Report Title:	**Children Challenging Industry** **Analysis of children's & teachers' data from the West Yorkshire region, 2003.**
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1 Executive Summary

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

The advisory teacher demonstrated how industry could be used as a resource, by providing a real and motivating context in which to teach science. The 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 as follows:

- 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

28 children completed questionnaires between January and July 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 dangerous with many people working on production lines. After the CCI project the children were more likely to say that an industrial site was safe and employed fewer people than expected.

The children drew pictures of their perceptions of industry, both before and after the project. Many of the children's drawings of the internal and external views of an industrial site were more detailed after the project.

The children were asked to draw someone in industry, give this person a job title and list other jobs carried out in industry. After the project, the children were more likely to mention scientist and engineer. The children were three times more likely to mention scientist, and nearly twice as likely to mention engineer. The number of children listing or drawing a 'materials handler' (i.e. jobs involving handling materials directly, such as pouring, stirring, etc.), dramatically decreased.

After the project, when asked which job they would choose to do in industry, the children were slightly more likely to choose scientist or engineer as a job they would like to do. They were less likely to choose to be a 'materials handler'.

Nearly all the children thought scientific testing was important.

By the end of the project, the image of scientists was more positive. If these views were sustained it might be expected that the number of children who wanted to work in industry would rise.

1.2 Teachers' data

Seven teachers returned questionnaires between January and July 2003, before and after the CCI project. Two of the teachers had not had recent training in delivering the science curriculum and training related to industry was much less common with only one teacher having experienced this.

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

The feedback from the training was overwhelmingly positive. The sessions were of a high standard and were highly rated by all the teachers. The weaknesses most likely to be mentioned were that there was too much to cover and there were problems with timing in the school calendar.

Prior to involvement in CCI, when prompted, nearly all the 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, six out of the seven 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 of good educational standard, related to the national curriculum, appropriate to the age range and free.

There was a positive change in attitudes towards industrial resources by the end of the project. All the teachers thought that industrial visits would be useful in future and said they would like to use resources with industrial context in the future.

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.

Successful teaching of science is dependent on adequate knowledge of science and 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.

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 some of the 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 targeted mail-shots within West Yorkshire. Clusters of schools close to industrial sites were selected, in order to increase the opportunities of offering site visits to schools.

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 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, where possible.

The training was provided to 16 classes in the spring and summer terms 2003 in the West Yorkshire region.

The teachers and children from seven of these classes returned questionnaires for analysis, before and after the project containing questions about science and industry. Four children from each class returned questionnaires making the total number of children's questionnaires 28, together with 7 teachers. Four of the schools included children from year 5 and three were children from year 6. There were sixteen girls and twelve boys.

The teachers' and children's data was collated and input into Stata, a statistical software package. The main areas of interest were:

- Children's views of industrial settings
- Children's views of industrial jobs
- Children's views of science and industry
- The reaction of teachers to the training
- Knowledge and perceptions of the teachers with regard to the teaching of science and industry.

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

Some of the variables analysed in this report are compared with the results obtained in the previous study by Joy Parvin (Parvin, 1999). This study refers to data collected in 1996 to 1998, when 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 and reports for four other regions.

All the schools that provided the questionnaires for analysis chose the topic *Water for Industry*. Only one school was able to benefit from a site visit as part of the project, and this was to Rohm and Hass.

3 Children's views of industrial settings

This section discusses the children's views of industry in two parts. The first part focuses on descriptions of industrial sites and the second part discusses the children's drawings of an industrial site.

3.1 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 most important area where there was noticeable improvement was in the children's attitudes towards safety. The proportion of children who said that industrial sites were safe, tripled from 8% to 25%. This is a more accurate view of modern industrial sites where safety standards are extremely high and where many of the processes have been automated. Before the project the vast majority of children saw industrial sites as dangerous places to work.

There was a dramatic decrease in the proportion of children who thought that industrial sites were dark from 42% down to 27%. However, there were no significant changes in the proportion of children who thought that sites were noisy, smelly hot or dirty. This was possibly due to the fact that only one school had a site visit. The site visit is important for raising awareness of the environment of industrial sites, which may be hard to convey in the classroom environment.

One aspect of industry that appears to have been learned successfully in the classroom is the accuracy regarding number of people on a modern industrial site. Before the project all the children said that they thought there would be many people working on site. Whereas after the project a third of the children (36%) thought that an industrial site would contain few people. This was a dramatic change from their initial views.

In summary the children had improved their views of industry in some areas such as safety, number of people working on site and whether a site was well or badly lit. there were some areas where the views of children did not improve significantly, possibly because they did not have a site visit.

3.2 Drawings

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 positive score demonstrated improved knowledge of industry and a 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.

The external drawings produced a median score of zero providing some evidence that there was no significant improvement in the children's knowledge of the external image of industry. However the median score for the internal pictures was 1 suggesting that there was a statistically significant difference in their knowledge. A Wilcoxon signed rank sum test (an alternative to the t-test, which is used when the data is not necessarily normally distributed) was significant ($p<0.01$) and

confirmed that the children's knowledge of the internal aspects of industry had significantly improved by the end of the project.

In the next section, examples of drawings have been provided to illustrate the differences between these pictures. 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 'old fashioned' 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. All the children completed the topic *Water for Industry.*

The following two pictures are from a child who studied *Water for Industry,* obtained a high score and did not have a site visit.

