

The pupils were asked whether they would like to be interviewed. A selection of those that had agreed to take part in interviews was then further questioned about their views of the project. This selection included the widest range of views expressed in the questionnaires; ensuring in particular that those with more negative views were interviewed.

The interviews were carried out November to December 2002. The ages given above were as declared on the questionnaire completed in the summer term of 2002. One girl was very close to 15 when completing the questionnaire and will have been 16 when interviewed.

The five schools, six groups and 15 pupils in the sample were:

Table 2-1: Profile of pupils interviewed

Schools	Groups	Ages
Hurworth Comprehensive	1 girl and 1 boy	14, 12
Branksome at Ellerington	1 girl	14
Durham Johnston	2 girls and 2 boys	13, 14, 13, 13
Parkside Comprehensive	2 girls and 1 boy	All 15
Teesdale Comprehensive	5a 2 girls;	Both 14
	5b 2 girls and 1 boy.	All 15

The interviews did not always separately identify responding pupils so systematic analysis of individual responses cannot easily be made. Where possible the different responses of pupils are kept separate. However details are largely given as group responses irrespective of the size of the group. In many cases the varying size of the group accounts for the varying extent of detail remembered and volunteered.

8 teachers were also interviewed to give information about the views of the project from the teachers' perspective.

The aims of this research are stated below.

Research aims

- To identify factors effecting the ability to recall the CCI project lessons
- To identify factors affecting the ability to recall the CCI project site visit
- To explore the range of memories and views concerning the project
- To identify the prevalence and range of lessons covering industry in secondary school
- To identify factors effecting the pupil's views on science and industry and science careers.

3 Background information

Sample

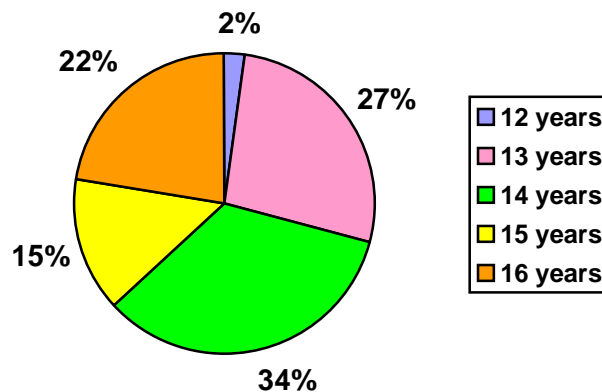
Questionnaires were returned by 90 pupils (35 boys, 53 girls and two unknown) in the summer term of 2002. Not all respondents answered all the questions. For this reason sample sizes differ from question to question.

The interviews were carried out with 15 pupils in six groups in five schools between 26 November and 5 December 2002. These were pupils who had completed the earlier questionnaire and had indicated that they were willing to be interviewed.

Age

The profile of the ages of the sample is shown in Figure 3-1. Nearly all the pupils were age 13 to 16. This means that five years previously when they had undergone the children challenging industry lessons, they were age 8 to 11. They were in years 4, 5 or 6 in primary school at this time. The two children who were age 12 were amalgamated with the age 13 group for all further analysis because they were too few to analyse separately.

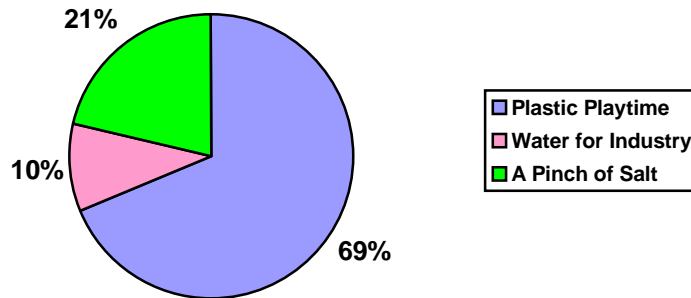
Figure 3-1: Age of sample



Topics

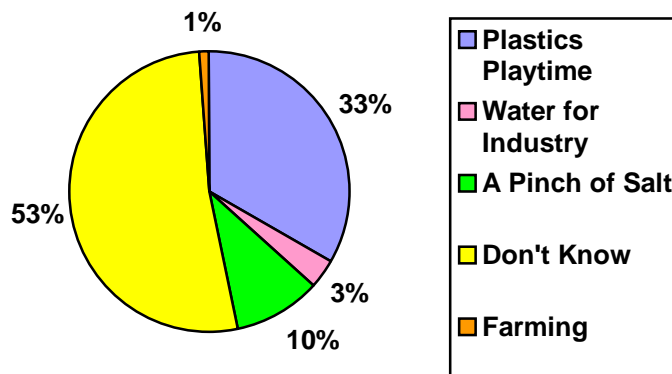
The topics actually covered by the pupils in the sample are shown in Figure 3-2. The majority of the children had undergone the *Plastics Playtime* module with smaller numbers covering *A Pinch of Salt* and *Water for Industry*. There were five pupils who had incomplete information about their school and the topic was unknown. This was a small proportion of the whole sample.

Figure 3-2: CCI Topic covered



The pupils were asked which topic they remembered covering. Nearly half remembered their topic. The results are shown in Figure 3-3. The vast majority remembered the right topic or said they didn't know.

Figure 3-3: CCI topic remembered



Three of the pupils gave the name of a different topic than the one they had covered. One pupil said they had covered the salt topic and another the water topic, when they had both covered *Plastics Playtime*. A third said they had covered the farming topic when they had actually covered *A Pinch of Salt*. The pupils may have remembered other projects covered in primary school and confused them with the CCI project.

4 Recall of the Children Challenging Industry lessons

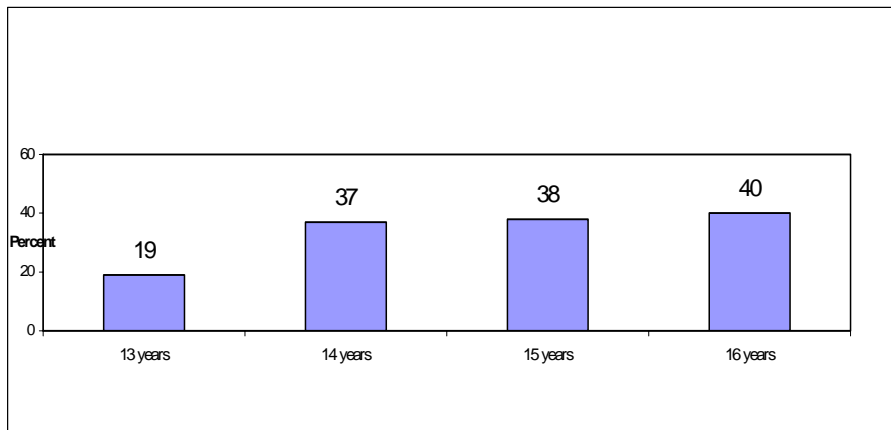
The results of the questionnaires are discussed first, followed by the results of the interviews.

The pupils were asked whether they remembered the lessons of the Children Challenging Industry project. 32% (29) said that they did remember the lessons and 68% (61) said that they didn't remember the lessons. An important point is whether there were particular groups of children who were more likely to remember the lessons.

Age

The age of the pupils was identified as one possible factor affecting their ability to remember the lessons. The number of pupils who remembered the lessons, from 5 years ago, who were 13 years old, was considerably lower than for older children. The trend is shown in Figure 4-1. A Chi square analysis was not significant.

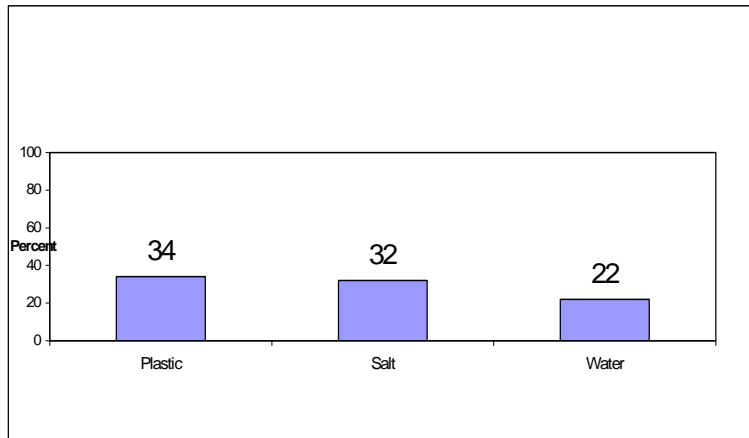
Figure 4-1: Change in recall of lessons by age



Topic

Another factor considered that might affect memory was the CCI topic covered. It is possible that certain topics were more memorable than others. It can be seen in Figure 4-2 that there were small differences between the topics but these were not significant.

Figure 4-2: Variation in recall of lessons by topic



Views on the lessons

The pupils were asked What they remembered about the CCI lessons and whether they thought the lessons were interesting.

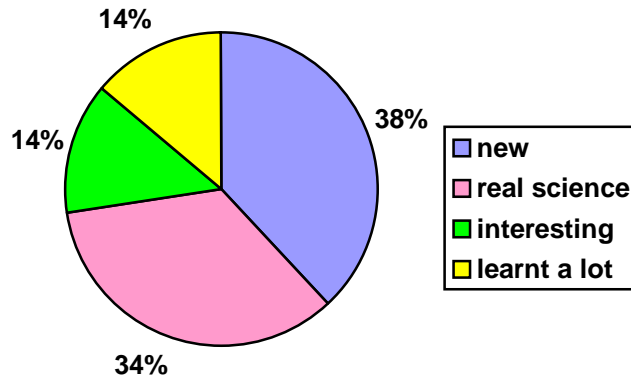
The element of the lessons that more pupils remembered than anything else was the carrying out of practical experiments. For half (16 out of the 29) of pupils who remembered the lessons this was what they remembered most clearly.

A small number of pupils remembered watching experiments or a video or stated they learnt something (8). 4 pupils left the question blank.

The vast majority of the children found the lessons interesting with only 2 children saying they did not find the lessons quite or very interesting. 8 children said they were very interesting and 17 said they were quite interesting.

The most common reason for finding the lessons interesting was because they were new and different and contained a large proportion of practical elements. They were felt to be real science that was relevant to everyday life. The results are shown in below. Some pupils put more than one answer.

Figure 4-3: What was interesting about the CCI lessons



The two main responses were that the CCI lessons were new and contained real science. Details of some of the responses are listed below to illustrate the types of answers given.

“There was lots of practical work, and the whole idea of being in a real company made everything really fun” (girl, age 14)

“When the visiting teacher taught us this I had never done it before and learnt a lot” (boy, age 15)

“Liked the teacher, taught in a fun way that was easy to understand, fun experiments. Teacher said we were real scientists.” (girl, age 14)

“I think this is because the experiments helped me understand how strong different plastics are and how many plastics there are.” (boy, age 13)

“Because it was different to normal science lessons” (boy, age 13)

“Included kinesthetic learning – making and building as well as listening to a teacher.” (girl, age 16)

“We have never done anything quite as fun before as I think if you make children enjoy science they will remember it more.” (girl, age 15)

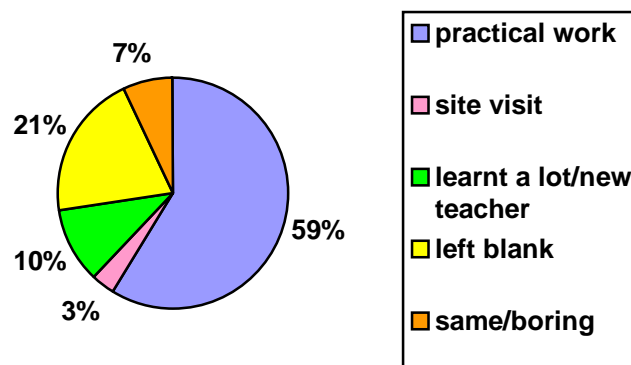
“We got to see and do things.” (boy, age 13)

Two of the children said that the lessons were quite dull. The reasons they gave were that they had to work from text books and didn't do their own experiments. However in the project the children did not use text books so these children may have been confusing this project with other primary science lessons.

The pupils who remembered the lessons were asked whether they thought the lessons were different. Over half (16 out of 29) of these children said they were very different. A further 6 said they were slightly different.

The main reason for this was because the lessons contained more practical work. The reasons are shown in Figure 4-4.

Figure 4-4: Differences between CCI lessons & other science lessons



This is an indication that the amount of practical work normally carried out in the classroom is considerably less than during the Children Challenging Industry lessons.

Further evidence that this is true is provided by Cerini (2003) who found that only a third of pupils responding to their questionnaire said their GCSE theory was regularly backed up by practical experiments. Setting the CCI lessons within an industrial context and including many practical elements increases the motivation and enthusiasm of children (Parvin, 1999).

The next question is whether there is any evidence that science taught in this way leads to an improvement in learning. The recent research by Cerini was conducted by 1500 pupils, asking their views on the science curriculum. Their results showed that 'practical experiments', 'going on trips' and 'class discussions' were found to be the only three ways of learning that scored highly for enjoyment and effectiveness.

The results of the interviews support the findings of the questionnaires.

When asked whether they remembered the CCI lessons some members of five of the six groups could remember the broad topic of their projects without any prompting. The sixth group remembered after an indirect prompt that a visiting teacher was involved. In some cases the interviewer needed to prompt to obtain further details. Table 4-1 summarises what pupils were able to remember.

Table 4-1: Memories of CCI topics

Aspect remembered	Number of groups	Number of individual comments
Details of practical classroom investigations	3	7
Factual recall	2	3
Visit to industry	2	2

In most cases pupils were able to remember a little of the topics covered and activities engaged in. However as pupils in any one group may have been to different primary schools the experiences reported may have been different depending on which materials their school had used and how. Examples of details of the classroom investigations were 'making polystyrene balls', 'wrapping Pringles to send through the post' and 'Tins and rust'.

The groups were asked whether they thought the lessons were interesting or different. Table 4-2 gives the response in relation to 'interest' and Table 4-3 in relation to 'different'.

Table 4-2: Reasons for interest in CCI lessons

Level of interest	Reason	No. of groups
Very interesting	Enjoyment	1
Interesting	Practical investigations	3
Quite interesting	None given	1

Table 4-3: Why groups thought that the CCI lessons were different

Ways in which CCI lessons were different	No. of groups
More practical sessions	5
Worked in teams/groups	2
New material	1
Different teacher	1

Members of each group said that the lessons were interesting and different and no pupil contradicted these statements. There were a number of reasons given but the most common reason (mentioned by 5 of the groups) related to the experimental and practical nature of the projects:

"Quite different because you got the, like, hands on types of things" (boy, age 12)

"I enjoyed it a lot because we didn't usually do things like that. It was usually the teacher who did it and we all just watched" (girl, age 15)

"And it was – you could see where it was going instead of just doing it for no apparent reason"(boy, age 14)

Other features mentioned were that, a different teacher was involved, it was a new topic and that they worked in groups or teams.

