RESEARCH

Children Challenging Industry

EVALUATION OF THE IMPACT OF THE CHILDREN CHALLENGING INDUSTRY PROGRAMME 2016 TO 2017

Hadeel Tabaqchali, Pam Hanley and **Maria Turkenburg-van Diepen**

AUGUST 2018

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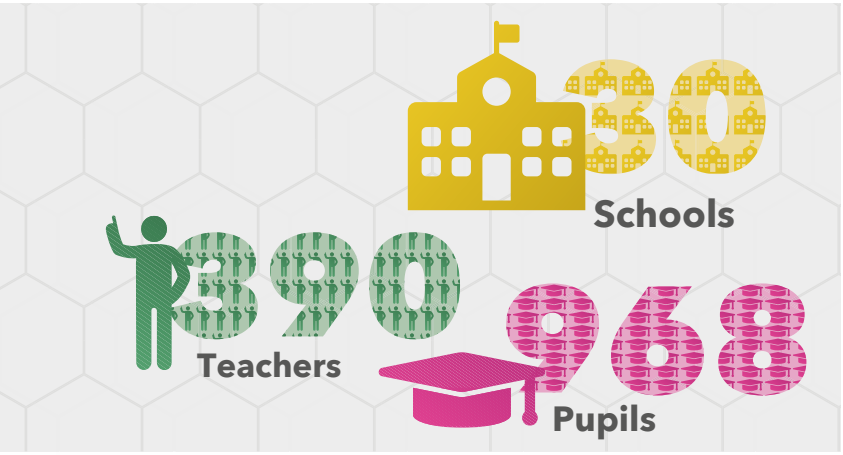
Since **CCI** began in 1996, around **46,000 pupils** have experienced **CCI**, involving over **1000 site** or **ambassador visits** from more than **120 companies**.



The Children Challenging Industry (CCI) programme places school science in a real-life context. It includes activities for children (in-school practical problem-solving usually followed by site visits to local industry or occasionally an ambassador visit) plus professional development for teachers and industrial partners. Key findings from 445 children (representing 21 schools) who completed pre- and post-CCI questionnaires are reported here. After participating in the programme pupils' attitudes towards science and industry become more positive, they become aware of the links between the processes that industries carry out and the science that they study in school, and they understand science-based industry's potential as a future employer.

'it taught me that i can do things in science and that science is not as complex as it first seems'

'I enjoyed the parts where we got involved and when we got to do experiments… When you don't get to have a go, you get less understanding and it's not as fun.'

'the whole experience has made me want to be an electrical engineer!'

IMPACT OF CHILDREN CHALLENGING INDUSTRY

96% SAID THEY HAD LEARNED SOMETHING NEW

85% LIKED SCIENCE MORE SINCE THEY TOOK PART IN THE PROJECT

87% LIKED LEARNING ABOUT INDUSTRY

CHANGED ASPIRATIONS

I'd like to be a scientist

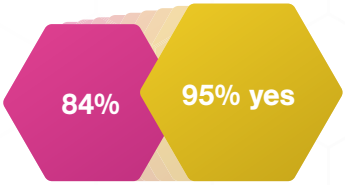
I could work for industry in future

GREATER AWARENESS OF JOB ROLES

Scientists have important jobs in industry

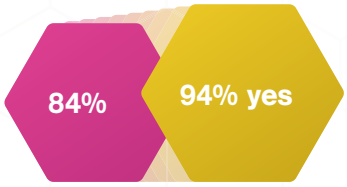
Engineers have important jobs in industry

Young people work in industry



There are women scientists and engineers

MORE FAVOURABLE ATTITUDES TO SCIENCE AND INDUSTRY



I like science

Industry is useful

Industry is safe

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CENTRE for INDUSTRY EDUCATION COLLABORATION

1. BACKGROUND TO THE CHILDREN CHALLENGING INDUSTRY PROGRAMME

The Children Challenging Industry (CCI) programme teaches science through practical problem-solving activities to enthuse primary school children, enabling them to see science being applied in a real-life setting through a visit to a local industry site. Children learn about the role of science-based manufacturing companies, increasing their awareness of the opportunities available within science and industry. The CCI programme also provides an opportunity for teachers to undertake science-related professional development, to enhance their ability and confidence in teaching enquiry-based science. Local industries get the chance to interact with the local community and inspire the next generation of scientists and engineers.