Figure 3-1: Child 1, external picture of industry before the CCI project

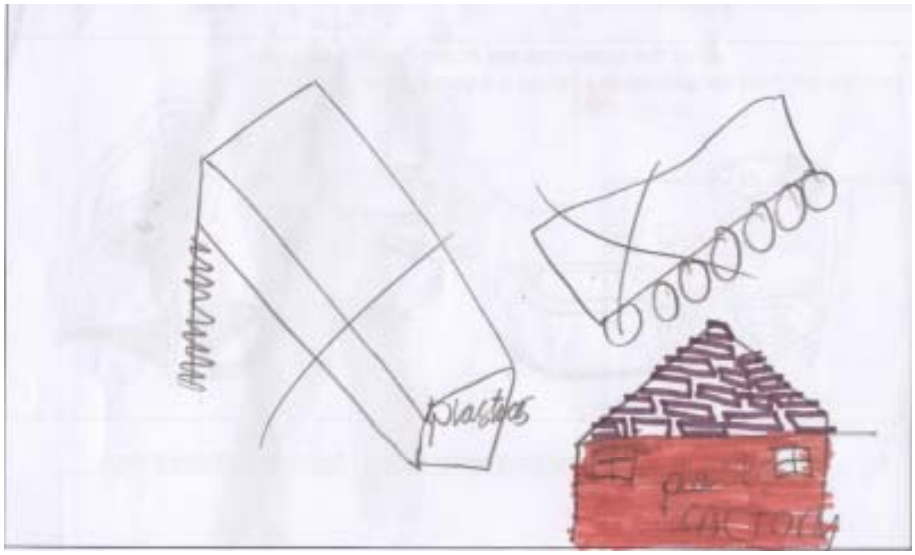
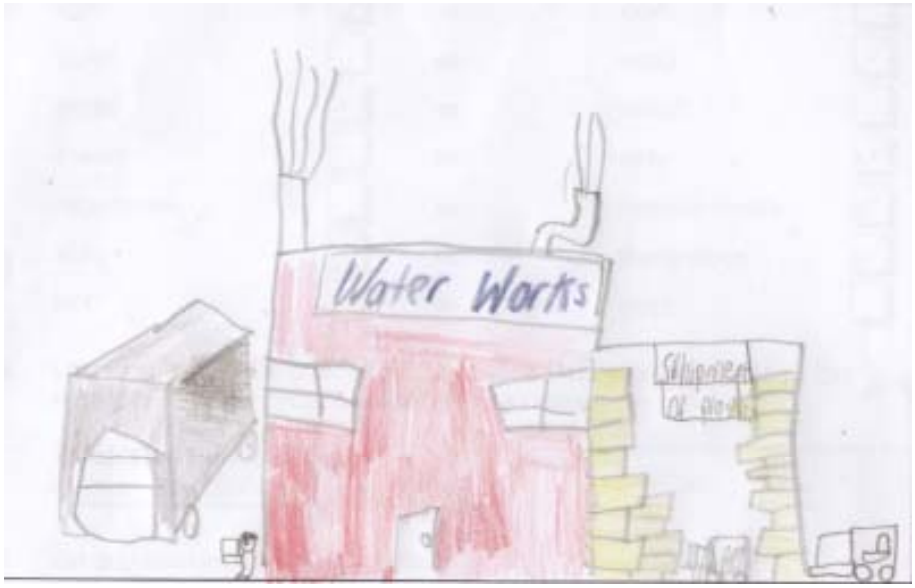


Figure 3-2: Child 1, external picture of industry after the CCI project



The pre-intervention drawing is quite vague with what appears to be two buildings but very little detail. The post-intervention drawing is more comprehensive. There are people and vehicles on the site as well as more detail on the buildings such as windows and a company name. Also included is an area labelled as shipment of plastic. This represents the area where raw materials are unloaded ready to be used on site.

The following before and after pictures are obtained by a child who also studied *Water for Industry*, received a high score and did not have a site visit.

Figure 3-3: Child 2, external picture of industry before the CCI project

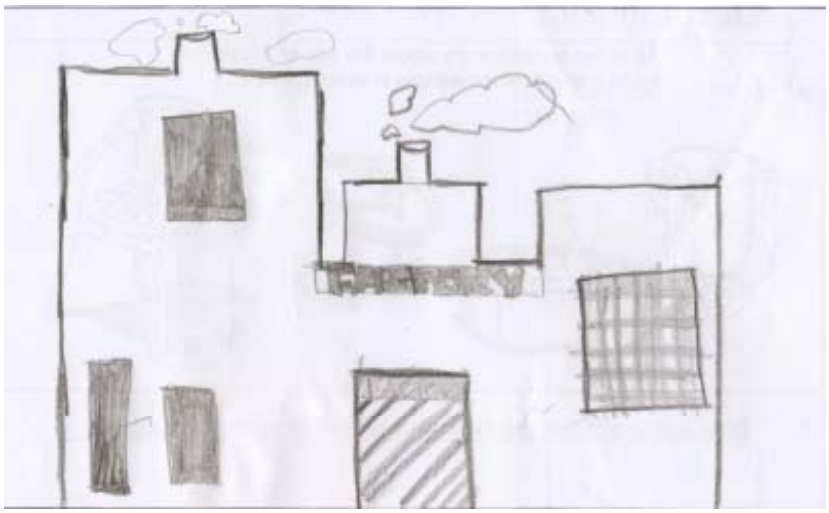
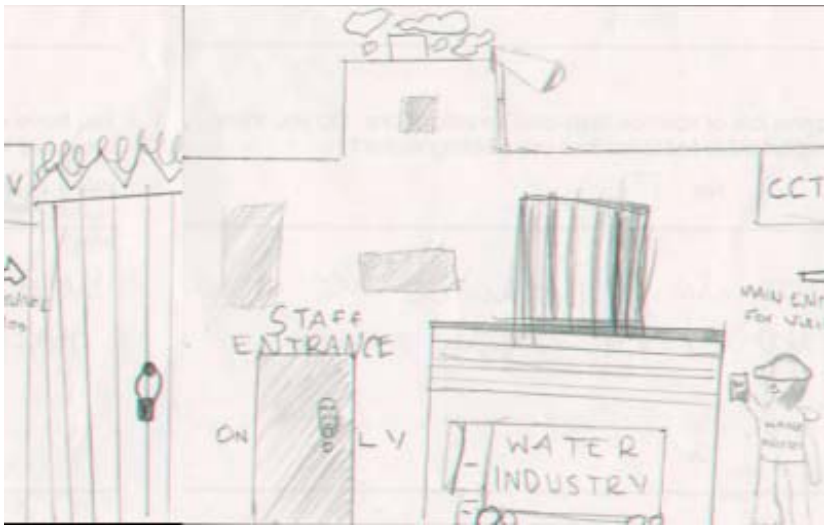


Figure 3-4: Child 2, external picture of industry after the CCI project



As before, the post-intervention picture provides more detail. A person has been included along with signs above the doors. The number of chimneys has been reduced from two to one. Very few sites ever have more than one chimney. It's not clear whether smoke or steam is depicted.