"The fact that we were told it was like a real company made it really fun and exciting, (girl, age 14).

Summary

Half of the pupils were able to remember the topic they did after a five year interval and a third were able to provide further information relating to the lessons. Older pupils were more likely to remember the CCI lessons compared with the youngest children, age 12 and 13.

90 percent of 31 pupils thought the lessons 'Very interesting' or 'Quite interesting' and half of the pupils said that the CCI lessons were very different. The most common reason for finding the lessons interesting and different was because they contained a large proportion of practical elements.

The vast majority of the pupils thought that the CCI lessons were memorable and enjoyable because they were different from their normal primary science lessons. This suggests that their primary science was often taught with little practical work to consolidate the factual elements.

5 Recall of the CCI site visit.

The results of the questionnaires are considered first, followed by the interviews.

The pupils were asked whether they remembered the site visit of the Children Challenging Industry project. 41% (37) said that they did remember visiting an industrial site and 59% (53) said that they didn't remember visiting an industrial site.

However, many of the children who said they couldn't remember visiting industry did not have a visit. 63 out of 90 of the children actually visited industry.

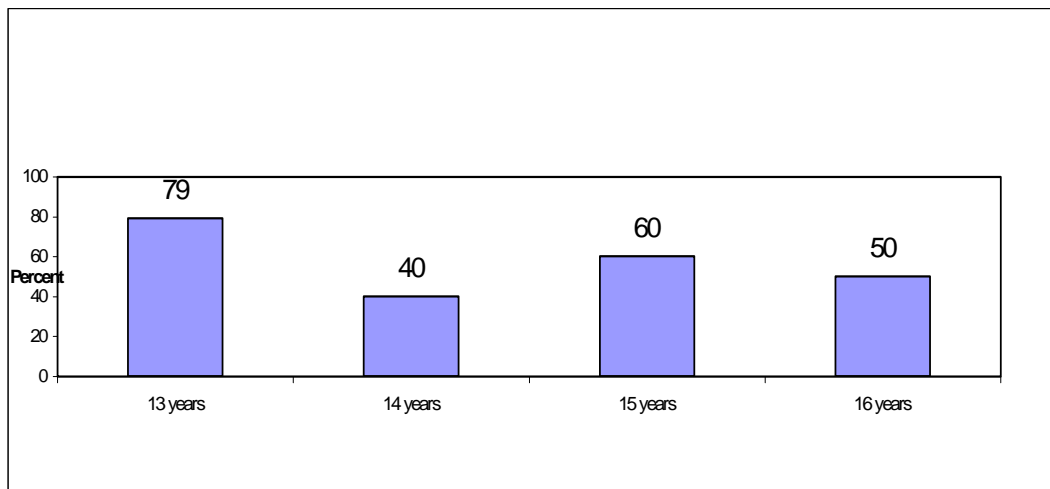
The percentage of children who visited industry and remembered it was 59% (37). This is significantly higher than the number who remembered the lessons which was 32%.

The data were analysed further to check if there were particular groups of children who were more likely to remember the lessons.

Age

The age of the pupils was identified as one possible factor affecting their ability to remember the visit. The number of pupils who remembered the site visit, from 5 years ago, who were 12 or 13 was considerably higher than for older pupils. The trend is shown in Figure 5-1. A Chi analysis was significant ($p=0.04$).

Figure 5-1: Change in recall of site visit by pupils' age



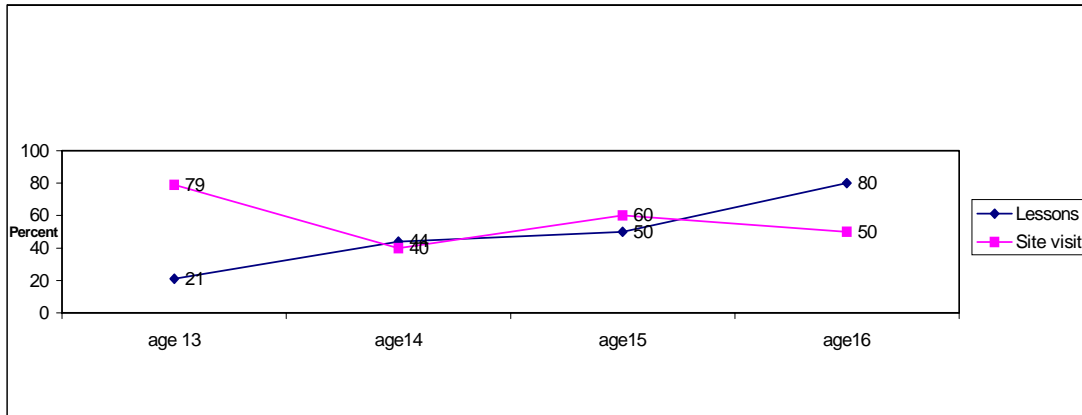
The trend shown for remembering site visit is the exact opposite of the trend for remembering lessons, which is very interesting. The pupils who filled in the questionnaire at 12 or 13 years were 7 or 8 years old when they underwent the CCI project. It seems that younger children of 7 or 8 may be more likely to remember the site visit five years later and children of 10 or 11 may be more likely to remember the practical lessons in the classroom.

The graph in

Figure 5-2 shows the results for recall of lessons and site visit by age on the same graph for the 64 children who had both lessons and a site visit. It should be noted that the results for the lessons were significant for this group (unlike the results for

the whole group, some of whom didn't have a visit). A Chi squared result, gave $p=0.04$. Although the results are significant the sample size is fairly small and therefore more evidence is needed to confirm these results.

Figure 5-2: Change in recall of site visit and lessons by age of pupils

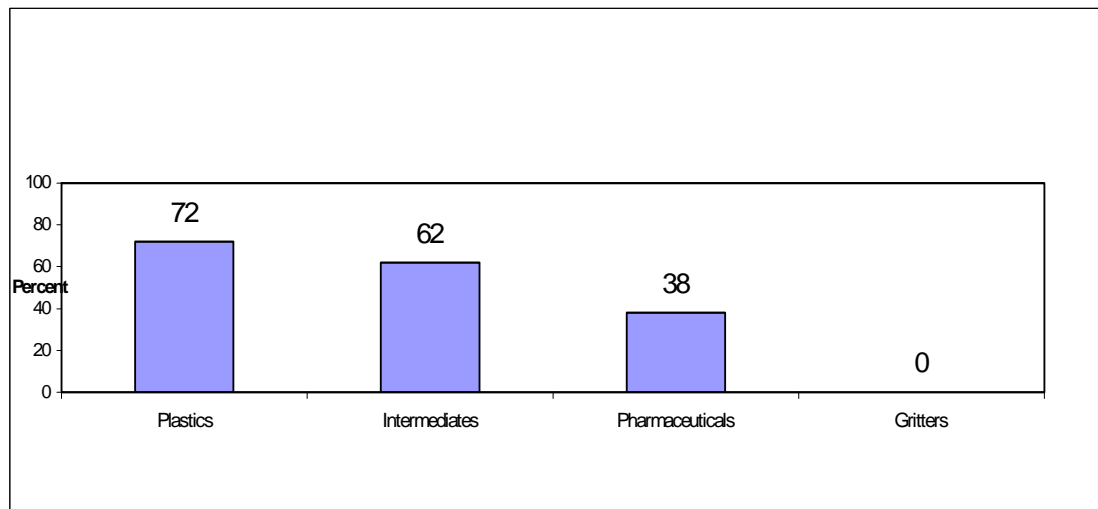


It is interesting to speculate why such a difference in what was remembered by the pupils of different ages might exist. It may be that younger children need to be stimulated in a different environment to ensure that they remember an experience. Younger children may be less experienced in carrying out practical work in the classroom independently and benefit more from seeing the whole process in a real environment. Older children may be more equipped to learn in a class environment because they are better able to appreciate the context of science and industry through practical experiments and watching videos of what happens on industrial sites. More evidence is needed to substantiate these theories.

Company visited

Another factor considered was the company visited. It was possible that certain companies were more memorable than others. In fact there was evidence that this was the case. The results are shown in Figure 5-3.

Figure 5-3: Change in recall of site visit by type of company



The pupils were more likely to remember the companies making plastics than companies making intermediate products. They were also less likely to remember

a pharmaceutical company or the Council Gritters. This was statistically significant with a Chi squared test ($p < 0.001$).

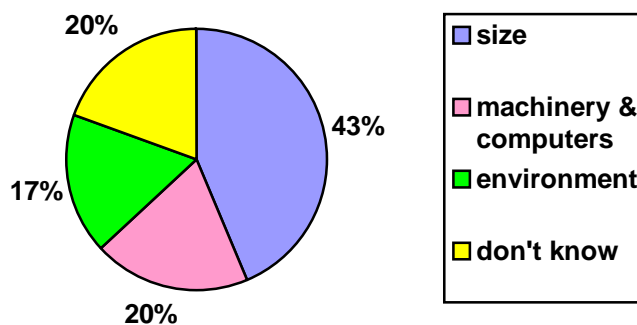
One explanation for these results may be that the sites making plastics received training on effective CCI site visits and they implemented the suggested programme extremely well. Other companies did not have the training or had limited implementation of the changes needed for pupil site visits. This also further substantiates the arguments presented in Parvin's research on how the trained companies' visits had a more positive impact than the non-trained companies.

The pupils may also have been more likely to remember the companies making end products such as plastic and plastic resins, than companies making intermediate products such as glues and ingredients for inks as they are more easily able to identify end products with things they see in everyday life.

Views on the Site visits

The pupils were asked what they remembered about the site visit. Some children gave more than one answer. The results are shown in Figure 5-4.

Figure 5-4: Pupils descriptions of industrial sites



The element of the site visits that more pupils remembered than anything else was the size of the factory. They also remembered machinery and the environment, that is, whether it was clean or noisy, etc. There were very few pupils who mentioned negative aspects of the factory. Four pupils mentioned that they remembered it being noisy, dirty or smelly.

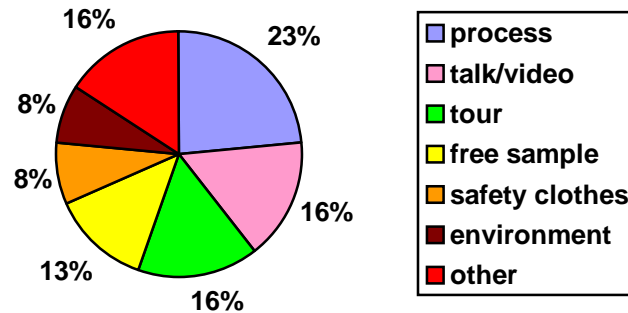
These views are similar but less detailed than the views that primary school children had immediately after having a site visit (Parvin). In her study, before the site visit the children thought that the site would be big and noisy with machines, and many children found this to be true.

After 5 years the memories about industry of the pupils had returned to a similar level of that of a primary school pupil. Their level of sophistication of views of industry would have improved if they had learnt about science through industry since the CCI project.

A small number of children also mentioned computers which could be due to their interest in computers, from use at school or at home.

The pupils were asked what was their main memory of the visit and this question produced a variety of responses. The results are shown in Figure 5-5

Figure 5-5: Pupils' memories of the industrial site



The answer given most often was that they saw something being made. Several pupils also said they remembered having a tour or a video.

Due to the fact that more of the younger pupils remembered the visit, the memories of the site visit were analysed by age to see if pupils tended to have different memories at different ages. Younger pupils were not more likely to say that their main memory was the environment – such as smell or noise. There did not appear to be any particular patterns in the data but it should be noted that the numbers are quite small.

The pupils were asked whether they knew the name of the company, what the company made and how they made this product.

The results for the number of pupils who remembered the name of the industrial site are grouped according to the site visited and shown in the table below.

Table 5-1: Pupils memories of site visit

Site visited	Number remembered	Number forgotten
Site 1	3	0
Site 2	6	2
Site 3	8	3
Site 4	5	9
Site 5	0	1

Although many of the children remembered visiting site 4, fewer children remembered the name. Whereas all the children who visited Site 1 remembered the name. Site 1 makes an end product that many people are familiar with which could be why more of the pupils remembered it.

How well the pupils remembered what the company made was analysed by the type of product the company made. The results are shown in Table 5-2.

Table 5-2: Memories of company product by product type

Type of product	Correct answer	Wrong answer	Left blank
Plastics (sites 3, 4 & 5)	23	1	2
Intermediaries (site 2)	0	8	0
Pharmaceuticals (site 1)	2	0	1

Pupils who had visited sites where plastic or pharmaceuticals were made usually remembered the product with only 4 out of 29 pupils putting a wrong answer or leaving it blank. However the pupils who had visited sites where intermediate products were made found it extremely difficult to accurately state what the product was, and all 8 pupils stated that the product was plastic.

The reason for this is probably because plastics and medicines are tangible products but intermediates made by companies are not.

The children were also asked whether they remembered how the product was made. The results are shown below.

Table 5-3: Memories of how product was made

Type of product	Melting/ moulding	Machines	Mixing/ checking	Don't know
Plastics (sites 3, 4 & 5)	5	5	0	16
Intermediaries (site 2)	1	2	0	5
Pharmaceuticals (site 1)	0	1	1	1

More than half of the pupils who could remember a visit did not feel able to comment on how the product was made and stated that they didn't know regardless of the type of product.

Pupils that had visited a site that made plastic said that machines or melting or moulding were involved in the process. However these are vague answers and in the case of melting and moulding are inaccurate. Pupils that had visited pharmaceutical sites mentioned that mixing and checking were involved in the process as well as machines.

The language used here is quite simple and similar to the language used by ten and eleven year olds in Parvin's first report before they had the site visit (Parvin, 1999).

In the previous study many of the children talked about machines and simple process equipment before they visited the site. After the visit they talked more about filters, heat exchangers and were much more specific. Five years later the language has once more returned to the level before they had visited industry.

The children had forgotten the more technical language associated with industry. Had the science industry link continued strongly at secondary school, they might have had more awareness of chemical change and reaction. None of the children used descriptive words involving chemical change and yet most would have studied chemistry for three years in secondary school.

The results of the interviews confirmed many of these findings.

The pupils were asked whether they enjoyed the industrial visit. Group responses are given in Table 5-4.