Few science initiatives target primary school children, with the majority of industry outreach programmes focusing on young people at secondary, college or undergraduate level. However, the ASPIRES project, which researched what influenced 10-14 year old children to aspire to science-related careers, concluded that "[e]fforts to broaden students' aspirations, particularly in relation to STEM, need to begin at primary school age. The current focus of most activities and interventions – at secondary school – is likely to be too little, too late" (Archer et al., 2013). The CCI programme has an important role, increasing children's interest in science and awareness of STEM careers early, so that these can be further nurtured later in their education.

Although there is a body of literature that considers education/industry links, like the initiatives it focuses on older learners. Post and van der Molen (2014) are unusual in conducting a quasi-experimental study of school visits to technology-related companies by 10-12 year olds. They concluded that the visits had no real effect on children's images of or attitudes towards technology and technological professions. The authors attributed this largely to the minimal teacher involvement in the programme. Their recommendations included several characteristics already inherent in CCI: the visit should be integrated more into the curriculum; preparation should include more familiarisation and exploration of misconceptions; and it should involve younger pupils (ie 9-11-year-olds, as covered by CCI).

Vennix, den Brok and Taconis (2018) looked at STEM-related outreach amongst secondary students and found that, depending on the nature of the activity, their STEM-related motivation and attitudes could be improved. Impact was higher when both in- and out-of-school activities were featured, and where teacher support was evident. In its review of informal science learning (Lloyd, Neilson, King, & Dyball, 2012), the Wellcome Trust advised that effective programmes should explicitly link with the curriculum and include materials that can easily be incorporated into school processes to prepare for, and afterwards develop, the experience. Nunes, Bryant, Strand, Hillier, Barros and Miller (2017) suggested that taking students to a science-related place, or bringing scientists into schools, could help socially disadvantaged learners in particular by showing them the relevance of science and the possibilities of science-related careers.

The CCI programme has been delivered by the Centre for Industry Education Collaboration (CIEC) at the University of York since 1996. The first evaluation report considered the impact of the CCI programme between 1996 and 1998 (Parvin, 1999). A change in both teachers' and children's views towards industry was seen, with a greater understanding of industry, including the role of science within it. Teachers reported gaining confidence to teach science through practical and investigative work.

Children who had taken part in this phase of the programme were re-contacted 5 years later (Evans, Hogarth & Parvin, 2004). The CCI lessons were remembered by 32% of the 90 respondents, and a large proportion said they did so because they were different to normal lessons due to the greater emphasis on practical work. 59% could recall the site visit. Recall of the visit was higher among those who wanted a career in science (46%) than those who did not (21%), although sample sizes were low.

Reports evaluating the CCI programme between 2003 and 2005 found similar positive results (Evans, 2006; Evans, Pook & Parvin, 2006). Two thirds of children acknowledged they enjoyed science more after the project, with the practical elements frequently receiving favourable comment in responses. Children were also more knowledgeable about industry afterwards. A large proportion of teachers who took part noted that they would use the CCI material again, and repeat the industrial visit.

Main findings from the 2008-2010 report included children being more inclined to consider a career in science following the programme, and teachers having a greater awareness of the career opportunities industry can offer (Porter, Parvin & Soomro, 2011). The most recent report covered data from 2012 to 2016 (Turkenburg & Hanley, 2017). 98% of children agreed that they had learned something new, and overall

attitudes to science became significantly more positive. For many of the industry-related questionnaire items, a positive improvement in attitude was also seen following completion of the programme. Teachers were overwhelmingly positive about the training they had received, many highlighting how their confidence in teaching science and knowledge of industry had increased.