The next 2 pictures are from a child who studied *Water for Industry*, received a moderate score and had a site visit to Rohm and Hass.

Figure 3-5 : Child 3, external picture of industry before the CCI project

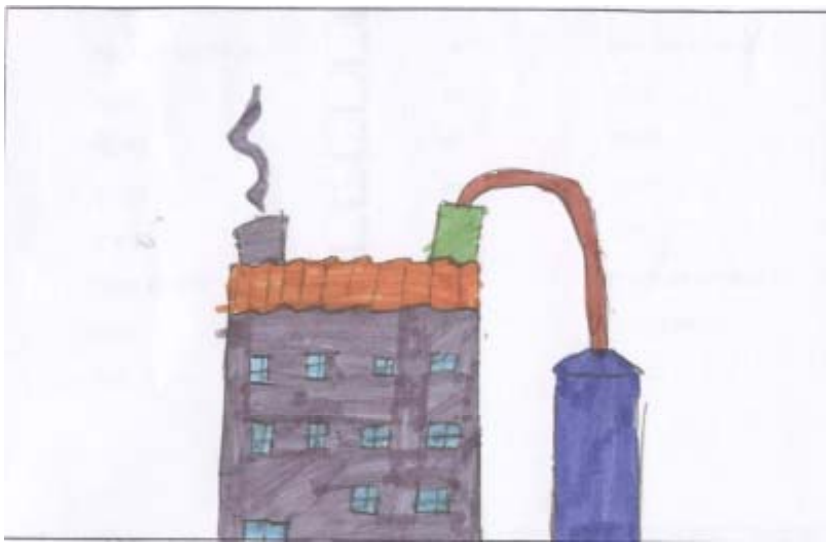
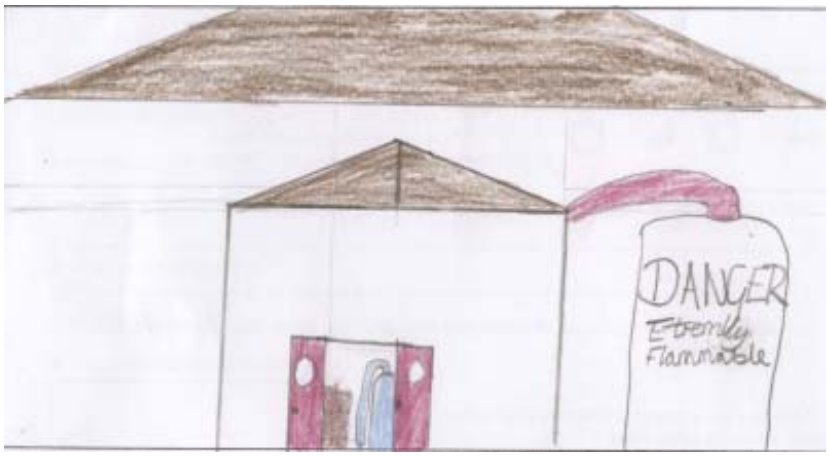


Figure 3-6 : Child 3, external picture of industry after the CCI project



Before the project, the child portrayed quite an old fashioned image of industry. The building drawn was dark and sombre with many small windows and a chimney belching out black smoke. Afterwards, the child's drawing depicted a more modern low level building with no smoking chimney. Other details such as storage containers and closed pipe-work, were included in both the first and second picture. A specific container was labelled as dangerous which may relate to what this child saw on the visit.

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, some of the children drew pictures depicting a very '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 by a child who received a high score and did not have a site visit.

Figure 3-7 : Child 1, internal picture of industry before the CCI project

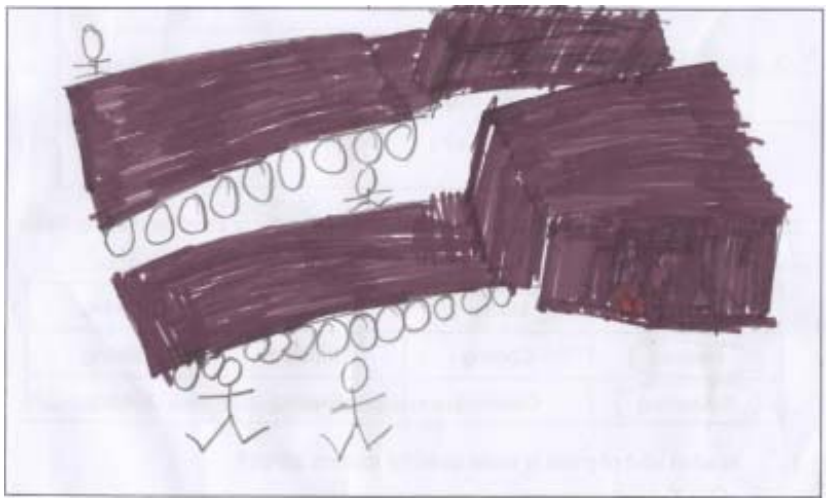
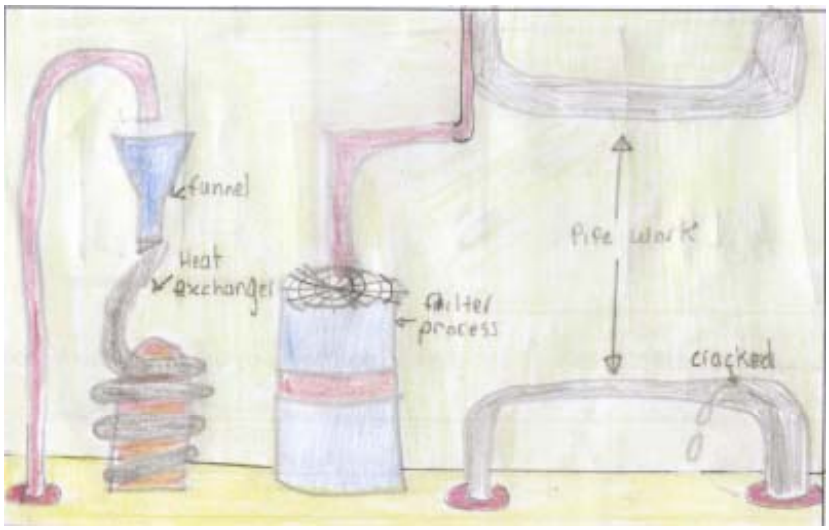