Table 5-4: Group responses concerning enjoyment of the site visit (reformat)

Site visited	Enjoyment?	Reasons	No. of groups
Site 3	Yes (all groups)	Went all around the factory Saw different plastics being made Nice lunch too	3
Site 5	Yes	Got hands on experience making cartons	1
Site 1	Yes Yes, quite	New experience, big scale, did not previously know what goes on inside a factory. Linked with own school work Parent works there Could see stages of the industrial work Talk was interesting	2

Pupils who had been on a visit reported that they had found it enjoyable or quite enjoyable. Several elaborated, explaining that they had found it interesting and novel, had never seen anything on such a big scale before, and one pupil linked it to the work done in school:

"I'd never been there before and we'd never – we've been on a school trip, but never to places like that and you could see where your work was, like, aimed at and things, so it was more interesting" (girl, age 14)

The pupils were asked what they remembered about the site visit. Responses are listed in Table 5-5.

Table 5-5: Pupils memories of the site visits

Memories of site visit	No. of Groups	No. of individual comments
Specific aspects of process	5	11
Environment	5	8
Products	4	7
Site safety	2	2
Specific jobs	1	2

Responses were very varied which reflected the diverse nature of the visits. Very few pupils could provide in-depth information about their visit and the production processes involved, even with prompting. There were more comments concerning specific aspects of the process than any other category. Some of the descriptions of manufacturing processes are included below:

".. they had big tubs with, like, plastic melted in and, like, powder plastic and that" (girl, age 14).

"One of the rooms had these conveyor belts and all the cartons that had gone wrong went off on one of them and right cartons went along the other" (girl, age 14).

“I remember the sterilisation bit – I was amazed at how everything was completely sterile and sealed off and I couldn’t get over that. Like, no germs whatsoever inside” (girl, age 14).

Several pupils commented on the environment of the site, which often included the large size of the factories they visited. A few pupils mentioned safety aspects of the site such as clothing.

“It seemed interesting and exciting because it was big and you had to wear hard hats to walk around and make, like, the peoples braces [false teeth] all different sizes and that” (girl, age 14).

Many answers were very general such as *“I think we just looked at stuff from, like, the beginning and making the route to the end”* (girl, age 15).

Most pupils had enjoyable and interested memories of the visit but they tended to be fragmented and lacking in detail in most cases, and also required a certain amount of prompting from the interviewer. This is not surprising when discussing an event that happened 5 years previously.

Jobs

As before, questionnaires are reported first followed by the interviews.

The Children were asked what kinds of jobs were done in the factory. The answers are given in Table 5-6. Ten out of thirty seven of the pupils listed more than one job.

Table 5-6: Types of jobs stated by pupils

Job title	Frequency	Percent
Don't know	21	57
Materials handler	8	22
Machine operator	7	19
Driver/fork lift driver	5	14
Computer technician	4	11
Scientist	3	8
Manager	3	8
Engineer	2	5
Safety officer	1	3

These results are very similar to the previous study by Parvin. The most frequently cited jobs were materials handler and machine operator. Both Parvin’s study and this study indicate that only a small number of children included scientists and engineers in the list of jobs carried out at industrial sites. The number of children citing scientists and engineers was more than in the pre intervention group but less than in the post intervention study in Parvin’s study. Computer technicians were more likely to be mentioned than scientists revealing the increasing awareness of automation processes that exist in factories.

Only 6 pupils stated jobs that they would be interested in. Nobody said they would like to work as a materials handler or a machine operator. In Parvin’s study many of the children said they wanted to be a materials handler after they had visited an industrial site.

The jobs mentioned in this study were manager (3 children), computer technician (2 children) and engineer. The remaining pupils either said they didn't want any of the jobs (7) or they left the question blank.

Five of the pupils gave reasons for the jobs that they might like to do:

“Working with machinery” (engineer, boy, age 13)

“Love using computer technology and the latest equipment” (Computer technician, Tester, boy, age 12)

“Because you get to work in a friendly environment and everybody works as a team” (Accounting, manager, boy, age 13)

“because they find out new things about plastics” (computers, girl, age 13)

Only a small proportion of the pupils wanted to have a job in industry five years after the training, compared with immediately after the training, when a quarter of the children said they would like to be a scientist or a computer user. In the recent MORI poll (The public Image of the Chemical Industry 2002), they found that 15 to 18 year olds, when compared to older adults, were significantly less likely to agree to the statement ‘the chemical industry is an industry I would work for, if I had the choice’. It appears that younger children are keener than older pupils to work in industry. As the older pupils mature into working adults they may become more aware of the opportunities in industry.

Another reason for the decrease in enthusiasm for industry is that during the project the children seemed to be more aware of the relevance of science used in industry but five years later many pupils saw industry as a boring repetitive place to work. Most of the older pupils did not see industry as an exciting place to work with opportunities in research and development. This could be due to the fact that the project is a distant memory and consistent links with industry have not been made since the CCI site visit.

The numbers are too small in this study to see if there is an association between those that would like a job in industry with those who have had industrial experience in secondary school.

In the interviews the pupils were asked why jobs on the industrial site did not appeal to them. Responses to this question are listed in Table 5-7.

Table 5-7: Views on jobs in industry

Jobs in industry	No. of groups	No. of individuals
Boring, repetitive	3	7
Noisy, hot	1	3
Don't like machinery	2	2
No interest in industry	1	1
unsure	1	1
Interested in industry	1	1

The most frequent reason why the pupils were not interested in jobs in industry was because these types of jobs were perceived as boring and repetitive. Other descriptions included ‘same thing day after day’ and ‘not exciting’. Other pupils said they didn't like the environment, that it was too hot and stuffy or noisy. Two pupils mentioned that they didn't like the machinery. A typical response was

"Probably quite dull really. If you're not interested in that sort of stuff then it's not a – you have to be quite sort of specialised I would have thought, to enjoy it every day" (girl, age 15).

However one pupil did think a job in industry could be exciting. She said

"It seemed interesting and exciting because it was big and you had to wear hard hats to walk around and make, like, the peoples braces all different sizes and that" (girl, age 14).

The pupils saw jobs in industry very much in terms of making the same thing each day rather than the research and development of scientists. This type of work would be more varied and also more closely linked to science.

Summary

59% of the pupils who had a site visit remembered it five years later. This is significantly higher than the proportion of pupils who remembered the lessons. In contrast to the CCI lessons it was the younger pupils of 12 or 13 years who were more likely to remember the site visit. The pupils were most likely to remember the industrial sites that made plastics. This could be due to the nature of the processes, or to the training they received from the project officer on effective CCI site visits.

Over three quarters of the pupils who remembered an industrial visit could also recall the name of the company and many pupils wrote about the company's products. Most answers were single words such as 'plastics', 'salt' and 'medicine', however many pupils wrongly identified products of companies producing intermediate chemicals. Most pupils gave some detail of how products were made, but their answers tended to be brief, and the language of description had not developed since their primary school days (Parvin, 1999), e.g. inclusion of machines and possibly a simple process.

The pupils' predominant memory of the site was its size, with other memories including seeing a process, hearing a talk, being taken on a tour or given a free sample. Many pupils found the visit enjoyable.

When asked about the jobs that they remembered being done on the site, nearly one third of jobs mentioned were management and office workers and but very few were scientific. Only 6 pupils said they would like to work in industry. The majority of pupils saw jobs in industry as boring and repetitive. The majority of the pupils were not aware of the link between science taught at school and an industrial career in research and development.

6 Secondary School experience of science and industry

Analysis of the questionnaires is followed by information from the interviews for each section.

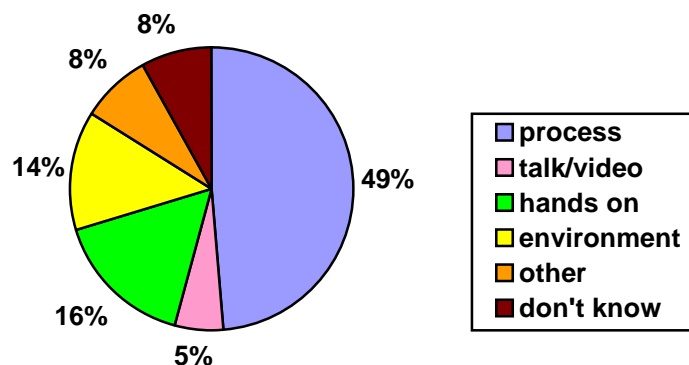
Industrial visits

The pupils were asked if they had been on a visit to industry while they had been at secondary school. 28 (31%) said that they had visited somewhere and the remaining two thirds of pupils either said no (54%), they couldn't remember (11%) or they left the question blank (3%).

The visits varied from the incredible – a visit to the Nestle factory in Switzerland, to the more familiar – a visit to a power station, quarry or industrial estate. Some of the visits named were not strictly speaking industrial visits and these were coded as the pupil not having had an industrial visit. These included the Millennium dome, a life centre and a science pantomime. Two thirds of the secondary schools arranged industrial visits while a third of the secondary schools did not have any pupils in this study who remembered a visit.

The visits were usually arranged through the science classes (10) or geography (7) but some other subjects were also involved in arranging trips such as technology (4), business studies (1) and IT (1). The pupils were asked what they remembered about their secondary school visit and the results are shown in Figure 6-1.

Figure 6-1: Memories of secondary school site visits



If these results are compared with what is remembered from the CCI site visit, it is clear that more children remember seeing a process in the secondary school visits. This may be because less time has elapsed since these more recent visits and many children remember more specific things such as the process involved rather than the environment or non-specific things such as having a talk. However it may also be due to the fact that the focus of the CCI visits was often not the process. For example, in 'A Pinch of Salt' and 'Water for industry' the focus was more on the general applications of salt and water in industry.

In the interviews the pupils were asked whether they thought it mattered that they hadn't visited industry since doing the primary school project. The responses are given in Table 6-1.

Table 6-1: The importance of post-primary school visits to industrial sites

Importance of visit	No. of groups	No. of individual comments
Helps learning/understanding	3	5
Job information	2	2
Different to lessons	1	1
Not important	3	2

Many pupils felt that post-primary school visits to industry helped them to remember, learn and understand topics more easily. One pupil mentioned that visits were different to the normal routine which also may help pupils to remember what they have seen and learnt. Other pupils felt they learnt more about employment which was useful for them in making career choices.

Three pupils stated that the visits were not useful. One pupil thought that it was more appropriate when pupils were older to help them make career choices. Another claimed that it was possible to obtain information about what goes on in a factory from television programmes and videos. The third pupil thought that if you were not interested in industry there was little point in going on a visit.

The quotes below illustrate these findings.

“I think it matters because it helps you learn and your work. It sticks in the mind more than just writing things in their book” (boy, age 12).

“I think it will be quite important for older people, about sort of Y8 and Y9, to go and visit because they’re the ones who are making career choices” (boy, age 13).

“I think maybe when you’re a bit older and you get shown around they explain things a lot more because you are not treated like a child” (girl, 15).

In the last chapter it was found that younger pupils were more likely to remember the industrial visit whereas older pupils were more likely to remember the videos and practical work. Older pupils may benefit from using alternative sources of information about industry rather than a site visit.

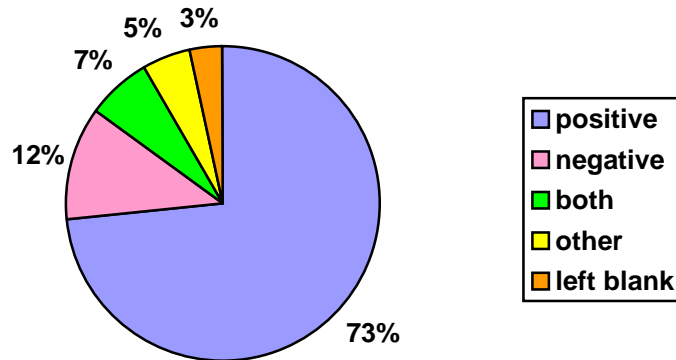
Industry in the classroom

The children were asked whether they had learnt about industry in the classroom and 59 (66%) said that they had, with smaller numbers saying that they hadn’t learnt about industry in the classroom (20%), or that they couldn’t remember (13%).

This figure is much higher than the number of children who visited industry in secondary school. This demonstrates that it is more common for pupils to learn about industry in the classroom than it is to go out and experience it first hand.

The answers given to the question on what the pupils had learnt about industry were categorised as either positive or negative aspects of industry. Sometimes both positive and negative aspects had been taught and sometimes there were neutral subjects which have been classified as ‘other’. The results are shown in Figure 6-2.

Figure 6-2: What pupils learnt in secondary lessons about industry



The majority of pupils said that they had learnt about positive aspects of industry rather than negative aspects such as pollution and danger. There was a huge range of topics with many different kinds of industry covered in different schools. A small number of children said that they had learnt about both positive and negative aspects of industry and a few had learnt about industry in the Victorian era which was categorised as 'other'. Examples of these topics are included in Table 6-2 a little later in this section.

From the results it appears that many secondary school children are learning about industry and it's importance in society. There may be some children who have learnt about negative aspects of industry such as pollution who did not report it in the questionnaire but these results provide evidence that many secondary school teachers are teaching a positive view of industry.

During the interviews the pupils were asked about what they had covered in their lessons about industry that they had experienced since primary school. The Pupils' responses are displayed in Table 6-2.

Table 6-2: Details of secondary school lessons covering industry

Secondary school lessons	No. of groups	No. of individual comments
None	2	2
Geography	2	2
Business studies	2	2
Science	1	1
History	1	1
Technology	1	1
Food technology	1	1

Most pupils had learnt about aspects of industry at some point during secondary school. There were many subjects where industrial topics could be taught, for example, science, geography, history, technology, food technology or business studies. Some were in school and others were special days held elsewhere.

The lessons or events recalled included, choosing sites for industrial development (geography), watching a video on packaging (food technology) or plastics (science), studying the Industrial Revolution (history), mining industry (geography) and mass production (technology). These results confirm those obtained from the questionnaires where it was found that two thirds of pupils had learnt about industry in the classroom.

The pupils were asked what impressions of industry these lessons give them. Responses to this question are summarised in Table 6-3.

Table 6-3: Pupils impressions of industry from secondary school lessons

Impressions of Secondary school lessons	No. of groups	No. of individual comments
Boring	1	1
Negative	2	2
Mixed	2	2

Impressions varied greatly depending on the experience and not all were impressions about industry but were sometimes about an event itself. There were no pupils who were really positive about their experience of industry in the classroom. At best there were mixed views and this was for the Industry day. However, two pupils said that it wasn't very informative about industry.

One pupil thought the geography lessons on where to place factories were boring. One group thought that the lessons gave a negative impression of industry as dirty and noisy while another group also had a negative impression of the Durham mining industry as having over worked the miners and of the pits closing.

