many were able to give examples of what the chemical industry produces.

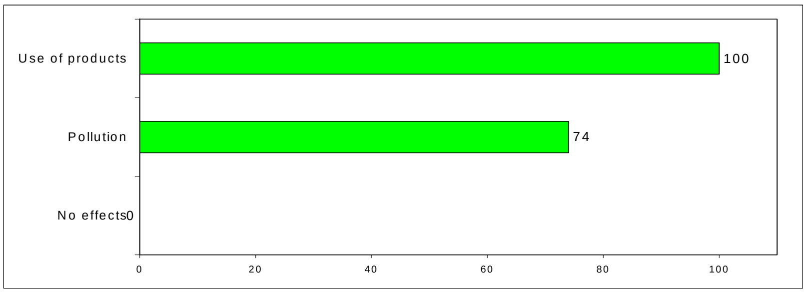
80% of teachers said they had learned something about industry or science, or both, after the training. Many teachers gained a more balanced view of the chemical industry after completing the training.

10 Attitudes of teachers

10.1 Attitudes towards industry before the training

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

Figure 10-1: Teachers views on industry



All the teachers thought that the chemical industry was necessary to produce the 'every day' products that we need. Most teachers (74%) also felt that there was a negative aspect of the chemical industry, namely pollution.

None of the teachers said that the chemical industry had no affect on their daily life. One teachers mentioned change in lifestyle which was probably a positive comment.

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.

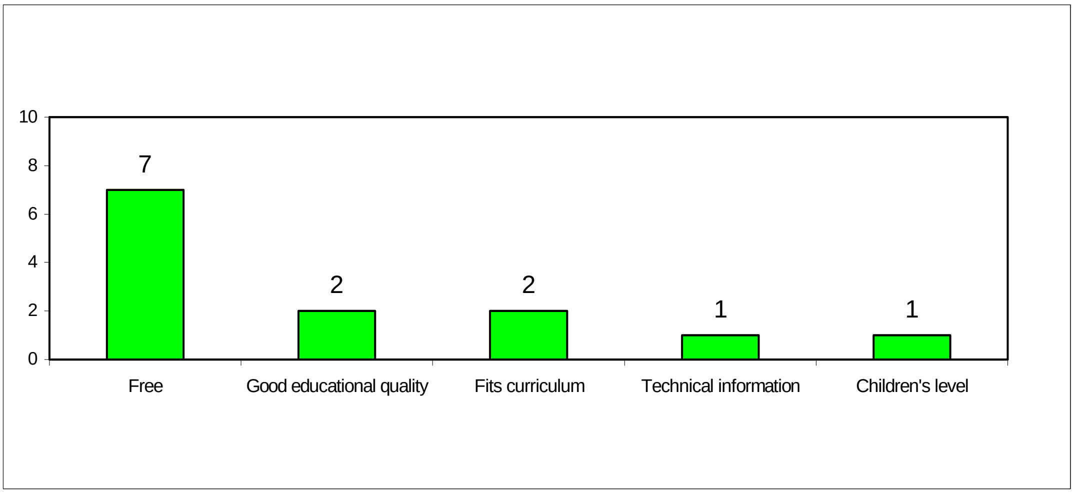
The attitude towards the chemical industry is quite similar to the attitude towards cars. Most people are willing to accept the risk of pollution if it is giving back something very useful. If prompted, most people would say that cars are pollutants but when asked to talk about cars, it's probable that 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.

10.2 Attitudes towards resources before the training

Teachers were asked whether they had used resources by industry and eight teachers (42%) said that they had. See Figure 10-2 for reasons why teachers used industrial resources. The results are displayed as frequencies not percentages.

Figure 10-2: 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 and fitting 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 similar answers.

The eleven teachers (58%) who had not used industrial resources were asked for reasons why they had not used them. Many teachers did not state any reasons why they had not used these resources. Of those that did give a response, five said it was because they had not seen any resources. None of the teachers said it was because of company propaganda. One teacher said it was because they were not suitable.

Some teachers may not know that useful information is available from companies for this age group. 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.