Figure 3-8 : Child 1, internal picture of industry after the CCI project



The pre-intervention drawing appears to depict two long conveyer belts with machine operators involved in the industrial process. It is not clear exactly what is being made in this picture. The post-intervention drawing provides more accurate detail of what occurs on a modern industrial site. There are enclosed pipes, that are labelled and which connect different sections of the site. There is also an excellent drawing of a heat exchange coil complete with funnel. This child has represented all the classroom activities in their picture, including investigating sealants for a fictitious "leaky pipeline". An industrial visit would have helped to contextualise what they had learnt in the classroom.

The next two pictures are from a child who had a high score and did not have a site visit.

Figure 3-9 : Child 2, internal picture of industry before the CCI project

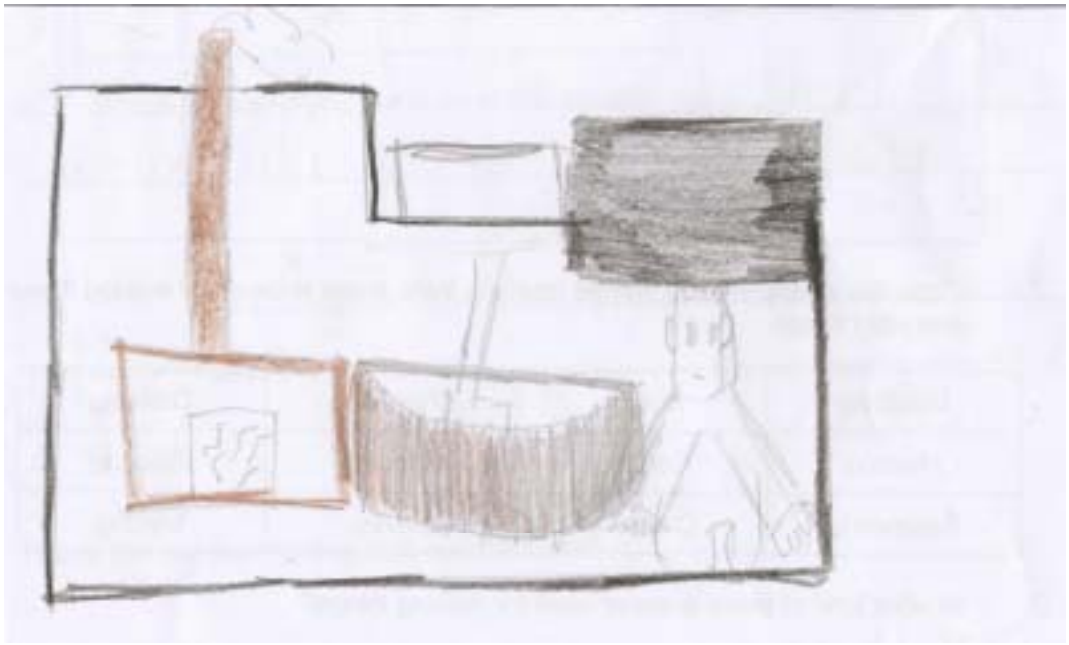


Figure 3-10 : Child 2, internal picture of industry after the CCI project

The pre-intervention drawing is difficult to interpret but seems to portray an old fashioned view of industry. There is a person working in a boiler room stoking up the fire which is producing smoke from the chimney. The post intervention drawing is very different and includes more detail with some items also labelled. There are enclosed pipes that lead into specific containers. There are warning signs for employees to wear the right clothes indicating that clothing and safety may have been emphasised during the project. The person portrayed in the picture is wearing a hard hat which supports this idea. There are other hazard signs such as "Warning no children", however if the child had been on a site visit they would have realised that children ARE allowed on site. They would have learnt that there may be warning signs in place but these indicate that the area is safe due to the many safety precautions in place.

The following two pictures are from a child who had a site visit.