Between September 2016 and July 2017, 968 children took part in the CCI programme from 30 schools within the North East and South East regions, and 390 teachers received professional development. Nine companies provided 26 site visits and four ambassador visits, including one new company which received training for 19 of its staff, and provided one site visit and one ambassador visit in its first year.

2. AIMS OF THE CCI PROGRAMME

The programme places curriculum science in a real-life context through a number of practical problem-solving activities and challenges. This approach aims to improve children's motivation and enjoyment of science, while helping teachers to teach science in an engaging manner.

The specific aims of the CCI project are to:

- provide classroom-based training for teachers in aspects of the National Curriculum for science;
- increase children's enjoyment of science;
- improve primary school children's perception of the science-based manufacturing industries, and their relationship with science;
- improve teachers' knowledge and confidence of teaching science;
- improve teachers' perception of the science-based manufacturing industries, and their relationship with science.

3. PROGRAMME DESIGN

The CCI programme contains multiple elements, comprising professional development for teachers and industrial partners, alongside the classroom activities and site visits for the children.

A full list of elements includes:

- a range of written and web-based materials which enables pupils to investigate science in a real life context;
- 7 hours of professional development, made up of 5.5 hours of classroom-based CPD, in which the children carry out practical enquiry-based science activities, and 1.5 hours of whole staff CPD;
- industrial partners receive a training session from a CIEC advisory teacher (typically a half-day);
- CIEC advisory teachers liaise with industrial partners on how to provide a successful site visit linked to the scientific concepts in the classroom investigation;
- a half-day site visit by each participating class (or when this is not possible, an industry ambassador will visit the school).

4. AIMS OF THE CCI EVALUATION

The evaluation was designed for two main purposes: to assess participant response to the CCI programme including providing formative feedback to the programme developers and deliverers, and to assess views of science and industry and how CCI might impact on these.

Specifically, the CCI evaluation explores:

- pupil and teacher attitudes to science;
- pupil and teacher attitudes to industry;
- and how these might change over the course of the programme;
- pupil and teacher evaluation of the CCI programme.

5. METHODOLOGY

DATA COLLECTION – PUPILS

Prior to embarking on the Children Challenging Industry programme, children completed a pre-project questionnaire devised to gauge the children's attitudes towards science and industry. Lessons examining a specific science topic and incorporating practical projects were conducted. These were led by a CIEC advisory teacher in the first and third sessions. The second session was led by the class teacher, with lesson plans and equipment being provided by the CIEC. Most of these children visited a local industry, however children from two schools were instead visited by a specially trained industry employee (industry ambassador) during CCI sessions. Upon completion of the project, the children completed a separate questionnaire with similar questions to allow analysis of any change in attitudes towards science and industry.

Questionnaires were completed online using SurveyMonkey in all but two schools who completed paper copies which were subsequently input manually. Basic demographics (gender and year group) were collected to enable analysis using multiple variables. Both questionnaires contained statements to be answered Yes/No/I don't know relating to attitudes to science and industry. Open responses about opinions on science and industry were also included in the pre-questionnaire to further understand the children's attitudes before the project. Post-project open questions included the aspects of the programme enjoyed most and least, followed by a series of 6 statements to be answered Yes/No/I don't know relating to the effect of the project and their experiences. Pre- and post-project questionnaires can be found here: http://www.ciec.org.uk/research-and-publications.html.

DATA ANALYSIS - PUPILS

Following the pairing of pre- and post-project questionnaires for each child and removal of responses as mentioned above, data were coded for use in SPSS. For positive statements, responses were coded as 1 for "Yes", 0 for "I don't know" and -1 for "No". Responses to statements with negative connotations (e.g. "We do too much writing in science" and "Industry is dangerous") were reverse coded. Paired sample t-tests were performed on pre- and post-responses to individual questionnaire items to see if answers differed significantly before and after the programme. This was not only done on the whole sample, but also on the North East, South East, girls, boys, Year 5 and Year 6 samples separately.