The industrial topics covered in secondary school seem to include positive aspects of industry but the view of industry that pupils depict is overall quite negative. In a later chapter evidence is provided that pupils are more likely to have a positive view of industry if they have learnt about industry in secondary school. Therefore the pupils may be saying that they are able to give sophisticated answers when discussing industry that include positive and negative views.

Events

The pupils were asked if they had been involved in any school events linked with industry. Fifty four pupils (60%) gave details of events that they had taken part in

with some pupils taking part in more than one event. Their responses are listed in Table 6-4.

Table 6-4: Events linked with industry that pupils undertook

Events linked with industry	Number
School work/project	32
Science competition/challenge (one pupil also described a Business Studies competition/challenge)	18
Science workshop	13
Work experience	13
Visiting speaker	9
Science club	1

The most common event linked with industry was a school project, with 36% percent of *all* pupils completing school or project work associated with industry. 12 of the 32 pupils who ticked this option gave further details. The responses were varied and are listed below:

- ❖ Farming and food production
- ❖ Global warming
- ❖ Industrial Revolution
- ❖ Building, designing and advertising games
- ❖ Projects on factories and how they work including quality of life
- ❖ Industry in Northern Italy and import and export.

20% of all pupils had been involved in a science competition or challenge. Again the responses are extremely varied, and are listed below:

- ❖ Learning about how rubber is made
- ❖ The Derwentside Engineering Challenge sponsored by industry with local speakers
- ❖ Help with building a bridge for Durham Cathedral
- ❖ Safety poster competition and hazard spotting at Aka Kvearner
- ❖ Materials challenge
- ❖ Industry Day that was part of a Business Studies course

Smaller numbers of pupils had been involved in a science workshop, Only two pupils' answers were clearly and solely about the science workshop and the topics covered were polymer production, archaeological exploration, and where to build houses so they are not flooded.

Of the 13 pupils who said that they had work experience linked with industry, 5 gave some details. However only 3 of the explanations seemed to be linked with industry and these were; garage mechanics work, work with an engineering company and the Council Environmental Health Department. Another pupil said that the link was *'using general knowledge and common sense in the workplace'*.

Only one industrial speaker was described, a man who came to a science class to talk about the chemical company he worked for and what they made.

One pupil reported a science club that had such a link but gave no further details. It is not possible to judge whether this was because science clubs are less common or that their activities have few links with industry.

The pupils were asked in the interview about the events they had been to, and what they had learned about industry at these events (Table 6-5).

Table 6-5: Industry-linked events in which pupils had participated

Event type	Details of event	What learnt from event
Lessons	Building bridges out of paper with engineers visiting school.	Learnt a lot – best structure for strong bridges.
	Building a strong house with straws.	Boring.
Projects	Geography project on industry and factories, Teacher video-taped pupils as news reporters about factories.	How things are made, how a factory site is chosen.
	project in lessons on metals	Learned how metal things are made.
Outside events	Industry day - Food production in factories and certain processes (2 groups).	Learned about budgeting, production lines and teamwork.
	Work experience - Council's Environmental Health offices.	Learned about air testing and the use of scientific equipment.

As the choices in the questionnaire had been very diverse, the experiences described by the pupils were inevitably similarly diverse. Events were different at each of the secondary schools. Some activities were very industry focussed, such as the Industry Day and the project on industry and factories. However some examples given by the pupils (not included in the table) had little to do with industry, such as work experience in a hairdressers' and science crossword challenge. One group did not give details of events linked with industry.

The industry day was clearly enjoyed by the pupils in group 5 and 6, and they learned about the organisation of production lines, the importance of teamwork and the need to read instructions carefully. Other events that the pupils enjoyed were the lessons on building bridges and the work experience at the Environmental Health offices.

Some events were not enjoyed by all the pupils, for example the lesson on building houses with straws. Some pupils said that they learnt a lot from an event but didn't necessarily enjoy it very much. This was the case for the geography project on factories. It is inevitable that not all the pupils in a class will enjoy the same event and it is therefore not appropriate to draw any firm conclusions with this small sample.

The pupils were further questioned about whether the experience of the event inspired them to want to continue studying science, or think about a career in industry.

The three pupils in school 4 were not asked this question as they had not provided details of an event linked with industry. Pupils in school 1 were not asked explicitly about the link with the events. Pupil responses are detailed in Table 6-6.

Table 6-6: Pupils' views on the influence of the events on their choice of career

Career choice	No. of groups	No. of individuals
Scientific (possibly industry)	1	1
Scientific (not industry)	3	5
Not Scientific	5	6
Don't know	1	1

Most of the pupils were clear about the type of career that they wanted, but very few pupils related their career choices to industry. The majority of pupils did not want a scientific career. This group of pupils listed music, IT, maths drama, English, history or the Army as their chosen career. However, some of the pupils expressed a desire to do scientific jobs such as, biology, electronics or veterinary studies, but only one pupil said that he wanted to be an engineer and work in industry. These results reflect the results obtained by the questionnaires.

Summary

A third of the pupils said that they had been on a school visit related to industry since the CCI project. This was usually arranged through science or geography lessons. The pupils usually remembered seeing a process or product.

When asked in interview if they thought it mattered that many pupils had not been on industrial related trips, there was a balanced response with some of the pupils giving details of positive experiences while others expressed more negative opinions. One group thought that the lessons gave a negative impression of industry as dirty and noisy while another group also had a negative impression of the Durham mining industry as having over worked the miners and of the pits closing.

Two thirds of pupils remembered learning something about factories and/or industry from their lessons. The majority of pupils said that they had learnt about positive aspects of industry rather than negative aspects such as pollution and danger although these were covered in some geography lessons.

On the questionnaire, two thirds of the pupils said that they had been involved in industrial related events at school. The most common answer was involvement with school work or a school project.

Most of the pupils had learnt about industry in secondary school with many carrying out school projects and some going on school trips. Many of the pupils described the lessons as positive views of industry. However, comments made about industrially-related trips were more likely to highlight negative aspects of industry.

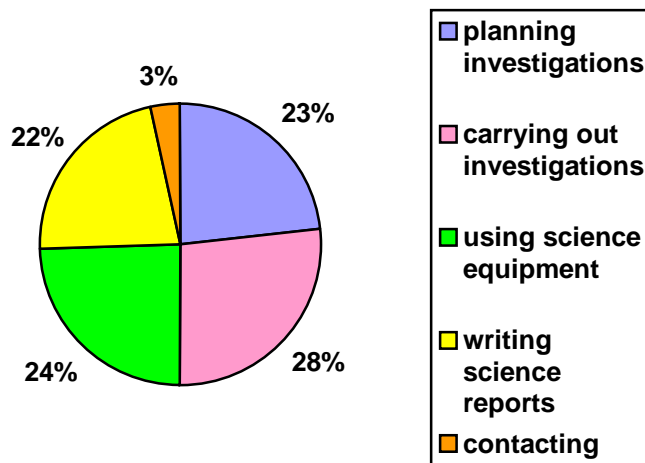
7 Views on how the CCI has helped with lessons

Science

The pupils were asked whether the CCI lessons had helped with their science classes since their involvement with the project. Thirty six pupils (39%) responded that the lessons had helped and fifty said that they hadn't helped. Four did not complete this section. However five of those ticking 'No' added a comment in the 'How have the lessons helped' section and they are included in the analysis below.

They were also asked to state in which areas of science the CCI lessons had helped, although it should be noted that some children could be referring to their primary science lessons in general rather than specifically referring to the CCI lessons. Responses to this question are presented in Figure 7-1. The data is presented numerically rather than as a percentage, due to the sample size. Some of the 36 pupils responding gave more than one answer; and the total of 90 is a coincidence and not associated with the total sample size.

Figure 7-1: Areas of science in which CCI reported to have helped



Approximately equal numbers of children reported that the CCI lessons helped them with planning investigations, carrying out investigations, using science equipment and writing science reports. However there were very few children who said that the lessons helped with contacting people. This could be because they haven't had an opportunity to contact people in the workplace since the CCI lessons. The difference between using science equipment and carrying out investigations was sometimes vague.

Six pupils said that there were other areas where the CCI lessons had helped them in science. Their responses were:

- ❖ More outside knowledge
- ❖ Team work
- ❖ Conclusions
- ❖ Researching into problems and discovering solutions for problems
- ❖ Science in general
- ❖ Course work for technology. Need to know about plastics

In summary, 40% of the whole sample had found that their primary experience of science-industry lessons had helped with their subsequent science work. This does

not include the two pupils who ticked 'No' but gave positive feedback when asked how the lessons had helped in science.

The pupils were asked how the CCI lessons had helped them, which produced a variety of responses. Thirty two pupils explained how the primary lessons had helped them. The greater proportion of responses were non-specific although some gave details especially about learning scientific processes such as planning and logical thinking and working. Three pupils said that the experiences had been motivating with respect to science.

The responses were grouped into five categories and the results are produced in Table 7-1.

Table 7-1: Reasons why CCI lessons had been of help

Nature of help	Number of responses
Generally helpful	13
Understanding process/method (planning, logical working)	8
Learnt something specific (electricity, how factories work, safety, affects of science on the environment)	5
Motivating (more interested in science/science as a career, science is fun)	3
Other	3

The following are examples of the range of reasons given.

"At secondary school experiments were harder but I already had some knowledge from primary school on how to plan and carry out investigations" (girl, age 13).

"Setting investigations out in the correct order. Knowing what to do for each part of the investigation" (girl, age 14).

"Yes because I have just completed an assignment on plastics at my secondary school" (boy, age 12)

"To understand that science is fun and its easy" (boy, age 14)

"The regular primary school science lessons have inspired me to this day to look for a career in science. It's also taught me a great deal in science" (boy, age 14)

The last remark indicates that some memories will be of science lessons other than those relating to the Industry Project. Only one pupil had a negative comment but this not necessarily referring to the CCI lessons

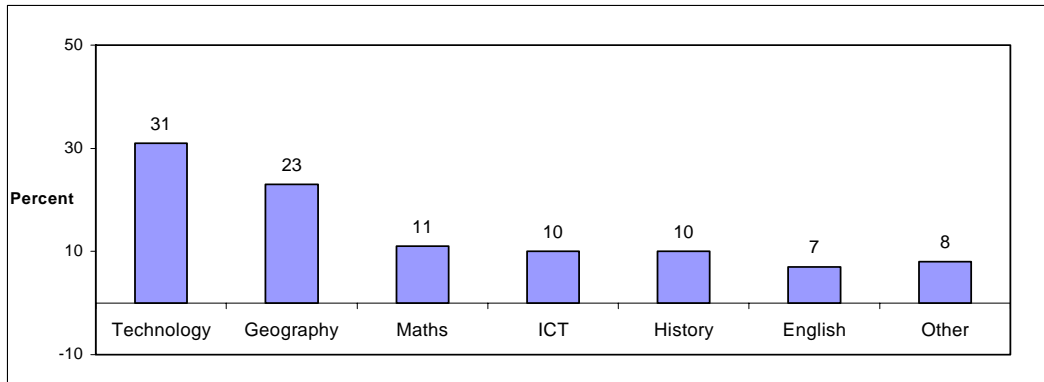
"In some it has made me do things like writing science reports incorrectly" (boy, age 13).

In summary many of the pupils said that they found the lessons helpful but found it quite difficult to give specific details about how they found the lessons helpful. This is not surprising as five years have elapsed from the lessons. Many of the children may be answering the question while thinking of all their primary school science lessons rather than focussing on just the CCI lessons.

Other subjects

The pupils were asked how the CCI lessons had helped them in subjects other than science. Forty five (50%) of the pupils completed this question. The remaining pupils either said that the CCI lessons didn't help them in any other subject or they left the question blank. Many pupils ticked more than one option. The results are shown in Figure 7-2.

Figure 7-2: Subjects in which pupils stated that CCI lessons helped



These results show that pupils perceive technology and geography lessons to have benefited nearly as much as science lessons from their primary experience with the CCI project. Note that 40% of the pupils thought that the CCI lessons had helped them with science compared with 31% who thought the lessons had helped them with technology. Technology covers a huge range of areas and some of these include 'how things are made'. A quarter of the children felt that the lessons had helped them with their Geography classes. This could be because industry is covered in geography when learning about employment and production of essential items as well as pollution.

Smaller numbers of children stated that the CCI lessons helped them in maths, ICT and history. These subjects may sometimes include aspects of industry such as learning about the industrial revolution in history, or learning about industrial processes in ICT.

Very few children claimed that the CCI lessons helped them with English, citizenship, language or music. This group, excluding English were categorised as 'other' in Figure 7-2. This may be because these subjects very rarely include topics related to industry.

Summary

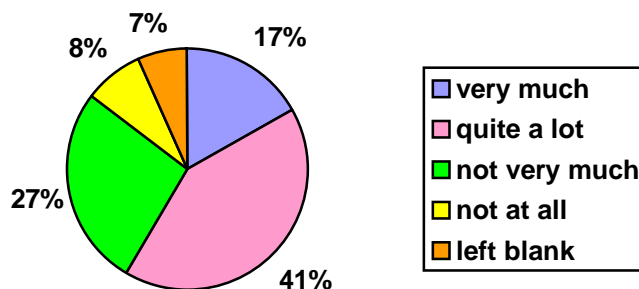
40% of the pupils said that they thought their primary experience of science-industry lessons had helped with their subsequent science work. Pupils reported that the lessons had also helped with a wide range of other subjects. Pupils perceived that technology lessons had benefited nearly as much as science lessons (31%) and geography was the next most quoted subject (23%).

8 Views on Science and Industry

Science

The pupils were asked whether they enjoyed their science lessons and the results are shown in Figure 8-1. The most frequent answer was that they enjoyed their science lessons quite a lot. One pupil left the answer blank.

Figure 8-1: How much the pupils enjoyed science lessons



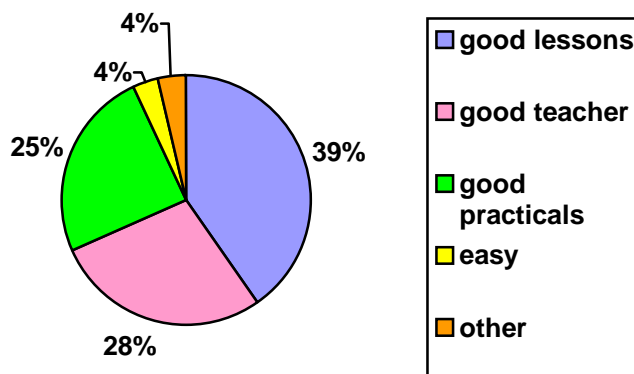
To simplify the categories further, 58% of the children sampled said they liked science lessons and 35% said that they didn't enjoy science. The remaining 7% gave no response to the question.

These results are similar to the results obtained in the recent study by Cerini, who found that 60% of pupils thought that their GCSE science was interesting and 55% thought that it was useful.