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

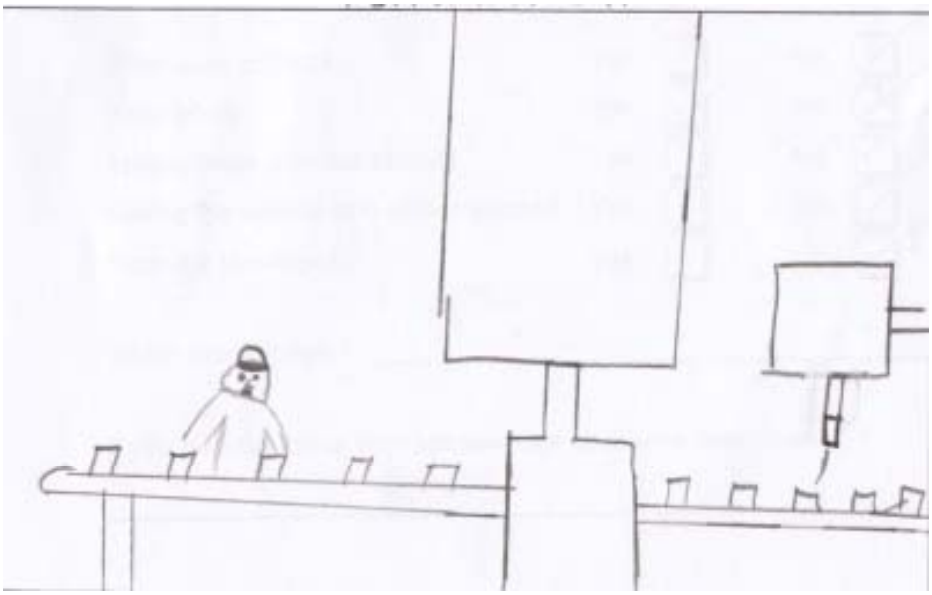


Figure 3-12 : Child 3, internal picture of industry after the CCI project

When asked to draw the inside of an industrial site, this child included a person working on a conveyer belt. The vessels on the belt appear to be open and filled from a machine on the right. In the second drawing, the conveyer belt has disappeared and tanks connected by enclosed pipes have taken its place. Again, as in the previous post intervention drawing there are many danger signs. It is unclear whether these indicate and increased awareness of danger or safety.

3.3 Chapter summary

After the project the children were more likely to say an industrial site was safe and contained fewer people than expected.

By the end of the project, many of the children were able to draw more detailed external and internal images of industry, particularly the internal aspects of industry, whether they had been on a site visit or not. This indicated an increased awareness of the processes involved in industry.

4 Children's views of science and industry

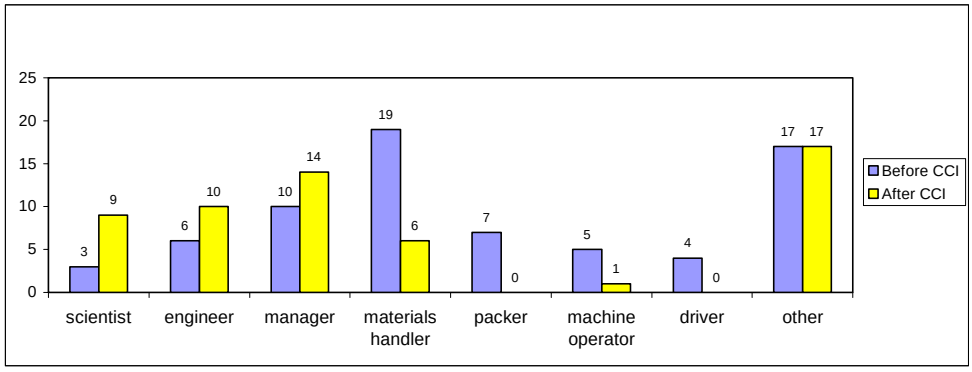
This section deals with children's perceptions of jobs occurring in the industrial workplace and of how science relates to industry. It is divided into three sections:

- Children's knowledge of jobs in industry
- jobs the children thought they would choose to do in industry
- importance of science testing.

4.1 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 also asked to list jobs, that they were aware of, that were carried out in industry. The answers from both these questions were combined to investigate how many children in total, before and after the project, were conscious that scientists and engineers worked in industry. The changes in awareness of these and other industrial jobs are shown in Figure 4-1.

Figure 4-1: Industrial jobs recorded by children



Before the project many of the jobs the children mentioned 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 often described what the person did rather than giving a job title. The number of children mentioning a materials handler decreased dramatically after the project from 19 children down to 6. Other jobs that were also mentioned less often were packer, machine operator and driver.

There were three jobs that increased after the project. These were scientist, engineer and manager. The number of children who mentioned scientist or engineer increased considerably after the project. Before the project took place, the children were unlikely to mention scientist or 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 who included a scientist in their drawing or list of jobs increased from 3 to 9 children. In addition, the number of children listing engineer increased from 6 to 10 children. The percentage of children who mentioned a scientist or engineer was 43% which is a similar figure to that obtained in other regions where larger sample sizes had been used.

The listing of other jobs that were categorised under 'other' did not change significantly such as security officer, cleaner, office worker and supervisor.

4.2 Chosen Job

The children were asked which job they would like to do on an industrial site.

Before the project, the most popular job chosen was 'materials handler'. Children wrote down words describing this type of job such as 'pouring', 'moulding', 'heating' or 'melting'. The children were far less likely (a reduction from 8 to 2 children) to choose this job after the CCI project. They were also less likely to choose supervisor (someone who checks that something is working properly) which reduced from 3 children to no children.

The children were more likely to choose scientist after the project which increased from 1 to 4 children. One child stated they wanted to be an engineer compared with no children giving this view before the project.

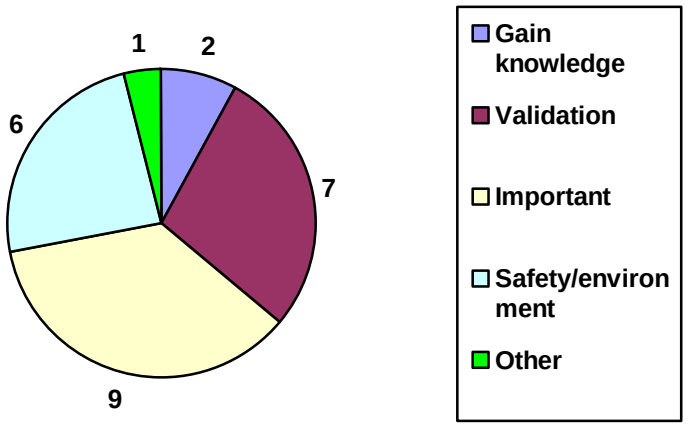
Parvin (1999) also found that materials handler was by far the most common job chosen before intervention. She too found a decrease in the number who chose 'materials handler' and a rise in the number of children who chose scientist after the project.