Changes in response to each statement from pre- to post-project were calculated and represented with a range of -2 to +2, where a positive number indicates an improvement in attitude or opinion and a negative number a deterioration. Independent-sample t-tests were performed to assess the significance of the changes in response between regions, genders and year groups to individual questionnaire items.

The questionnaire items asked to probe the children's attitudes to science were assessed for their suitability to form part of an overall attitudes to science score using Cronbach's alpha statistic. The same analysis was performed to assess the suitability of items to form part of an overall attitudes to industry score. Where Cronbach's alpha was ≥0.7 for both the pre- and post-project data, and therefore the scale had an acceptable level of internal consistency, the coded data for each statement were taken together to form a score. For instance, for the attitudes to science score each person was given a score of between -12 (disagreeing with every positive statement and agreeing with every negative statement) to +12 (agreeing with every positive statement and disagreeing with every negative statement). Paired sample t-tests were then performed using the pre- and post-questionnaire data scored as above, to see if there is a significant difference in attitudes to science before and after the programme. This was repeated for the North East, South East, girls, boys, Year 5 and Year 6 samples separately.

The underlying structure of the data was assessed using factor analysis. This was performed on data collected in both the pre- and post-questionnaire to enable observation of any change in underlying concepts across the course of the project. Where Cronbach's alpha was <0.7 when testing suitability to form an overall attitude score (as explained above), it was repeated on the groups of questionnaire items found to be representing an underlying construct in the factor analysis. This was used to see if these groups of items could be used to calculate an overall attitude score.

The post-project questionnaire included six statements designed to understand how children felt about their experience of the project. Independent sample t-tests were used to look for significant differences in opinions between the genders, regions and year groups for individual questionnaire items. To see if the items could form part of a 'post-project evaluation score' Cronbach's alpha was calculated. Taking all six items together as a scale gave a range of possible scores from -6 (disagreeing with every statement) to +6 (agreeing with every statement). Independent sample t-tests were used

to look for significant differences in the overall mean score between the genders, regions and year groups.

Common phrases and descriptions made by the children in their answers to open-response questions were given a code. Repeating patterns and overarching themes were identified in the data and quantified using the coding system.

DATA COLLECTION – TEACHERS

Prior to taking part in the project, teachers were asked to respond to a questionnaire. Questions included those determining their previous engagement with professional development opportunities related to science and industry, alongside their schools' prior links with industry and related services. Teachers were then asked to rank their main objectives for taking part in the CCI programme from a list of four, with the option of adding their own objective. An array of statements was then presented, devised to gauge their attitudes towards industry and the jobs it offers. The teachers were asked to respond with their level of agreement for each statement (4-point scale from 'strongly disagree' to 'strongly agree').

The post-project questionnaire began by asking the teachers to rate the programme on a scale from 'satisfactory' to 'good' to 'excellent'. Teachers were also given a list of 12 statements and asked to indicate which they considered true regarding the strengths of the classroom training, as well as being given the option of adding their own. These statements were originally compiled after semi-structured interviews were undertaken between 1996 and 1999. Teachers were also encouraged to add any comments about both the classroom part of the programme as well as the site visit/ industry ambassador talk and how they could be improved. The same statements as in the pre-project questionnaire were included post-project, and the exercise was repeated to highlight any changes in opinions of industry. They were also asked to respond with their level of agreement to statements intended to gauge their views on the programme as a whole, and what they learned from the experience.

DATA ANALYSIS – TEACHERS

Pre- and post-project questionnaires were paired for each teacher and incomplete responses removed as stated above. Too few responses were gathered to enable statistical analysis, therefore data were analysed in a simpler manner than the children's data.

Where a level of agreement with statements was required, the data were coded between 1 (strongly disagree) and 5 (strongly agree) with "I don't know" as the midpoint. Negative statements such as "I feel negative about industry" and "Industry causes pollution" were reverse coded. The mean score (between 1 and 5) for the whole sample of teachers was then calculated.