The results of the views of the children regarding the CCI lessons were more favourable with 86% of the pupils who could remember the lessons maintaining that the lessons were enjoyable compared with 58% of pupils who thought that secondary school science lessons were enjoyable. However these results may be biased as the children who did not enjoy the CCI lessons may be less likely to have remembered the CCI lessons.

When asked for an explanation, 82 of the children gave positive and/or negative reasons why they did or didn't enjoy science. Some gave more than one answer. The results for the positive answers are shown in Figure 8-2.

Figure 8-2: Positive reasons for enjoying science



57 pupils (63% of the total sample) gave positive reasons for enjoying science.

Nearly two thirds of those pupils that gave positive reasons declared that they enjoyed science because they enjoyed the lessons and/or they enjoyed the practical sessions. These are pupils that enjoy the subject and are interested in learning more about science.

Just over a quarter of the pupils expressed that they were interested in science because they liked the teacher. This is a concern because these are pupils who would be more easily put off science by having a teacher who may not be quite as enthusiastic or inspiring than the science teacher from the previous year. The pupils who only like science because it is easy may also be easily put off continuing to study science as the difficulty increases as it inevitably does at a higher level.

Although more than half of the pupils gave positive reasons for enjoying science, only a small proportion of pupils go on to take A level science subjects. More detail on this subject is given a little later in the report.

In the interviews the pupils were asked what they thought made a teacher a good teacher. Responses from pupils are set out in Table 8-1.

Table 8-1: Characteristics of a good teacher identified by pupils

Characteristic	No. of groups	No. of individual comments
Friendly/likeable/not frightening	4	5
Interesting/enthusiastic	4	4
Fun/funny	3	3
Does practical work	2	3
Knowledgeable/good ideas	2	2
Can control class	1	2

Pupil responses covered a variety of valued teacher characteristics. Several pupils mentioned aspects relating to the personality of the teachers such as being approachable, enthusiastic, friendly, lively and amusing.

The hands-on and experimental teaching approach was also mentioned as well as the ability to explain things. Knowledge of science was expressed by 2 pupils.

“Somebody who does practical quite a bit because I think you learn more than by just writing things down in our book. So, like, being more involved in what you’re doing, that makes a good science teacher – lets you do things” (boy, age 13)

It’s clear from these results that pupils feel it is very important that teachers are friendly and approachable, enabling them to ask questions at any time they are unsure of something. The reason that pupils are less likely to state ‘knowledge of science’ as an important factor may be that they take it for granted that their teacher will be knowledgeable about science, and not that they don’t mind if their teacher isn’t knowledgeable!

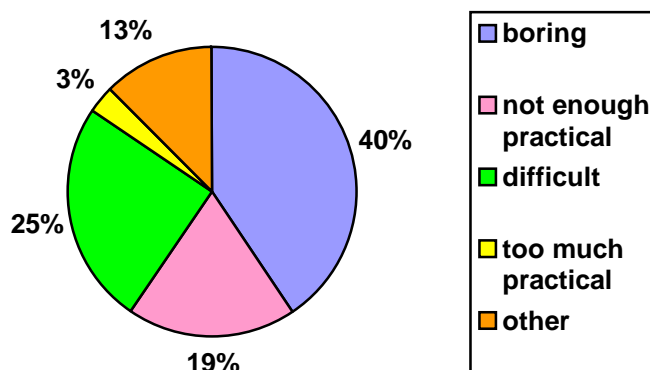
In the interviews the pupils were asked about the differences, in their view, of how their primary teachers taught them science compared with their science teachers in secondary school.

The most common answer was that the science lessons were more advanced or more specialist in secondary school and contained more scientific language. One pupil said they had more experiments in secondary school but less individual attention as the class sizes were larger.

All pupils noticed differences between their experiences of teachers at primary and at secondary level. They mostly focussed on the difference between generalist primary teaching and specialist secondary teaching and hence the difference in level, detail and amount of work.

Thirty two (36% of the total sample) gave negative reasons for not enjoying science. The results are shown in Figure 8-3.

Figure 8-3: Reasons for not enjoying science



The number of children who gave positive responses regarding what they thought of science was far more than the number of children who gave negative responses (63% compared with 36%).

The main reason the pupils gave for not enjoying science was that it was boring. This could be because they were not interested in science or because the lessons were boring. Many of the children remarked that they particularly enjoyed the practical aspect of the science lessons. The children that didn’t like science often cited not enough practical work as the reason (19% of those giving a negative response).

Many of the pupils who said science was boring may have had a different opinion if their lessons were taught in a more practical way with more hands-on practical

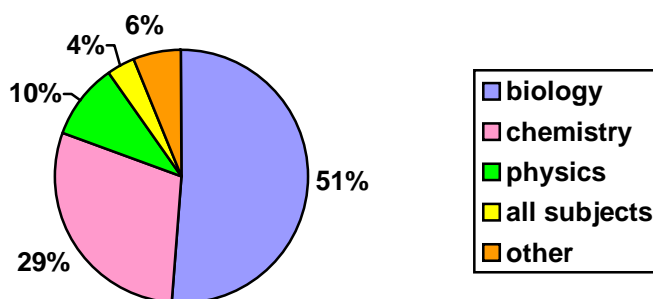
sessions and science lessons taught in a more relevant way, such as with industrial context, similar to the CCI lessons.

The second most common reason that the pupils did not like science was because it was difficult.

The results obtained here are similar to the results obtained by Cerini (2003) who also found that 'boring' and 'difficult' were the most common negative responses to the question on views of Science. Approximately 33% of the pupils who were asked to describe their GCSE science lessons used the word 'boring' and 30% of the sample used the word 'difficult'.

The pupils in this study were asked which was their favourite science subject. The results are shown in Figure 8-4.

Figure 8-4: Favourite science subject at secondary school



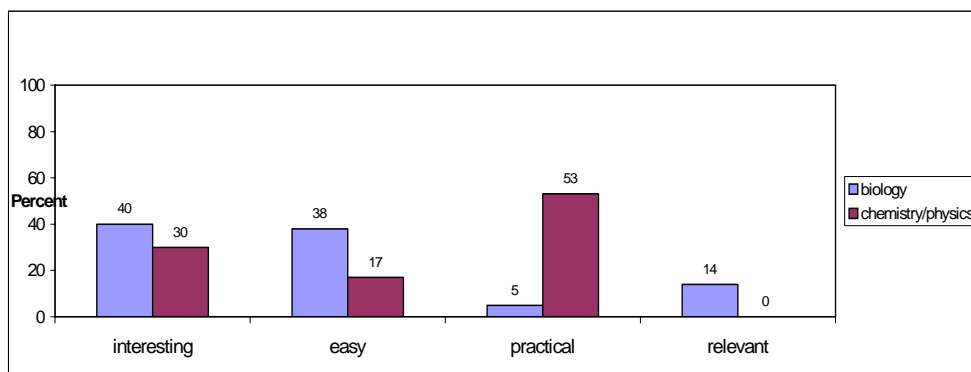
Half of all the pupils named biology their favourite science subject (42 children). About a third cited chemistry, and the remaining 20% was comprised of physics, electronics, circuits, the environment, the planet, or saying that all science subjects were their favourite. Similar results were obtained by Cerini (2003) who also found that pupils were more likely to cite biology topics as their favourite area of science.

As expected, pupils across the country are more likely to take A level biology than chemistry or physics. In 2002 the percentage of pupils taking, biology A level was 7.4%, while for chemistry A level it was 5.2% and for physics A level it was 4.5%. These figures indicate that only a small proportion of 18 year olds are entering further education to do a science degree. However, it should be mentioned that the only subjects taken more often than biology were English, maths and general studies.

The number of pupils taking chemistry and physics has been dropping for many years now. In 1990 the percentage of pupils taking each of the three science subjects was the same at approximately 7%, but while the number of pupils taking biology has risen by 29%, the number taking chemistry and physics has dropped by 18% and 31% respectively. There are probably many contributing factors, one of which may be that biology is perceived to be easier and more relevant to everyday life.

Chemistry and physics were combined to compare the reasons why pupils prefer biology versus pupils who prefer Chemistry and physics. These results are shown in Figure 8-5.

Figure 8-5: Reasons why biology and chemistry/physics are favourite subject



There was a significant difference between the two groups (Chi squared, $p < 0.001$). Pupils who preferred biology were more likely to say it was because it was easy and relevant, whereas pupils who preferred chemistry or physics were more likely to say it was because of the practical sessions.

Children who preferred practical activities may therefore be more likely to choose chemistry or physics over biology which is not perceived as being as hands on as other science subjects. Pupils who struggle with science may be more likely to choose biology over other subjects as it is seen to be easier.

None of the pupils who chose chemistry as their favourite subject said it was because it was relevant to everyday life. From previous studies detailed in Parvins’s previous report, children find subjects with more relevance more interesting. It is therefore crucial that chemistry is taught in secondary school in context, to ensure that pupils enjoy learning chemistry and are motivated to study it to an advanced level. Salter’s chemistry is an example of a chemistry curriculum for GCSE and ‘A’ level that does teach chemistry in context.

During the interviews the pupils were asked whether they thought that teaching/learning about the relationship between science and the industrial workplace makes science more relevant. The pupils answered ‘yes’ or ‘no’ and gave their reasons. The Pupils’ answers are summarised in Table 8-2.

Table 8-2: pupils views on relevance of industry to science

Yes	No	Reasons
3		Helps learning/understanding
3		Seeing classroom science in the workplace/every day life
	1	About machinery (specific visit)
1		Other

Most respondents felt that the teaching about the relationship between science and industry did make science more relevant. The pupils felt learning about science within an industrial context improved their understanding of science by helping them to visualise the scientific theory used in the classroom. Some quotes from the pupils are provided below.

“... a lot of the things we’d been taught in the lessons at school we actually saw in practice” (girl, age 15)

“... when you go [on a site visit] you find out how particles are actually linked to things. It’s not just words that are written on a blackboard” (girl, age 15)

“... on the site you saw how everything, like, started off and how it came to end. So you got, like, the process as you were going round which helped a lot” (girl, age 15)

However not all pupils did think that there was a close connection because their experiences in school were about making plastics by hand and in the factory the plastics were made by machines.

“everything we had done in lessons, that we had done by hand was, was done by a machine so it was really different and proving more efficient and faster” (girl, age 13)

Further analysis was carried out to explore whether some children were more likely to enjoy science than others.

If pupils said that they went on a ‘secondary school’ industrial visit there was a significant increase in the number of pupils who said that they enjoyed science very much (21% compared with 15%). This is a similar finding from earlier in the chapter where it was claimed that children were less likely to state that they enjoyed science if they found it boring, with not enough hands on practical work. Practical work and out of school visits are both practical applications of science theory which may make learning science more interesting to pupils.

In the questionnaires the pupils were asked what influenced their ideas about science. The pupils gave a variety of responses to this question which are given below in Table 8-3.

Table 8-3: Influences contributing to pupils’ ideas about science

Details	Individual comments	No. of groups
School (videos, lessons, visits, school clubs)	13	6
Media (TV, newspapers, internet)	7	4
Family and friends	5	4
Books	2	2

Pupils were most likely to say that their source of information about science was their school, either from lessons or visits that they had experienced. Other common sources were television and newspapers as well as family and friends.

“I think mainly school for me but some of the media-like the things on TV and videos and everything. But it’s mainly school because you see the videos there rather than on the TV” (girl, age 15).

While several watched TV they did so in a selective manner by only watching programmes of particular interest to them. Several pupils thought that TV Science programmes were presented in a boring fashion and could be made more lively and modern.

Two pupils had relatives with science-based careers and found that that gave them an opportunity for more discussion and information.

These results contrast dramatically with the data collected by Parvin (1999) who found that primary school children were least likely to mention school as a source of information but were more likely to cite media, friends and family. This points to the fact that far more science is taught at secondary school than at primary school.

Pupils in Cerini's study (2003) were asked what was missing in the primary school science curriculum and the general consensus from their sample was that not enough science was taught in primary school, with the emphasis on English and maths.

Careers in science

When asked whether they would like a career in science 35% of the pupils said that they would, 61% said that they did not want a career in science and 4% left the question blank.

Of the twenty pupils who gave a positive response all except two mentioned their career aspirations as the reason. One pupil was interested in a science based career because he liked technical gadgets and the other saw science as an exciting area. Some pupils had one career in mind while others mentioned several possibilities for science based careers.

The careers listed were:

- ❖ Science chemical engineering, biologist, forensic scientist, environmental health
- ❖ Medical doctor (5 pupils), vet (4 pupils), nurse (2 pupils), pathologist
- ❖ Industry/business chemical lab work, electricity, industrial work, engineering, business man
- ❖ Education teacher (3 pupils)
- ❖ Law/crime crime scene investigator, lawyer, forensic psychology
- ❖ Other – psychologist, armed forces

Eleven pupils said they did not want a science based career, and this was usually because they had alternative careers in mind. One pupils said that it depended on GCSE results and the remaining four were not interested in science or found it boring or not enjoyable. In summary most pupils did not give a reason for not wanting a science based career, but the few who did had an alternative career in mind.

There were factors that predicted whether a pupil wanted a science career or not.

Children that remembered the CCI industrial visit were significantly more likely to want science careers (Chi square, $p=0.04$). If they remembered the visit 46% said they wanted a science career whereas if they didn't remember the visit only 21% said they wanted a science career. This only included children who actually had a visit. There was no such association with secondary school site visits.

Having positive experiences of industry in primary school may have more influence over career choices in later life than experiences in secondary school. It is possible that children are making career decisions as early as primary school.

In the interviews, all the pupils were asked their views on science-based careers. If they had given answers when asked about school events these answers were brought forward. The results of the interviews are shown in Table 8-4.

Table 8-4: Pupils career plans and their relation to science

Career aspirations	No. of individual comments	No. of groups
Science based career	8	4
Non-science based career	6	4
Don't know	1	1

Eight of the 15 pupils expressed an interest in science-based careers. These included medicine, veterinary science, physiotherapy, biology, engineering, and electronics. The non-science careers included teacher, journalism and plumbing. Only one pupil said that they didn't know what they wanted to do.

Industry

The children were asked in the questionnaire what it was that links science with industry. Fifty seven pupils answered this question and several made more than one point. Almost all of the pupils who gave a view saw links between science and industry. However, many pupils left the question blank implying that they weren't sure of the answer. The various responses are shown in Table 8-5.