4.3 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 industries that manufacture the products they have been studying. 26 out of the 28 children said that they thought the tests were important. Only one child did not think the tests were important and one child gave no response.

The children were asked their views on why they felt the tests were important. The children gave many different reasons for their views. These are shown in Figure 4-2.

Figure 4-2: Reasons why children think science tests important to industry



Roughly a third of the children felt the tests were important for safety reasons. Some quotes are provided below.

"Yes because it is not good for people to drink dirty water."

"It keeps you safe."

"So no-one is in danger."

Another third felt it was important for testing or checking (validation)of the process to ensure that the process is correct. Some quotes are included below.

"Because they may need to make sure it is right."

"Testing for chemicals in the water."

"I think they do because we had to get things perfect. So do they, but they use more things."

About a third said tests were important but did not give further details other than because they are useful.

"I think that the investigations that we did were very important and factories will do similar things. Cooling water is very important for lots of different reasons like to mould plastic."

"This is because it shows how useful water can be."

"Because materials may need cooling before being used."

Two children also mentioned that tests were important to gain knowledge about the material or process.

"Because they would like to know what would happen."

"To improve the way things work."

One child explained why they thought tests were not important.

"No because it takes too long and will be so hot and large."

One child's answer was categorised under 'Other'.

"Because if they didn't do these tests they would get sacked!"

These responses are an indication of the range of responses that can be expected from this age group. The vast majority of the children understood that the experiments they carried out in the classroom were related to what occurs in industry, albeit on a smaller scale.

4.4 Chapter summary

The children learned about the importance of scientists and engineers and their roles on industrial sites. After the CCI project the children were 3 times more likely to mention scientist (an increase from 3 children to 9 children) and nearly twice as likely to mention engineer (an increase from 6 to 10 children). In addition, they were far less likely to mention materials handler when asked to draw or list industrial jobs. Nearly half of the children stated that scientists and/or engineers worked in industry.

The proportion of children saying they would like to be a scientist or engineer increased after the project from 1 child to 5 children. The children were far less likely to choose to be a materials handler after the project. The classroom sessions therefore seemed to increase the children's knowledge of the role of scientists in industry. The classroom sessions were designed specifically to link the science done in the classroom with that done by professional scientists on a site.

Nearly all of the children felt that scientific testing was important and relevant. There were many reasons why they held this opinion, the most common ones being safety considerations or for validation of the industrial process.

5 Teachers' links with science and industry

5.1 Training and Work experience

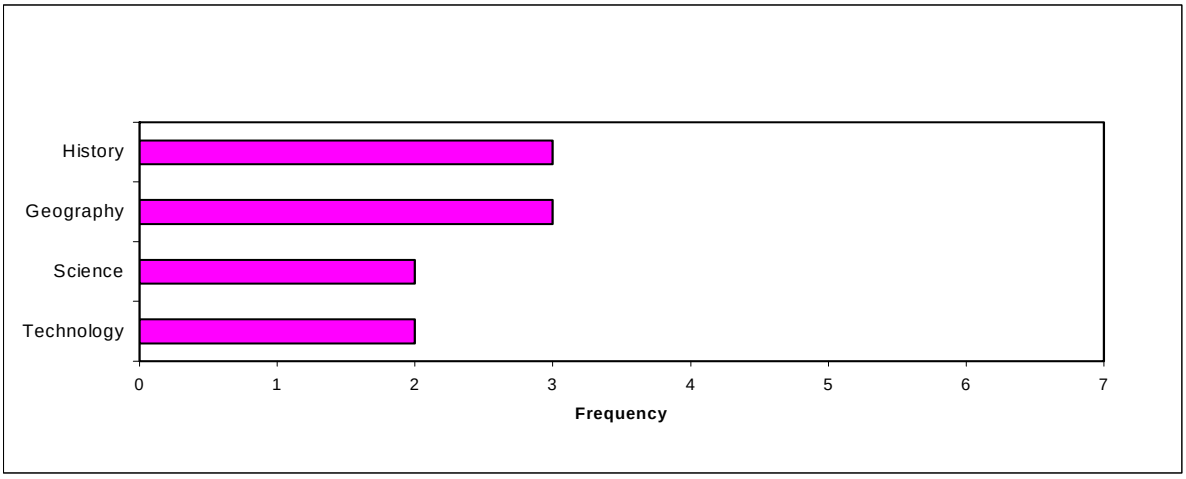
Teachers were asked how many days of science training they had undergone in the last 3 years. Five of the seven teachers had had up to four days' science training experience. However, experience of industry training was less common than science training, with only one teacher having this type of training.

Teachers were asked if they had worked in industry. None of the teachers had ever worked in industry. All teachers have five training days per year where they must cover all aspects of the primary curriculum. 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 SETPOINTS which provide industry-related information, and possibly placements.

5.2 Teaching of industry within the curriculum

Teachers were asked where they taught about industry in the primary curriculum. The results are shown in Figure 5-1.

Figure 5-1: Subjects covering industry in the curriculum



The teachers were slightly more likely to teach about industrial topics in history and geography than in the science curriculum. These subjects tend to portray industry in an old fashioned way through learning about the Victorian era or World War 2, or as a polluter when learning about the environment in geography. Industry was included in the 'materials' topic in science by two of the teachers.

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.

5.3 Industrial links and use of resources

Teachers were asked about their links with industry. Only one teacher said that their school had a policy on industrial links although three teachers said that their

school had links with a local company. These were Ferrybridge power station, Rohm & Haas Chemicals and Linpac plastics. The teacher who had links with Linpac also said that they had links with a local company. All three of the teachers who had industrial links felt that they would like future links with companies such as visits to and from the companies. The teacher who had links with two companies said they wanted to see industry producing ideas for scientific investigation on QCA topics.

It is clear that teachers at schools with industrial links are aware of the benefits to children and would like to sustain and develop these connections with industry in the future. One of the aims of the training was to encourage teachers who did not have industrial links with industry, to forge new links with companies and learn about their benefits to the school.