Few teachers gave responses to the open-ended questions, meaning only basic analysis was possible since too few responses meant common themes could not be quantified.

6. CHILDREN'S DATA

6.1 Sample

Pre- and post-project questionnaires were returned from 10 schools in the North East region and 11 schools in the South East region. However, not all children completed both the pre- and post-questionnaires and these children were removed before analysis. Sample sizes differ between individual questions with not all children answering all questions on the questionnaires. Responses from children who answered a question only on the pre- or post-questionnaire were removed for that question. The dataset comprised a total of 445 children, 54% girls and 46% boys. This represents almost half of all children involved across the year. 58% of data were derived from South East children and 42% from North East. Year 5 children made up 52% of the sample and Year 6 children the remaining 48%.

Each class followed a practical topic relevant to the industry the children were to visit or be visited by, so that appropriate activities were undertaken. The different topics and the percentage of children doing each can be found in Figure 1.

Figure 1. Range of CCI activities undertaken.

6.2 Results

QUANTITATIVE DATA – RESPONSES TO INDIVIDUAL QUESTIONNAIRE ITEMS

The percentage of children responding Yes/No/I don't know for individual questionnaire items before and after the programme is represented in Figures 2-5. An asterisk (*) highlights the questionnaire items where the mean response changes significantly from pre- to post-project. For the positive questionnaire items, a decrease in the fraction of children answering "no" indicates an improvement in attitude, whereas the opposite is true for negative questionnaire items.

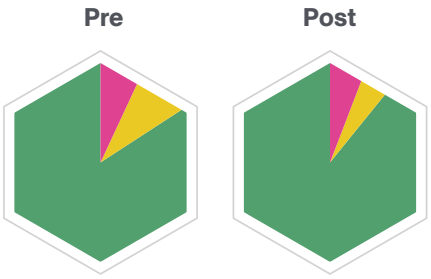
Children's attitudes towards science and industry mostly improved as seen through analysing the percentage of children whose opinions improved, deteriorated and stayed the same across a range of statements. A significant increase in children responding positively to the statement "I like science" was observed, although a high percentage of the children answered positively in both the pre- and post-questionnaire (84% and 89% respectively). Significantly more children also responded positively to the statement "Scientists are important in industry" (81% to 92% answering "yes"). For this statement, 85% of children who were undecided pre-project now gave positive responses. For "I'd like to be a scientist", significantly more children gave a positive response although the proportion of children responding positively in the post-questionnaire was still only 28% (doubled from 14%). This is slightly higher than seen in previous years (although not significantly higher and still a low proportion). An increase was also seen in the number of children unsure about whether to pursue a career as a scientist. 53% of children responding "I don't know" in the post-questionnaire had responded "no" in the pre-questionnaire, which could be interpreted as a less negative attitude.

Science work seemed to be regarded more positively after the CCI project, with a significant change in the children's answers to "We do too much science in school" and "We have to do too much work in science". Perhaps the integration of more practical aspects into the children's learning experience through the CCI project makes it seem less like work and more enjoyable. This is supported by the information collected by the post-project evaluation and the qualitative analysis detailed below. Although not statistically significant, an increase was also seen in the number of children no longer finding science too difficult (73% to 79%).

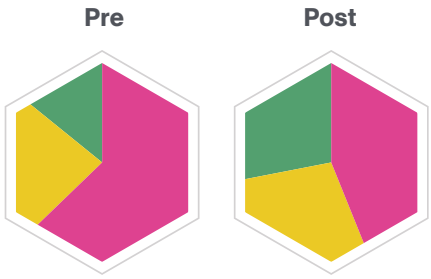
All but one of the questions designed to examine the children's attitudes to industry showed a significant positive change in opinion. "I learn about industry from TV" had similar responses in the pre- and post-questionnaire. However, this feature was not a direct part of the CCI project. Questions relating to the types of people working in industry, such as scientists, engineers, young people and females, alongside the usefulness and role of industry were aspects that it was intended the site visits or ambassador talks would address. This is reflected in the increase in positive responses post-project. Children also began to understand that the negative aspects associated with industry in terms of safety and pollution, when controlled, are not as adverse as they first seem. The children's responses to the statement "I learn about industry from my teachers" also changed significantly. The proportion of children agreeing increased from 38% to 68%, indicating how the CCI project has enabled the teachers to teach a topic not always mentioned. Further details of the statistics can be found in Appendix Table A1.