Table 8-5: Pupils views on what links science with industry

Reason	No of responses
Industry based on scientific knowledge/investigation/technologies	28
Use similar/same processes	11
Use similar/same materials (chemicals and machinery)	11
Work on similar projects/new products/research	7
Science underpins everything	2
Bad substances/pollution	1
Depends/varies	1
No response/don't know	32

Just over half (53%) stated that industry is based on scientific knowledge, investigation and/or technologies including two pupils who said more generally that science underpins everything. In this study 63% of pupils were able to give information about the chemical industry. This is a favourable result when compared with the results obtained by MORI (The Public Image of the Chemical Industry 2002), where only 8% of 15 to 18 year olds stated that they knew a fair amount about the chemical industry.

Examples of their statements are:

"Without science there would be no industry" (boy, age 13).

"Science plans investigations on which parts are needed. Where they go and if it works and industry uses this information to make things" (girl, age 13).

"Through researching in science, technology is developed and new industries are made" (boy, age 16).

“Industry uses scientific technology to find new ways of doing things” (boy, age 16).

“Science explains how things work the way they do which could help industry to work out how to do things efficiently & economically. Science provides vital information like chemical properties, boiling points and reactions which can help industry” (girl, age 16)

“It is all around us we use it every day” (boy, age 14).

‘In order for industry to improve and evolve, science must also evolve, as it can provide logical and valuable methods of improving the industry at present into more useful and environmentally friendly technology.’ (girl, age 16)

The similarities in processes, materials and equipment were also highlighted by 19% of pupils.

Seven pupils (12%) pointed to the fact that science and industry can work to the same goals such as food and drug production.

Only one pupil made a negative comment about science and industry producing pollution. These results are very different from the previous study by Parvin where a much higher proportion of children associated industry with pollution and factories which belched out smoke and chemicals.

In the interviews the pupils were asked their views on industry. 3 out of the 6 groups were able to describe what influenced their ideas about industry. Details of the responses of the pupils are given in Table 8-6.

Table 8-6: Influences contributing to pupils’ ideas about industry

Details	No. of individual comments	No. of groups
Media (TV, newspapers, magazines)	7	3
Friends and family	3	3
Living near industry	1	1

By far the most common response was that information had come from the media. This could be from the news on television, newspapers or magazines. The following quotes were typical responses.

“I think what influences my opinions – I think because we have a lot of industry locally, on the local news pretty much every week is more job losses everywhere and that does not really give us a very good impression of it” (girl age 13)

“Television because my Dad, like, watches lots of documentaries. Like, I’ll be sitting downstairs and I’ll get watching how they make certain things like in a distillery generally” (boy, age 12)

One pupil in answering the question pointed out that some information on industry comes not just in science or industry based programmes but also from other programmes ‘you pick up bits from there’. The programme he cited as an example was ‘The Simpsons’ (Homer working in the nuclear industry). Fiction was cited as a source of information more frequently in Parvin’s initial study. Pupils of this older age group seem to be able to separate fact from fiction more accurately.

Some pupils mentioned friends and family and the following quote is an interesting one.

“My mum complains a lot about industry, she says it’s not very environmentally friendly ... I normally just follow what my mum thinks quite a lot of the time and I kind of think the same but I haven’t really got high opinions on industry because most industry isn’t really environmentally friendly. If industry was more environmentally friendly I would probably have a different view of it” (girl, age 13).

The profile of answers given was very different from the responses to ‘what influences your ideas about science’. None of the pupils said that school was a source of information about industry whereas school was the most common source of information about science given by pupils.

What is of concern is that, the media does not always relate the facts in an unbiased way. If pupils are using the news (or cartoons!) as their only source of information about industry they may not be learning as much factual, unbiased information as they would if they were learning about industry from other sources, such as school lessons/videos or documentaries.

The pupils were asked how familiar they felt with science being used in industry. 13 pupils said that they did feel familiar with science being used in industry and one pupil said they didn’t know.

The pupils were also asked if they would like to know more about science and the pupils in the three groups who were asked said that they would like to know more.

The three groups of pupils who said they would like to know more were asked where they would find out more information. The responses are presented in Table 8-7.

Table 8-7: Pupils’ awareness of science being used in industry

Source of information	No. of individual comments	No. of groups
Internet	5	1
Television	1	1
Teachers	1	1
Books	1	1

Almost all pupils were familiar with the fact that science is used in industry and a few were able to give examples of associations that they had made:

“I’ve recognised that more and more jobs are getting more science linked” (girl, age 15)

“Yes. I mean you see so much science in industry, because obviously they’ve got to do so many tests” (girl, age 15)

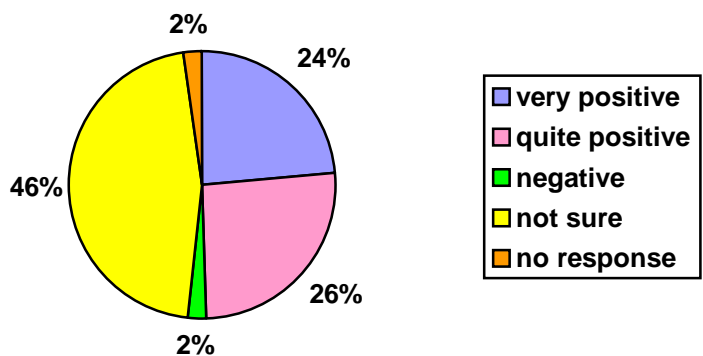
The fact that some pupils do not always make explicit connections by themselves was highlighted in different ways by two pupils. One perceptively explained that pupils are unable to make strong connections because they are not taught this:

“Well we all know that industry is obviously heavily reliant on science but we can’t really, or I can’t really, make strong connections because we are not taught that sort of thing” (boy, age 13)

In the questionnaires the pupils were asked how industry affects their lives. 50% felt positive about industry. Most of the remaining half said they weren't sure, with only two children feeling negative about industry (one quite negative and one very negative).

Results of the views regarding industry are shown in Figure 8-6.

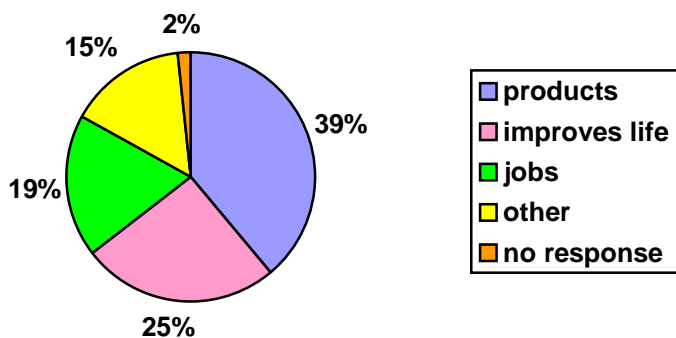
Figure 8-6: Affect of industry on my life



The sample of pupils was evenly split between positive and unsure in each group. These findings are strengthened by the 2002 MORI poll on attitudes towards the chemical industry, where they found that just over half of the youngest age group (15-18 years) agreed with the statement 'I accept the chemical industry in spite of all my reservations'. Interestingly this was a significantly lower figure than for older adults where nearly three quarters agreed with the statement.

Reasons for these views are outlined in Figure 8-7 and Figure 8-8 respectively.

Figure 8-7: Positive views of industry



The most common response from the pupil's questionnaires was that industry is positive because it provides us with products, or it improves our lives in some way. Results from the MORI poll strengthen these findings. They found that 47% of 15 to 18 year olds thought that chemical products improve the quality of life.

Many pupils also mentioned the importance of jobs in industry. Some of the answers from pupils who said they felt positive about industry are given below.

"Science is very important today as are in a changing world and we must adapt to continue living on this planet" (girl, age 15).

"They are always trying to improve the quality of your life" (boy, age 15).

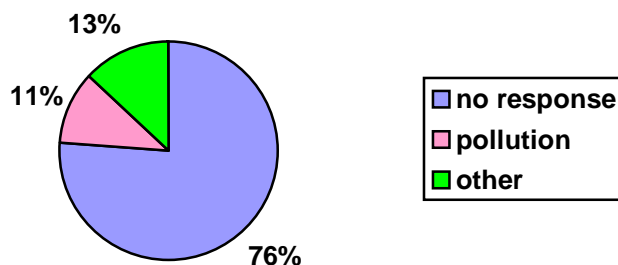
“It helps the country's economy. It mass produces products for every people. Allows science to be used without people realising” (boy, age 16).

Some pupils thought that industry was positive but also had an additional negative impact on society. The ‘other’ category in Figure 8-7 includes negative views of industry, for example ‘pollution’, that were expressed by pupils who said that overall they were positive about industry. The quote below is an example of a pupil in this category.

“It creates things that we just take for granted like plastic bottles and things so it helps us in life. However industry & factories also cause pollution which can affect our health. So industry has both advantages & disadvantages” (girl, age 16).

As previously stated, approximately half of the pupils were not sure whether they were positive or negative about industry (See Figure 8-8).

Figure 8-8: Negative views of industry



31 out of the 40 of the pupils who ticked the ‘Not sure’ response box when asked about their views on industry, did not elaborate on their answer. Many pupils at this age have not yet formed strong opinions of the chemical industry. This was also highlighted in the recent MORI poll where 15 to 18 year olds were less likely than older adults to believe that the chemical industry is essential for the national economy. They were also less likely to think that without the industry’s contributions, our standard of living could not be maintained.

The negative aspect of industry most likely to be mentioned was pollution . Four of the remaining nine pupils explained that there were positive and negative aspects of industry and five pupils gave only negative views of industry.

The pupils who mentioned positive aspects of industry, even though they had said that overall they were not sure about industry, were categorised as ‘other’ in Figure 8-8. These pupils mentioned positive aspects of industry such as ‘products’ and ‘quality of life’.

The main difference is that those with positive views mentioned the fact that industry produces useful products as the main impact of industry. Examples were given and these included domestic appliances, medicines, hobby materials, clothes, food, games, cars, computers and shelter. A notable proportion of responses linked industry’s role in making products with providing people with a good quality of life.

On the other hand, the pupils who said they were not sure about the impact of industry, or they were negative about industry, were usually not able to give reasons why they held these views. Pupils of this age often seem to lack the knowledge needed to give an opinion but tend not to be sceptical about industry,

therefore leaving the question blank. The recent MORI poll on attitudes towards industry found younger adults were significantly more likely to trust the chemical industry than older adults.

Pupils with positive and negative views were equally likely to refer to the negative impact of industrial pollution. Those with positive views of the impact of industry were more aware of the necessity of industry to produce essential products despite the issues of pollution.

In the interviews, four groups of pupils were asked about the 'good' and 'bad' aspects of industry. The pupil's answers are summarised in Table 8-8 and .

Table 8-8: Pupils' perceptions of 'good' aspects of industry

'Good' aspects of industry	No. of individual comments	No. of groups
Invent things/products/cures	4	3
Important	1	1
Make life easier	1	1
Science development	1	1

The responses in the interviews were very similar to those in the questionnaires. The most common view was that industry was 'good' because it made things and made life easier. Other positive views not included in the questionnaires were that industry was important and that industry provided science development.

Table 8-9: Pupils' perceptions of 'bad' aspects of industry

'Bad' aspects of industry	No. of individual comments	No. of groups
Needs to be more environmentally friendly	9	4
Uses up resources	1	1

The results of the interviews are, again, similar to the results from the questionnaires, with the majority of pupils claiming that pollution is the 'bad' aspect of industry.

In the interviews the pupils were asked whether one side, positive or negative, outweighs the other when thinking about how industry affects their lives.

Of the 14 pupils who made a judgement four felt that the good outweighed the bad, nine thought the balance about equal and only one felt that the balance was on the negative side. Typical comments are given below.

"I think more good things because, like, if we didn't know science we wouldn't know half the stuff what we've got now" (girl, age 14).

"Like when vaccines go wrong buy they save a lot of people as well" (girl, age 13).

Most concern about the negative side of industry was focussed on impacts on the environment. Another pupil commented,

"I mean if we keep inventing more and more new, modern technology things from it. There's other areas that need, like, working on like recycling and the environment and things like that" (girl, age 15).

Some pupils felt that the public heard more about the negative aspects of industry than the positive ones. The majority of the pupils were not able to make the decision about whether pollution was an acceptable by product of living with all the products and modern conveniences that we crave.

Those who were more positive towards industry may have the view that **pollution** should be reduced to a minimum while those with negative views think that **industry** should be reduced.

The children with more positive answers are in our view giving a more informed opinion than the children with more negative views. The broad views of society today are that industry and its products are essential and pollution should be reduced to an acceptable level. The acceptable level of pollution may vary from country to country and person to person but the vast majority of people would not contemplate going without most of the products of industry.

Children who had learnt about industry in secondary school lessons were significantly more likely to have positive, and therefore more balanced views, about industry than those who learnt nothing or little about industry (64% compared with 24%, Chi square, $p=0.001$). It did not make a difference whether they learnt about industry in science or geography.

This shows the importance of continued learning about industry in secondary school. This could be through science, technology or geography as all these subjects are able to provide information about industry in a balanced format.

Summary

Nearly two thirds of the pupils said that they enjoyed their science lessons. The three main reasons given were 'good lessons', 'good teacher' and 'good practical work'. Similarly the reasons given for not enjoying lessons were that it was boring, difficult or that there wasn't enough practical work.

Biology was the favourite subject for half of the pupils followed by chemistry (29%) and physics (10%). Pupils that chose biology as their favourite science subject usually did so because it was interesting, easy and relevant. However, those that chose chemistry or physics as their favourite science subject, chose it because it involved more practical work.

Pupils were most likely to say that their source of information about science was their school, either from lessons or visits that they had experienced.

When asked whether they would like a career in science a third of the pupils said that they would. The pupils who remembered the CCI industrial visit were more than twice as likely to want science careers compared with those who couldn't remember the visit.

The majority of the pupils enjoyed their science lessons. However, biology was far more popular than chemistry or physics. As many of the pupils were already making decisions about their future careers at the age of 13 or 14, it is important that chemistry is perceived to be as interesting and relevant as when it was first taught, in primary and early secondary school. If this does not happen, few pupils will pursue chemistry as a career.

Two thirds of the pupils thought that there were connections between science and industry. The most common response was that industry is based on scientific knowledge.

The sources of views on industry were very different from the sources of information on science. Most pupils relied on the media for information about industry, which can be biased toward reporting the more sensationalist 'negative' views of industry, with little information about the processes involved. (Charlotte – it might be worth pointing out that, although the pupils do not state school as a source of information, it clearly is – based on the number of industry-events and coverage in lessons that they quote.)

Half of the pupils were positive about the ways in which industry affects their lives, and the other half were not sure about the affects of industry. Only 2 pupils had negative perceptions. The most popular responses from the positive pupils were that industry provided products and improved the quality of life. Most of the pupils who were not sure about the affects of industry gave no reason for this opinion.