The teachers were asked whether they had used any resources from industry. Two of the teachers said that they had used industrial resources in the past and these were produced by BP and Esso.

5.4 Chapter summary

It was rare for teachers to have had industrial training. Only one teacher had done so compared with five teachers who had had science training. None of the teachers had worked in industry.

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

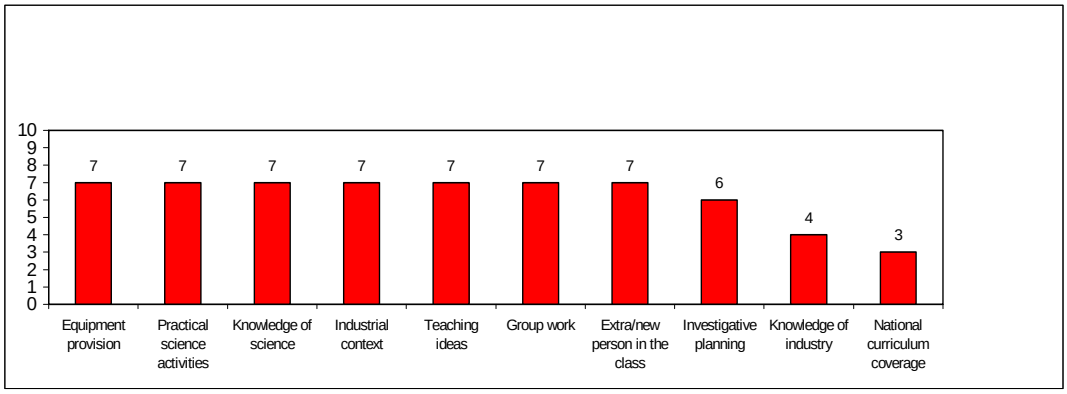
Only one teacher said their school had a policy on industrial links although three teachers said they had links with other companies. Two of the teachers had used industrial resources in the past.

6 Teacher's reaction to the CCI project

6.1 Strengths

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

Figure 6-1: Strengths of the CCI project



All the teachers indicated that equipment provision, practical science activities, knowledge of science, industrial context, teaching ideas and group work were strengths of the sessions. Investigative planning was also rated as a strength by all but one of the teachers. However only three out of the seven teachers rated National Curriculum coverage as a strength. Is it possible that the relationship of the training to the curriculum is not being stressed enough. Recent changes to the science curriculum have put more emphasis on testing investigative methods and therefore the training is extremely relevant to this part of the curriculum.

Another interesting factor was that knowledge of industry was rated as a strength less often than knowledge of science. The teachers may be more likely to see the visit as the industry side of the training and the classroom activities as the science side of the training. However as only one class had a visit this idea could not be analysed in any more detail.

6.2 Weaknesses

The teachers were asked whether they thought there were any weaknesses to the sessions. One teacher thought that there was too much to cover. This has already been considered by the team of advisory teachers and strategies to deal with it put in place. Two teachers thought that timing in the school calendar was an issue. Actions have been taken to offer all schools freedom of choice of when they do the project. It is therefore unlikely that the proportion can be reduced much further as it is due to the unavoidable problem for teachers of shortage of time.

6.3 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.

The weaknesses most likely to be mentioned were, 'too much to cover' and 'timing'.

7 Knowledge and attitudes of teachers

7.1 Knowledge of the chemical industry

The teachers were asked to describe the chemical industry. The most common response was that the chemical industry made products or chemicals. Quotes from the three teachers who gave this type of response are provided below.

"An industry which produces various materials for everyday life."

"Provides essential items."

"Produces chemicals."

Two of the teachers were able to say that chemicals were combined to produce new products, which was seen as the most informative answer. See the quotes provided below.

"Produces/mixes chemicals to make new and useful chemicals for other industries/users."

"Making products and bi-products using scientific processes."

The remaining two teachers commented on other aspects of industry such as whether it was good or bad.

"Useful but not always responsible in their actions as motivated by profit."

"Large factories."

Only a minority of the teachers provided any detail about the industry. Parvin took this questioning further and found that information was more likely to come from the media and other sources that are prone to spend more time discussing the negative aspects of the chemical industry, rather than what the chemical industry actually does.

Teachers were asked to list products of the chemical industry of which they were aware. All the teachers listed two or three products. The results are shown in Table 7-1.

Table 7-1 Products listed by teachers

Product	Number of teachers
Household	5
Paint	4
Plastic	3
Medicine	3
Oil	2
Agrochemicals	1
Food	1

It was hoped that during the training the teachers would learn more about industry, and how it relates to science.

7.2 Industrial knowledge gained through the training

Teachers were also asked what they had learned about science. Five out of the seven teachers stated that they learned something new about science.

Three teachers wrote that they had learned about aspects of science that would be covered in the National Curriculum.

"Processes, heat exchange, sealants."

"Heat exchanger activity is something I will do, not done before. All activities very good, will relate to industry."

"The use of the bottle of water to cool warm water was more effective when the pipe was inside the bottle – I thought it would be the other way round."

The remaining two teachers thought the project had improved their delivery of science lessons by making science more fun or giving it a real life context.

"Science can be fun if you have help and support."

"Scientific investigation is best carried out using examples from industry – give it a real life context."

Teachers were asked whether they had learned anything about industry. They were also asked what they had learned.

Two out of seven of the teachers stated that they learned something new about industry during the training sessions. Quotes from both these teachers are provided below. The first quote is from the teacher who had visited industry.

"Put the work we had done with John in context. Positive image of chemical industry – hopefully planted a seed of future careers."

"Brought to the forefront that industry affects our lives constantly in one way or another."

It was disappointing that so many of the teachers did not say they had learned something about industry. One reason for this may be that only one of the schools that returned questionnaires, visited industry and it was the visit that the teachers most closely associated with learning about industry

All except one of the teachers said that they learned something about industry or science, or both.