ATTITUDES TO SCIENCE – POSITIVE QUESTIONNAIRE ITEMS

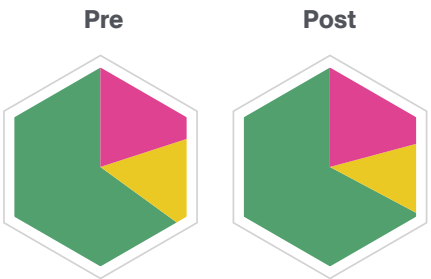
I like science*



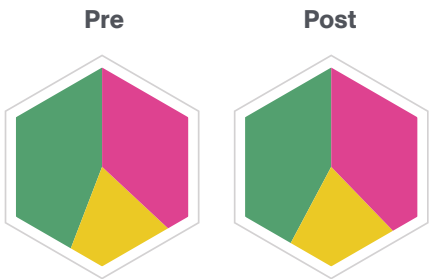
I'd like to be a scientist*



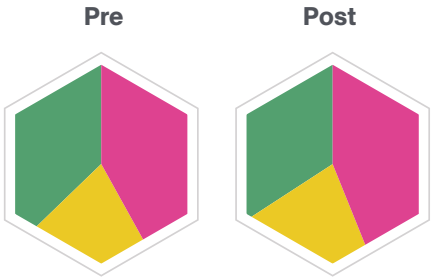
I like doing science experiments at home



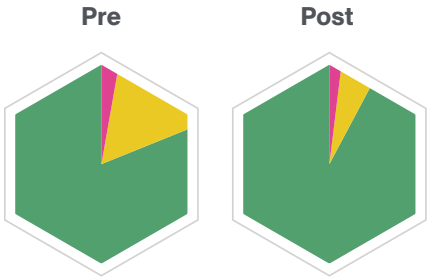
I like watching science programmes on TV



I like reading science stories



Scientists are important in industry*



School science clubs are a good idea

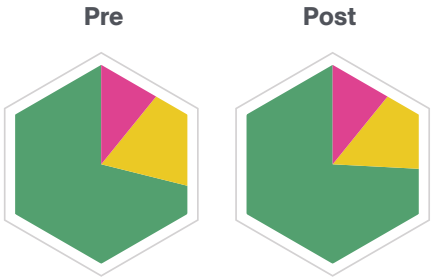
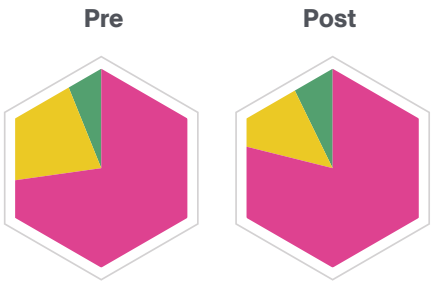


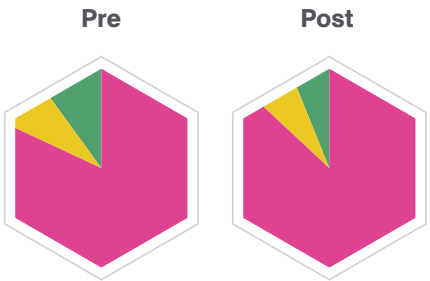
*Figure 2. Percentage of Yes/No/I don't know responses to positive statements used to assess the children's attitudes to science. *indicates items where the difference between pre and post-project responses is significant*