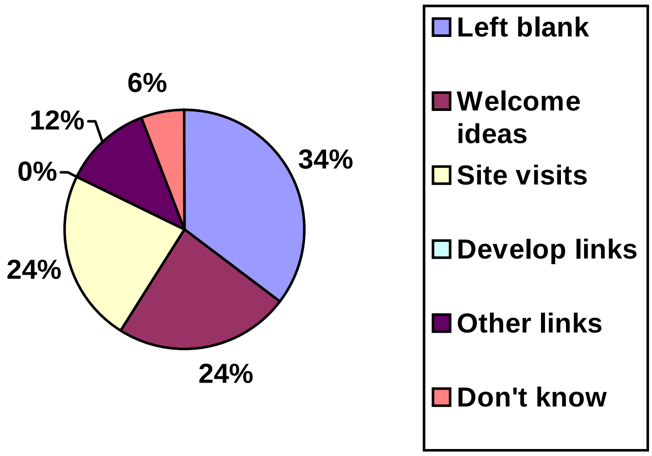
Teachers may be more likely to use industrial resources if another teacher in the school passes them on, or a company sends copies of the resources to the teacher. Another source of information could be science training, either by the teacher or the science co-ordinator in the school

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.

10.3 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 10-3: Suggested links with industry before the CCI project



40% of the teachers either did not answer the question and left it blank or said they did not know about possible links with industry. Some of the teachers wrote down specific links such as site visits and some said they would welcome ideas. Categorised under 'other links' was 'practical experience' and community links.

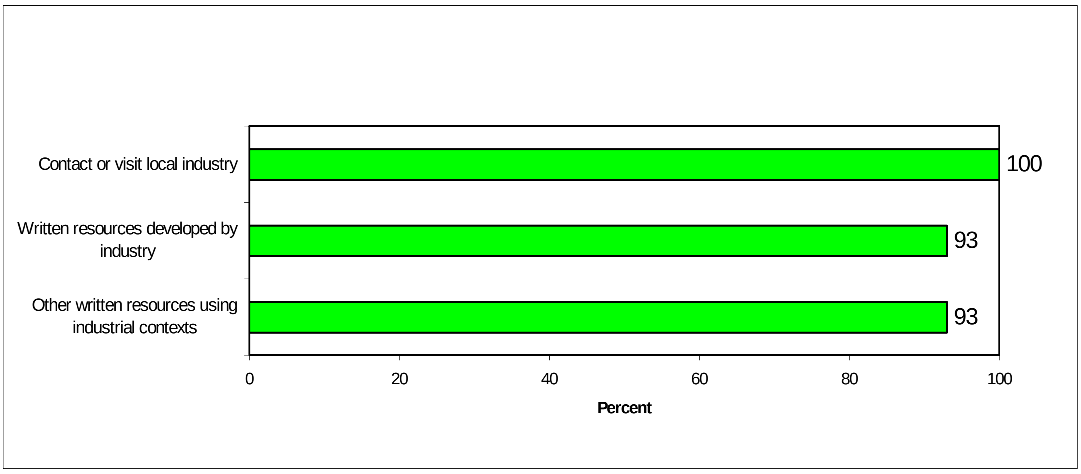
60% of teachers said they wished to create a link, which suggests that teachers would like to learn more about how industrial links could be beneficial to them.

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.

10.4 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 10-4: Use of resources after the CCI project



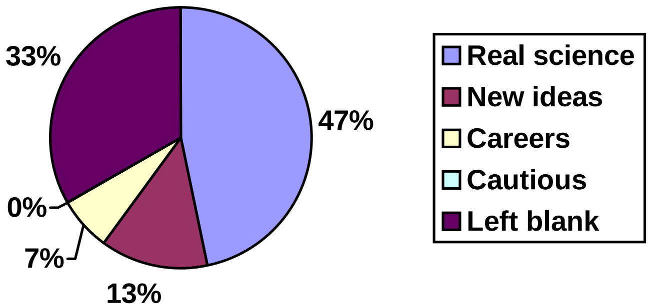
All the teachers stated that they would like to have contact with local industry and all but one of the teachers said they would consider using resources developed by industry or other sources.