7.3 Attitudes towards industry, links and resources before the training

Teachers were asked their views on how industry affected their lives. One teacher did not fill in this part of the questionnaire. All six teachers thought that the chemical industry was necessary to produce the 'every day' products that we need. Five out of the six teachers also felt that there was a negative aspect of the chemical industry, namely pollution.

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 their attitudes are not that there should not be a chemical industry.

Teachers were asked whether they had used resources and two teachers said that they had. Both said this was because of the good educational quality of the materials and the fact that they fitted in with the National Curriculum, as well as

being cheap or free. They also thought that they were appropriate for the children's age group.

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

The five teachers who had not used industrial resources were asked for reasons why they had not used them. Three of the teachers did not give any reasons why they had not used any resources. Of the remaining two teachers one was a new teacher who said she had not seen any as she was just starting her teaching career. The seventh teacher said that he had not seen many but was also worried about company propaganda.

Teachers have limited time to assess the suitability of educational materials so it would be difficult for teachers to search for information when they do not know where to find it. In addition, some teachers may not be aware that useful information is available from companies for such a young age of children. Other teachers may think that there is enough information in the curriculum already.

Teachers were asked what types of links they would like to have with industry before being involved in the CCI project. Three of the teachers did not answer the question and left it blank. Two of the four remaining teachers thought that site visits would be useful and one school already had links of this nature with a local company.

"Continue visits to Rohm & Hass. Actual visit to labs etc. to see computers."

One teacher favoured resources provided from industry and the remaining teacher wanted to re-establish links with a local company but gave no specific details.

"Would like to see industry producing ideas for scientific investigation on QCA topics."

"Need to re-establish Clariant links." (local company)

7.4 Attitudes towards resources and links after the training

After the training sessions and visit to industry if they had one, teachers were asked about their views on using resources produced by industry in the future.

Six out of seven of the teachers said they would like to use resources developed by industry in the future. All the teachers stated that they would like to have contact with local industry and would consider using resources developed by other sources.

The response of teachers after they had the training sessions was positive compared with the half who said they wanted links before the training.

The teachers were also asked why they would or would not consider using industrial resources. Five of the teachers highlighted the fact that teaching primary science without giving it a context made it more difficult for the children to understand the relevance of science. Quotes are provided below.

"Places science in real world context."

"It helps to bring science into context for the children, showing them its applications in the day to day world."

"Visit would place science in a real life situation. Not something that stands in isolation."

One teacher mentioned that having visits and using industrial contexts increases enjoyment of primary science for the children.

"A great experience."

One teacher was more sceptical.

"I am generally sceptical of materials developed by people who don't work with children."

What many teachers do not realise is that the materials are written by teachers.

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. They were given a list of reasons which was compiled from all of the teacher responses from an open ended question in an interview in Parvin's original study. This list did not include real science so they would have had to have added it under 'other reasons' but none of the teachers did this. 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.

Time was 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.

7.5 Chapter summary

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

All except one of the teachers said they had learned something about industry or science, or both, by the end of the training.

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 most of the 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 two teachers who had used resources said that they did so because they were of good educational quality, fitted in with national curriculum, were free and were appropriate for the age group.

Four of the teachers said they would like their school to have links with industry.

There was a positive change in attitudes towards industrial resources by the end of the project. All the teachers thought that visits would be useful and would consider

using resources with an industrial context. Six out of the seven teachers also said they would use resources developed by industry.

8 Conclusions

8.1 Children's data

The CCI project involved children from primary years 5 and 6. The advisory teacher was able to offer a variety of topics to the teachers and children, to suit their needs and interests. The topic *Water for Industry* was the most popular choice and was chosen by all the schools where data was collected.

After participation in CCI, children were able to depict more detailed drawings of the internal images of industry. This demonstrates their increased awareness of the processes involved in making products. Results indicate that as a consequence of the project the children were more likely to think that industrial sites were safe, and had fewer people than expected, a more accurate reflection of how industry is today.

However, the children had other views of industry that remained unchanged such as the environment of industrial sites and the external image of industry as depicted in their drawings. This is almost certainly due to the fact that very few of the children had a site visit. A site visit would have increased the children's awareness of environmental factors such as temperature and noise as well as what modern sites look like.

The classroom and site visits provide 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 mention a scientist or engineer as an important job in industry and less likely to draw a materials handler.

When given a choice more children chose scientist and engineer as jobs they would like to do in industry after the project. The project raised the children's awareness of the variety of jobs held in industry. The children were aware of the need for scientific testing and had many opinions as to why testing was important.

8.2 Teachers' data

The reaction to the training was very positive. Most of the teachers had nothing but praise for the training received. Most of the teachers had not had recent training in science, and training in industry was even less common.

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

Only two of the teachers were able to say with any detail what the chemical industry does at the beginning of the project. By the end of the project nearly all the teachers reported that they had learned something about science and/or industry. However they were more likely to say that they had learned something about science rather than industry. The main reason for this is possibly that only one school had a site visit.

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.

A positive change in attitudes occurred towards industrial resources as a result of the training. All the teachers thought that visits would be useful after the project, and six out of seven of the teachers wanted to use resources developed by industry.

8.3 Summary

Although only a small sample size of 7 teachers and 28 children, this study indicated, that by the end of the project the children and teachers were more knowledgeable about industry and the role of scientists. Many of the children were able to depict industrial sites more accurately and the processes involved inside industrial sites. The teachers felt they had learned about teaching science and reported that they were more likely to use industrial resources. More children appeared to be aware of the roles of scientists and engineers, and aspired to working in these professions in the future. The teachers and children appeared to have increased their awareness of the link between science and industry. The main recommendation for the future would be to increase the proportion of children who visit an industrial site, to build on the improvements in knowledge and attitudes of children and teachers towards the chemical industry.

9 Appendix 1

questionnaires

10 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.

11 References

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