About 15% of all the pupils, regardless of whether they were positive or unsure about industry, mentioned pollution as a negative aspect of industry. The majority of the pupils who were interviewed held the view that the positive and negative aspects of industry were balanced.

When pupils were asked about what they thought about jobs in industry, almost all of the pupils thought that it would be boring or would not interest them.

The majority of the pupils had positive or neutral views of industry, even though most of their information was obtained from the media rather than school. Despite the fact that two thirds of the pupils had said that they enjoyed science at school and a third said that they wanted a science career, there were very few pupils who thought that they would like to work in industry.

9 The Teachers interviews

Eight teachers were interviewed to provide in-depth examination of their views on the CCI project which took place in 1996 to 1998. One teacher had changed schools between the project and this survey. The questions were split into 5 sections. These were:

- Memories and views of the CCI lessons
- Memories and views of the CCI visit
- Impact of the CCI project on teaching science
- Impact of the CCI project on the children
- Impact of the CCI project on the teachers

Memories and views of the CCI lessons and materials

The teachers were asked what they remembered about the CCI project. Some of the teachers covered more than one of the categories. The responses are summarised in Table 9-1.

Table 9-1: Teachers memories of CCI project

No of teachers	Comments
4	Practical & activities
3	Pupils' responses e.g. enthusiastic
1	Subject matter
1	Level of material more advanced

Half of the teachers remembered the practical activities. Comments in this category included the practical and very hands on nature of the sessions. One teacher also mentioned the industrial scenario in which the children were involved in, in all kinds of different activities. Many of the teachers also remembered the children's response to the project. They remembered how enthusiastic the children were about the project. One teacher mentioned the subjects covered which were plastics and recycling. Some quotes are provided below.

'I remember that it was very practical and very hands on for the children. I remember that the children had to design their own experiments. ... a lady came in and we did lots of practical investigations with loads of AT1 – predicting, hypothesising and getting to know about the chemical industry a little better (plastics).

'Very practically- based, based on an industrial scenario in which the children were involved in all kinds of different activities.' (cleaning water).

'... the enthusiasm of the children. It was a lovely class I had that year and they were so enthusiastic and they got so much from it.' (salt).

'I do remember that the children were very keen. They were very enthusiastic about collecting all of the apparatus and the resources.' (water for industry).

'More advanced than I could have done ... and her [Joy's] ideas were excellent.' (packaging).

In summary, all the teachers were extremely positive about the project and seemed to have nothing but good memories about the CCI lessons.

The teachers were asked which topic they had done and all of them were able to answer this question. Four of the teachers interviewed had been involved with 'Plastics Playtime', three with 'Water for Industry' and one with 'A Pinch of Salt'.

The teachers were asked whether they could remember anything about the written materials provided. The results are given in Table 9-2.

Table 9-2: Teachers memories of written materials provided

No of teachers	Comments
8	Remembered the materials
7	Materials were helpful
6	Still have the materials
4	Still use the materials

The response of the teachers towards the materials was extremely positive. All the teachers could remember them, and seven stated that they had found them helpful or useful with many good ideas. The eighth teacher had been out of school since the initial CCI project but was aware that other teachers in the school had used the materials again. Three quarters of all of the teachers still had the materials and half of the teachers were still using the materials after five years.

Two teachers expanded on different positive aspects of the materials:

'... they were fun and the children enjoyed working from them.'

'It's always nice that someone's already thought through an activity and gone through the steps.'

The teachers were asked whether the CCI materials supported the National Curriculum and also, whether they supported Sc1. The results are shown in Table 9-3.

Table 9-3: Teachers views on the CCI materials

Question	Answer	No. of teachers
Supported National Curriculum	Yes	6
	Can't remember	1
	No answer given	1
Supported Sc1	Yes	7
	Can't remember	1

they related to the attainment targets. You could tell they were planned like that Gathered results, fair test, practical based investigation

The majority of the teachers felt that the materials supported the science curriculum including Sc1. In fact none of the teachers said that the sessions did not support the NC or Sc. Two of the teachers could not remember clearly enough to answer the question. One of these teachers said that she couldn't remember because the curriculum has changed since the project.

Some of the reactions from the teachers are provided below.

'From the problem being posed, the children were able to formulate their own ideas and predict how they thought it would happen and then, they'd gather their results and retest, to make sure it was a fair test.'

'That's an area where I think particularly in primary school, we are quite weak over-all. I've talked to other science teachers about it and they're very good at getting the knowledge into children's heads but it's the scientific approach we find difficult and the ideas that were generated from the project were really helpful.'

'It was all practical based investigation, each lesson, so that was really good.'

The overwhelming opinion was that the CCI materials were useful and relevant to the science curriculum.

In summary, the teachers views of the CCI lessons were that they were interesting, useful and relevant to the science curriculum. Furthermore, half of the teachers were still using the materials after 5 years.

Memories and views of the CCI site visit

The teachers were asked whether they remembered having a site visit. Five of the teachers recalled the CCI industrial visit and two teachers remembered other site visits which were not related to the CCI project. These results are shown in Table 9-4.

Table 9-4: Teachers memories of the site visit

Site	No. of teachers	Comments
Site 2	2	Interesting, enjoyable, good communication with children
Site 3	1	Well organised, child friendly
Site 4	1	Very successful
Unknown	1	No details
Non CCI visit	3	Other sites visited

The five teachers that reported on the CCI visits said they were very successful and enjoyed by the pupils. Aspects that were appreciated by the pupils were, wearing hard hats and so feeling part of the site, interactions with a range of staff including fork lift drivers and scientists, and a child friendly atmosphere. None of the teachers mentioned any negative aspects of the CCI visits. These results are similar to the children's views, reported earlier, of visits to sites 2, 3 and 4 (sites 3 and 4 make plastics and site 2 makes intermediaries).

The teacher who gave the most detail explained:

'We had a very, very interesting day. The children, again, loved it because they felt they were part of the site because they went on, they had their coats, their lab coats. They had their hats, and when they saw all of the different people around the site they were very keen to ask them quite informed questions. You know they knew what they were doing. And they especially liked it when they went into the laboratory. They walked in and I remember seeing one boy's face when he saw the water coolants in the laboratory, he said "We've just been doing something about that." And he got straight into a chat with the scientist.'

The teachers were overwhelmingly positive about the CCI site visit.

Impact of CCI project on teaching science

The teachers were asked whether the CCI sessions had had a positive impact on their teaching methods. The results are summarised in Table 9-5.

Table 9-5: Teachers' view of impact on teaching methods

No. of teachers	Impact
5	Understanding of chemical industry/real world
1	Investigative approach
1	Impact unknown
1	No impact

Six out of the eight teachers thought that the project had had a positive impact on their teaching methods. Five of the teachers remarked that the Project had helped widen their perceptions of science and/or industry; one of who particularly valued the receptiveness of the companies associated with the project.

One teacher had very much appreciated the investigative approach and liked the approach of the problems posed which was not too abstract for the children. And finally, one teacher felt that there was an impact on his/her teaching methods but didn't give any further details.

The teachers were asked whether the CCI sessions had had any impact on their views of the National Curriculum. These responses are summarised in Table 9-6.

Table 9-6: Impact of CCI project on teachers' view of National Curriculum

No. of teachers	View of NC
2	Not enough practical or investigation
1	Not enough information on chemical industry
1	Not enough visits to industry
4	No obvious change in views

All of the teachers provided comments about the science NC but in some cases they did not clarify whether their current views of the NC had been different before the classroom sessions.

Two of the teachers felt that there could be more practical sessions, especially for years 5 and 6 and one teacher felt there should be more visits to industry. This teacher had rewritten the science plans for the school to include more opportunities to visit various places when doing science projects. One teacher felt that more information about the chemical industry would be useful as well as suggestions for activities.

The remaining four teachers did not provide information about how the project had changed their views of the science NC. Two teachers commented that the SATs determine what work is covered but gave no indication whether they thought the SATs should contain more investigative or industrial related material. One teacher thought the science NC was a very woolly document but didn't give any indication of how to improve it.

Half the teachers felt that the science NC does not provide enough practical elements (in or outside the classroom) or enough information about industry.

The teachers were asked whether the CCI sessions had any impact on their classroom links with industry. The results are shown in Table 9-7.

Table 9-7: Impact of CCI project on classroom links with industry

No. of teachers	Links
2	Improved links
3	Already had good links
1	Initially improved but now reduced again
2	Links not followed up

Two teachers reported that the project had definitely encouraged them to arrange further visits. One teacher explained that she had not realised that chemical industries were prepared to take younger children. Following a very successful visit she had subsequently arranged industrial visits to suit particular topics (not always chemical) such as a visit to a power station (electricity) and to a Water treatment works.

Three schools already had industrial links in place. In two schools the links had not been continued. A third teacher had moved schools and so was not aware what had happened in her previous school.

The teachers were asked whether the CCI sessions had any impact on their views of industry-sponsored materials. The teachers responses are shown in Table 9-10.

Table 9-8: Impact of CCI project on views of industry-sponsored materials

No. of teachers	Views
1	More positive since CCI
1	Already positive before CCI
4	Positive (unclear whether different from b4)
2	Cautious

Six of the teachers were very positive about using industrial sponsored materials and two were cautious about using these types of materials. For four of the teachers it was difficult to deduce whether they had always been positive about industrial sponsored materials or they had grown more positive since the CCI project.

One teachers said he/she was definitely more positive and tended to look at these types of materials more than previously. One teacher made it clear that he/she had always been positive and open to new ideas and had used industry-sponsored materials many times.

The two teachers who were cautious as well as the more positive teachers gave a number of points that could influence the take up of industrially produced resources:

- They need to be clearly linked to the NC and the QCA approach.
- They must be well planned and clearly organised.
- Fresh ideas, particularly focussed on investigation, are welcome.
- Materials would be more likely to be used if they came as a package with someone to teach as with CCI.
- They should not be primarily promoting a particular company or products such as sugar.
- It takes time for teachers to appraise the quality and usefulness of the materials.

- Not all teachers in the school will see the materials. Possibly the science co-ordinator acts as a filter for materials received or use of the materials may be decided by year group/age.
- Schools have medium term science curriculum plans and materials may not immediately fit the scheme.

The teachers were asked whether the CCI sessions had any impact on their school. The results are shown in Table 9-9.

Table 9-9: Impact of CCI project on the school

No. of teachers	Impact
3	Other teachers in school also using CCI materials
2	Implemented in science plan/school wide
2	Partly used again
1	Don't know

The impact was mostly described in terms of the continued use of the materials. Seven teachers responded that they, or other teachers in the school, were currently using the materials, in whole or in part, or had incorporated aspects of the project into their science plan.

Five out of the seven teachers answered here that they were using the materials, although the results from earlier responses claimed that just four of the teachers continue to use the materials. The responses to this question show that two teachers have adopted a new approach to science rather than simply using new materials. For example one school had adopted the approach to science that the project used, throughout the whole school.

Two teachers said they had used the materials again in part, either to fit in with SATs or to link the science curriculum with what happened outside school.

Although this is a small sample of eight teachers, the preliminary findings are that a long term impact on schools has occurred as a result of the CCI project.

The teachers were asked whether any science or industry links had been continued or introduced as a result of the project. The results are shown in Table 9-11.

Table 9-10: Impact of CCI project on science and industry links

No. of teachers	Links
1	Introduced
3	Continued
3	No links
1	Don't know

Only one out of the eight teachers introduced industrial links that didn't already exist in their school. The school carried out projects concerning water and made contact with National Rivers Authority and water treatment works.

The remaining teachers claimed that they were continuing with existing industrial links or had no industrial links, the same situation as before the CCI project. One teacher explained that new contacts had been made with a company but this was to replace links that had been lost due to a company closing down. Three out of the eight teachers had no industrial links.

These results demonstrate that developing industrial links may be difficult for teachers. Responses to previous questions illustrate how useful the teachers thought the site visits were, but only one of the schools increased their links with science and industry as a direct result of the CCI project and half of the teachers still had no links with industry. One reason may be that it is quite time consuming making the links with industry.

In summary, there were many positive effects on the teaching of science due to the CCI project. Teachers reported that there was a positive effect on their teaching methods and three quarters of the teachers had passed on the materials or information to other teachers in the school. Half of the teachers thought that the national curriculum should contain more information on industry or practical work.

Half of the teachers also had links with industry and most of the teachers were positive about industry-sponsored materials. Although this is a small sample it is a more positive picture than for the teachers in Parvin's report (1999) who had not yet had the CCI lessons.

Teachers' Perceptions of Impact of CCI project on the children

The teachers were asked whether the CCI sessions had any impact on the children's skills. The results are shown in Table 9-11.

Table 9-11: Impact of CCI project on children's skills

No. of teachers	Impact
5	Improved investigative skills
5	Enthusiasm/enjoyment
2	Confidence in science
1	Improved SATs results
1	General views of industry
3	Unsure

All the teachers gave details of the positive impact on the children. Some mentioned impacts that were not strictly speaking skills such as enthusiasm. One of the most common responses was that the project had improved the children's investigative skills. The teachers mentioned a number of aspects of these skills, such as measuring, careful recording, fair testing, more independent thinking and problem solving.

More than half the teachers also thought that the CCI project had increased the children's enthusiasm and enjoyment of science. The teachers used language that portrayed this enthusiasm about the CCI project. Some of the phrases included '*It really fired their enthusiasm*', '*they used to love the sessions*', '*amazing*', and '*they remember It now*'.

In addition to increasing enthusiasm of science, two teachers felt the project had increased the children's confidence. Comments included '*increased their appetite for science*' and '*children's ideas valued on site visit*'.

One teacher felt that the sessions had increased the SAT scores and one teacher thought that the sessions changed the children's stereotypical view of big chimneys and men in factories.

Three teachers questioned the long term impact on the children. This study has shown that many pupils remember the CCI project. However specific skills have

not been measured making it difficult to deduce the exact long term impact of the CCI project on children.

In summary, all the teachers felt that the CCI project had a positive impact on the children’s skills and/or enthusiasm for learning science.

The teachers were asked whether the CCI sessions improved the children’s awareness of industry, and whether the CCI project had any impact on the children’s understanding of the relevance of science to industry. The results are shown in Table 9-12 and discussed below.

Table 9-12: Impact on the children’s awareness of industry

No. of teachers	Awareness
3	Employment
3	Industry
1	Real science
1	No details given
1	Don’t know

Seven teachers felt that the pupils had become more aware of industry and this was mostly expressed in the context of the industrial visits. The opportunity to see inside an industrial site was seen as important in raising the children’s awareness of industry. One comment made was *‘They were amazed at what went on in the factory’*.

There was also a feeling that the pupils gained a view of the real world, either related to employment or real science, which was invaluable for pupils who had not otherwise seen a workplace. One teacher commented that it made the children think about what type of jobs they would like to do.