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 60% 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 30-40%.

The teachers were also asked why they would or would not consider using industrial resources. The results are shown in Figure 10-5.

Figure 10-5: Reasons for using industrial contexts



Nearly 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 20% of teachers gave other reasons for using industrial contexts such as it gave them new ideas for teaching science other than real life context or it teaches children about possible career paths.

A third of 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 wonderful quotes from teachers talking about why they think industrial context is a good thing:

“Using industry in this way takes science beyond the classroom and opens up new areas of understanding.”

“Gives a reason for investigative science.”

“I know feel industry is more accessible and can see links particularly with AT1 work.”

“Sets the learning areas in a context, which makes it easier for children to understand.”

“Helps make science meaningful to pupils.”

“Any extra professional resources would be useful. Contact with industry would give children a clearer picture of the world of work and help them make career choices later - gives them something to work towards.”

“It gives a great context for learning and roots learning onto something tangible. The video we watched about Styrofoam really got the class thinking about the world outside school and they went home and found out all about packaging.”

“It made it interesting for pupils and brought science to life.”

Time is often 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.

10.5 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 42% of teachers who had used resources were most likely to say that they did so because they were free.

The change in attitudes towards industrial resources that occurred during the training was very positive. All the teachers thought that visits would be useful and 93% of teachers wanted to use resources developed by the industry or other sources. This was very positive when compared with 42% of teachers who had used industrial resources and 60% 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.

11 Conclusions

11.1 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 small 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, smelly, dark and hot.

The classroom and site visits provided ideal environments to learn about the roles of scientists and engineers. Many of the children learned about the importance of scientists and engineers and their roles on industrial sites. After the CCI project the children were more likely to draw a scientist or engineer and significantly less likely to draw a materials handler.

When given a choice, children chose scientist as jobs they would like to do in industry 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 8% after the project which was not significant with a sample of this size. However if this increase was maintained with a larger sample it would be significant.

The project raised the children's awareness dramatically, of the variety of jobs held in industry. After the project, a third of all the children mentioned that scientists and engineers worked in industry. Jobs such as 'materials handler' were mentioned 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 had gained an insight into how the work they carry out in the classroom was related to how science is carried out in the real world in industry. This could be in a laboratory on site or on a huge scale in production. Having this knowledge could encourage children to consider careers in industry in the future.

11.2 Teachers' data

The reaction to the training was extremely positive. Most teachers had nothing but praise for the training received. Many 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 geography curriculum, than the science curriculum. This means that many children are more likely to learn about the more negative aspects of industry such as pollution rather than the positive side of manufacturing. Many teachers were not aware of the relevance of teaching science with an industrial context to make the subject more interesting and relevant. Half 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 during the project. Some of the teachers were able to say with detail what the chemical industry does at the beginning of the project. By the end of the training eight 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. All teachers thought that visits would be useful compared with 60% of teachers wanting links before the training. After the project, 93% of teachers wanted to use resources developed by the industry compared with 42% of teachers who had used resources before the training. After the project, the majority of teachers were extremely positive towards the chemical industry.

11.3 Summary

The CCI project clearly achieved its main goals. The children and teachers were more knowledgeable about industry and the role of scientists after the project. Children were able to depict industrial sites 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. More children were aware of scientists and engineers and their roles in industry. 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. The children were really enthusiastic about the project as reported by the teachers.

12 Appendix 1: Questionnaires

- Background
- Pre-questionnaire
- Post-questionnaire

13 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 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
- Addition of pipes
- Removal of furnace
- Removal of conveyor belt
- Addition of control panel
- Addition of process or scientific equipment
- Addition of company name
- Labelling, which demonstrates particular pieces of new knowledge
- 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.

14 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 14-1: Sources and results of children's images of industry

Child	Code	Result for outside picture	Result for inside picture	Industrial visit
1	271/2	4	6	None
2	273/1	3	5	None
3	282/4	2		Avecia
4	288/4	0	0	None
5	275/2		2	None