ATTITUDES TO INDUSTRY – NEGATIVE QUESTIONNAIRE ITEMS

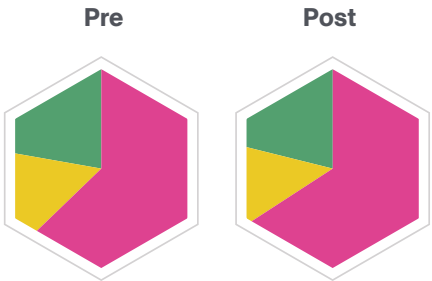
Science is too difficult



We do too much science at school*



We do too much writing in science



We have to do too much work in science*

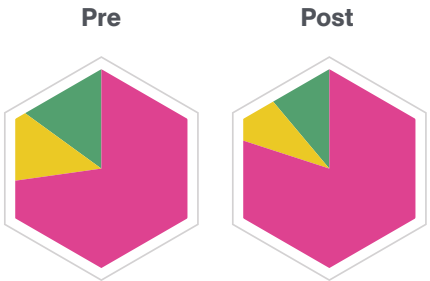
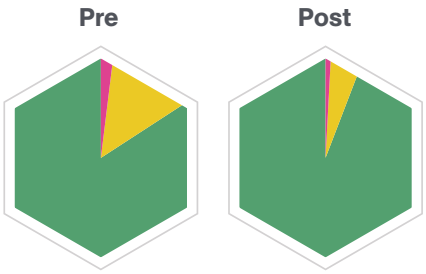


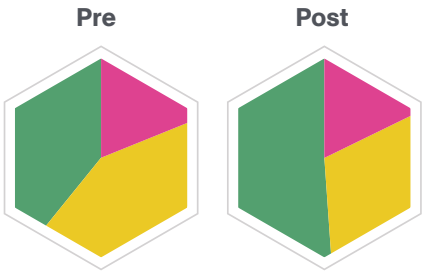
*Figure 3. Percentage of Yes/No/I don't know responses to negative statements used to assess the children's attitudes to science. *indicates items where the difference between pre and post-project responses is significant.*

ATTITUDES TO INDUSTRY – POSITIVE QUESTIONNAIRE ITEMS

Industry is useful*

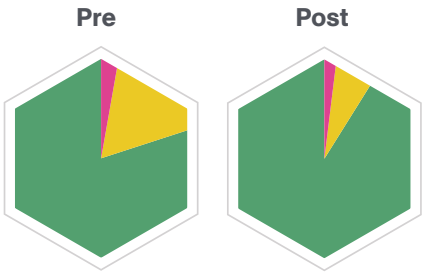


Industry is safe*



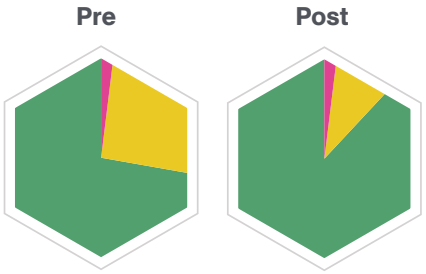
Many scientists work in industry*

Scientists have important jobs in industry*

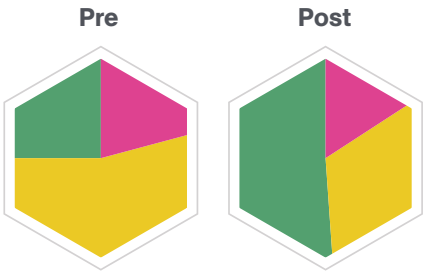


Many engineers work in industry*

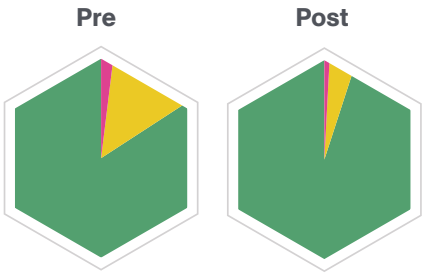
Engineers have important jobs in industry*