One teacher said that he/she didn’t know and felt that pupils’ stereotypic views of scientists as white coated men with funny hair or bald and with funny glasses might be reinforced rather than modified depending on the type of place they visited.

All the teachers said that the children were able to see the link between science and industry as a result of the CCI lessons. Three teachers that expanded on there answer, claimed that the links were made as a result of carrying out practical work and then seeing real life situations on the site visit.

The following quote demonstrates one teachers view on the importance of a ‘real life’ experience.

‘Yes, I think at the time they could really see. And real life situations, real life investigations, seeing, going and making site visits, seeing how it fitted in with reality and fair testing and things like this. That they were able to see it actually in action was really powerful’.

One teacher said that a few parents worked at a local site so links may have already been in place for some children. Another teacher mentioned that below average pupils may not have picked up the links and it was noted that this school had not had a site visit.

The teachers were asked whether they perceived that the CCI sessions had any impact on the children’s performance in the science SAT’s. The results are shown in Table 9-13.

Table 9-13: Impact on the children’s performance in their science SAT’s

No. of teachers	Performance
2	Definitely improved
4	Think it improved
1	Don’t know

Two teachers thought that the results had definitely improved that year. These two teachers strongly felt that the CCI lessons had helped improve the SATs scores. Their comments were '*They did do extremely well in their SATs, and 'had best science SATs results in school up to that point'*'. Results can vary from year to year due to the mix of pupils so an increase may or may not be attributed to the CCI lessons.

Many of the teachers could not remember accurately whether the science SATs had increased that year but thought that they had improved.

One teacher could not remember what the results had been like at all.

In summary many of the teachers perceived that the children’s SAT scores had improved in science after they had experienced the CCI project. However, remembering back five years made some answers a little vague. Relying on this type of information from teachers is not as accurate as checking the results directly.

The teachers were asked whether they thought the CCI sessions helped as a preparation for secondary school. The results are shown in Table 9-14.

Table 9-14: How the project helped as preparation for secondary school

No. of teachers	Preparation
4	Useful practical work
1	Improve investigative approach
1	Useful site visit
1	Increase in enthusiasm
1	Limited
1	Don’t know

Most teachers thought that the Project had been helpful and a number of aspects were mentioned. The most common example of good preparation for secondary school was the experience of carrying out practical work. Experience of the investigative approach was also mentioned as well as the site visit. One teacher mentioned that it prepared the pupils by increasing their enthusiasm for science.

One teacher was more cautious about the positive aspects of preparation for secondary school and said it was useful to a certain extent. Only one teacher was not prepared to comment as she had no experience of secondary school science but she assumed that those planning the CCI project would have considered the need to prepare pupils for secondary school.

In summary, the effect on the children of the CCI project was perceived by the teachers to be overwhelmingly positive. All the teachers felt that the project had increased their enthusiasm for science and improved their investigative skills. In addition, two teachers were confident that the children’s SAT scores had increased as a result of the project.

All the teachers felt that the children had learnt about the link between science and industry, together with an increased awareness of what went on in industry including employment opportunities.

Furthermore, three quarters of the teachers felt that they had been better prepared for secondary school science as a result of the project.

Impact of CCI project on the teachers' views and links

The teachers were asked whether they had much contact with their secondary school. There was considerable variation in the range and types of contact. The results are shown in Table 9-15.

Table 9-15: Teachers contact with their secondary school

No. of teachers	Links with secondary school
2	Good links since the CCI project
4	Existing links
2	No links

Two of the teachers reported improved links with secondary schools since the CCI project. One of these teachers said 'the CCI project gave us the idea to do it – teachers observe each others lessons'. The other teacher said that there were close links now with science but not at the time.

There were existing links in four of the schools but it was not clear whether they were as a result of the CCI project or not. In one school the children had had the opportunity to see more scientific equipment in secondary school, and a secondary teacher (some years ago) had visited another primary school to look at the topics they cover in order to avoid duplication. One teacher mentioned that a secondary school science teacher had observed some of their lessons but didn't make it clear whether this was as a result of the CCI project. Some of the information on links was not relevant to the science curriculum. One school had links with the maths department but not the science department.

Two teachers said that they didn't have any links with secondary schools at all.

The majority of schools (6 out of 8) had experienced some degree of contact with the secondary schools but some of these links were sporadic or out of date. The CCI project had motivated 2 out of the 8 teachers to improve links with other schools.

The teachers were asked how comfortable they felt describing industry. The results are shown in Table 9-16.

Table 9-16: Teachers views on describing industry

No. of teachers	Describe industry
4	CCI improved understanding/awareness
2	Feel confident
2	Don't know/cautious

Six of the teachers stated that they felt more comfortable and were fairly confident in describing industry. Five out of the eight teachers implied that their ability to describe the chemical industry had improved since the CCI project. One teacher said that her view had previously been very simplistic and rather like the children –

black factory tower chimneys, so she had been 'highly surprised' by what she had seen. Another teacher said '*It deepened my understanding*'. One teacher said that the project had deepened her understanding but that her description of industry was still not as clear as it could be.

Two out of these six teachers had been fairly comfortable with describing industry anyway but for one of them the Project had raised his awareness of what was available by way of primary school visits.

Two teachers were more vague about their abilities to describe industry. One was not able to say how well she could describe industry and the other was cautious about answering the question.

In summary, three quarters of the teachers still felt more confident about describing industry five years after the CCI project.

The teachers were asked if the CCI project had changed their views on industry. The results are shown in Table 9-17.

Table 9-17: Change in teachers views of industry

No. of teachers	Views of industry
5	More positive since project
3	Already positive before project

Five teachers perceived that the Project had improved their understanding of industry. For them the project had been insightful at different levels. One had had a Dickensian view of industry as dark and dismal and now felt that she would not mind if she had to go and work in industry. Others, who had had a less extreme initial view, still felt that their understanding had been deepened. One teacher explained that she was better able to see more positive links between education and industry and that industry has a lot to offer as a resource. Another teacher realised how receptive people were to helping schools.

Three teachers felt that they were well informed and positive about industry before the CCI project, so their views had not altered. One of these teachers was amazed at how little, senior people in the chemical industry, knew about what went on in primary schools and what the children were capable of.

In summary, after experiencing the CCI project all the teachers had positive views of industry.

The teachers were asked if the CCI project had altered their views on the risks from industry. The results are shown in Table 9-18.

Table 9-18: Change in teachers views of risks of industry

No. of teachers	Views of industry
1	More positive than before CCI
2	Clearly positive (no change since CCI)
3	Possibly more positive (no change since CCI)
2	Not enough information available

Three of the teachers were positive about industry and the risks of pollution and accidents. They felt that the industry attempted to reduce the risk of accidents and/or pollution. One teacher thought her views had become more positive since the CCI project and two teachers felt that they had been positive before the CCI project. The fact that site visits usually involved a safety talk was mentioned as

one aspect of risk or hazard awareness - *'having things explained does make you realise that maybe industry is necessary, you know its a balancing act'*

Three teachers were not overtly positive but said that they thought that they might be more positive since visiting industry or they said that they hadn't thought about it since the visit but they possibly were a bit more positive.

Two teachers had not answered the question in enough detail to ascertain whether they felt positive or negative. One teacher felt that there were risks involved everywhere but didn't say whether he therefore thought that this was a bad thing or an inevitable aspect of industry.

Three teachers were positive about the risks of industry. The remaining five teachers found it hard to articulate their views on the risks of industry.

In summary, the teachers were overwhelmingly positive about the CCI project but much more reserved about voicing their views on the risks of industry. All eight teachers were positive about industry 5 years after the project, but only three out of the eight teachers said that they were positive about the risks of industry 5 years later.

Three quarters of the teachers felt comfortable describing industry. Six of the teachers also had links with secondary school science departments.

10 Conclusions: Children

Recall of the Children Challenging Industry Lessons

Half of the pupils were able to remember the topic they did after a five year interval and a third were able to provide further information relating to the lessons. Older pupils were more likely to remember the CCI lessons compared with the youngest children, age 12 and 13.

90 percent of 31 pupils thought the lessons 'Very interesting' or 'Quite interesting' and half of the pupils said that the CCI lessons were very different. The most common reason for finding the lessons interesting and different was because they contained a large proportion of practical elements.

The vast majority of the pupils thought that the CCI lessons were memorable and enjoyable because they were different from their normal primary science lessons. This suggests that their primary science was often taught with little practical work to consolidate the factual elements.

Recall of the CCI site visit

59% of the pupils who had a site visit remembered it five years later. This is significantly higher than the proportion of pupils who remembered the lessons. In contrast to the CCI lessons it was the younger pupils of 12 or 13 years who were more likely to remember the site visit. The pupils were most likely to remember the industrial sites that made plastics. This could be due to the nature of the processes, or to the training they received from the project officer on effective CCI site visits.

Over three quarters of the pupils who remembered an industrial visit could also recall the name of the company and many pupils wrote about the company's products. Most answers were single words such as 'plastics', 'salt' and 'medicine', however many pupils wrongly identified products of companies producing intermediate chemicals. Most pupils gave some detail of how products were made, but their answers tended to be brief, and the language of description had not developed since their primary school days (Parvin, 1999), e.g. inclusion of machines and possibly a simple process.

The pupils' predominant memory of the site was its size, with other memories including seeing a process, hearing a talk, being taken on a tour or given a free sample. Many pupils found the visit enjoyable.

When asked about the jobs that they remembered being done on the site, nearly one third of jobs mentioned were management and office workers and but very few were scientific. Only 6 pupils said they would like to work in industry. The majority of pupils saw jobs in industry as boring and repetitive. The majority of the pupils were not aware of the link between science taught at school and an industrial career in research and development.

Secondary school experience of science and industry

A third of the pupils said that they had been on a school visit related to industry since the CCI project. This was usually arranged through science or geography lessons. The pupils usually remembered seeing a process or product.

When asked in interview if they thought it mattered that many pupils had not been on industrial related trips, there was a balanced response with some of the pupils giving details of positive experiences while others expressed more negative opinions. One group thought that the lessons gave a negative impression of industry as dirty and noisy while another group also had a negative impression of the Durham mining industry as having over worked the miners and of the pits closing.

Two thirds of pupils remembered learning something about factories and/or industry from their lessons. The majority of pupils said that they had learnt about positive aspects of industry rather than negative aspects such as pollution and danger although these were covered in some geography lessons.

On the questionnaire, two thirds of the pupils said that they had been involved in industrial related events at school. The most common answer was involvement with school work or a school project.

Most of the pupils had learnt about industry in secondary school with many carrying out school projects and some going on school trips. Many of the pupils described the lessons as positive views of industry. However, comments made about industrially-related trips were more likely to highlight negative aspects of industry.

Views on how CCI has helped with lessons

40% of the pupils said that they thought their primary experience of science-industry lessons had helped with their subsequent science work. Pupils reported that the lessons had also helped with a wide range of other subjects. Pupils perceived that technology lessons had benefited nearly as much as science lessons (31%) and geography was the next most quoted subject (23%).

Views on science

Nearly two thirds of the pupils said that they enjoyed their science lessons. The three main reasons given were 'good lessons', 'good teacher' and 'good practical work'. Similarly the reasons given for not enjoying lessons were that it was boring, difficult or that there wasn't enough practical work.

Biology was the favourite subject for half of the pupils followed by chemistry (29%) and physics (10%). Pupils that chose biology as their favourite science subject usually did so because it was interesting, easy and relevant. However, those that chose chemistry or physics as their favourite science subject, chose it because it involved more practical work.

Pupils were most likely to say that their source of information about science was their school, either from lessons or visits that they had experienced.

When asked whether they would like a career in science a third of the pupils said that they would. The pupils who remembered the CCI industrial visit were more

than twice as likely to want science careers compared with those who couldn't remember the visit.

The majority of the pupils enjoyed their science lessons. However, biology was far more popular than chemistry or physics. As many of the pupils were already making decisions about their future careers at the age of 13 or 14, it is important that chemistry is perceived to be as interesting and relevant as when it was first taught, in primary and early secondary school. If this does not happen, few pupils will pursue chemistry as a career.

Views on industry

Two thirds of the pupils thought that there were connections between science and industry. The most common response was that industry is based on scientific knowledge.

The sources of views on industry were very different from the sources of information on science. Most pupils relied on the media for information about industry, which can be biased toward reporting the more sensationalist 'negative' views of industry, with little information about the processes involved. (Charlotte – it might be worth pointing out that, although the pupils do not state school as a source of information, it clearly is – based on the number of industry-events and coverage in lessons that they quote.)

Half of the pupils were positive about the ways in which industry affects their lives, and the other half were not sure about the affects of industry. Only 2 pupils had negative perceptions. The most popular responses from the positive pupils were that industry provided products and improved the quality of life. Most of the pupils who were not sure about the affects of industry gave no reason for this opinion.

About 15% of all the pupils, regardless of whether they were positive or unsure about industry, mentioned pollution as a negative aspect of industry. The majority of the pupils who were interviewed held the view that the positive and negative aspects of industry were balanced.

When pupils were asked about what they thought about jobs in industry, almost all of the pupils thought that it would be boring or would not interest them.

The majority of the pupils had positive or neutral views of industry, even though most of their information was obtained from the media rather than school. Despite the fact that two thirds of the pupils had said that they enjoyed science at school and a third said that they wanted a science career, there were very few pupils who thought that they would like to work in industry.

11 Conclusions: Teachers

Teachers interviews

The materials were well received and their value and impact remembered five years later by seven out of the eight teachers. Aspects of the CCI project that were valued were:

- NC and QCA focus of industry provided resources
 - Focus on scientific enquiry (Sc1)
 - Well planned and easily understood lessons and activities
 - Attractive and teacher friendly format
 - Context based approach with problem-solving story line
 - Industrial visits which were focussed on the needs and interests of the age group
 - Outsiders (CIEC/industrialists) team teaching with teachers
 - Materials/equipment brought in by industry/CIEC
- The main impacts of the CCI project were:
- The materials were still in use, in varying degrees, in schools.
 - The investigative approach had been strengthened in several schools despite the SATs imperative.
 - Pupils were very enthusiastic.
 - The context based teaching approach had been adopted throughout one school
 - Several teachers were more likely to consider industry related material more favourably in future if suitable. Several already had a positive attitude to industry provided materials.

12 Appendix

References

Cerini, B. Murray, I. & Reiss, M. Student Review of the science curriculum - major findings.

Parvin, J. Children Challenging Industry: the research report. Chemical Industry Education Centre, University of York, 1999.

MORI. The Public Image of the Chemical Industry 2002, Research Study Conducted for Chemical Industries Association.