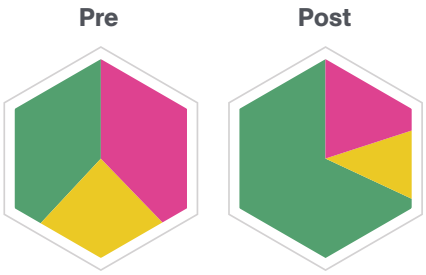
Young people work in industry*



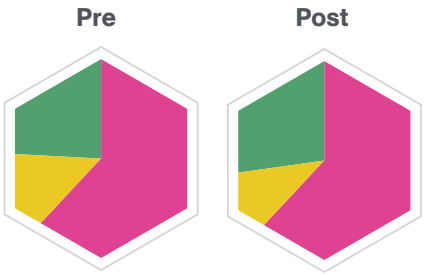
There are women scientists and engineers*



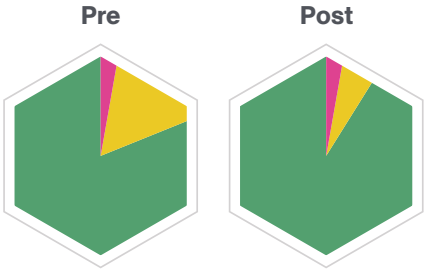
I learn about industry from my teachers*



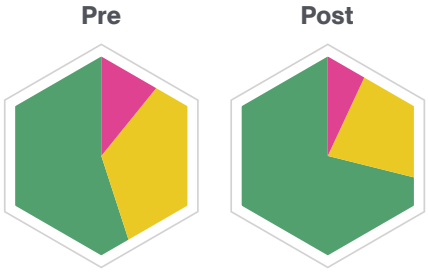
I learn about industry from TV



Industry makes things we need*



Our lives would be worse without industry*



I could work for industry in the future*

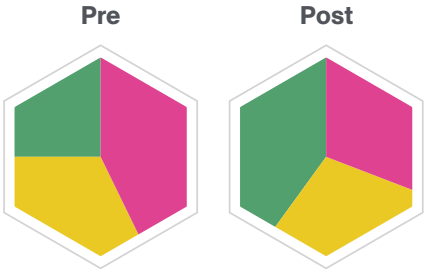
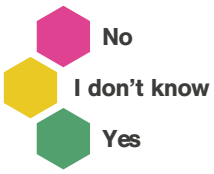
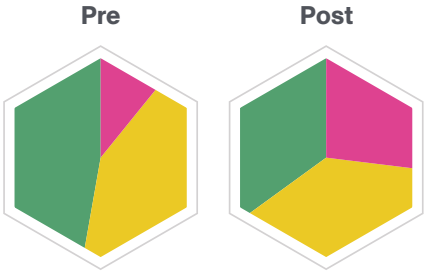


*Figure 4. Percentage of Yes/No/I don't know responses to positive statements used to assess the children's attitudes to industry. *indicates items where the difference between pre and post-project responses is significant.*

ATTITUDES TO INDUSTRY – NEGATIVE QUESTIONNAIRE ITEMS



Industry causes pollution*



Industry is dangerous*

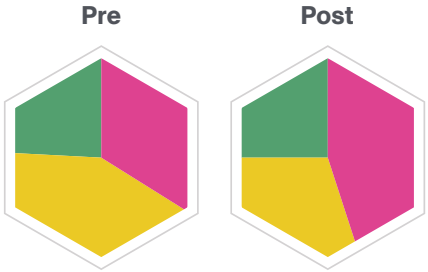


*Figure 5. Percentage of Yes/No/I don't know responses to negative statements used to assess the children's attitudes to industry. *indicates items where the difference between pre and post-project responses is significant.*

A significant difference in the mean attitude change between genders, regions and year groups was observed for some of the questionnaire items gauging 'Attitudes to science' and 'Attitudes to industry' (Appendix Table A2). Many of the significant results were for statements where, pre-project, a noticeable difference in attitudes was seen between the samples, but which balanced out to give similar post-project views. An example where this was not the case is between the year groups for the statement "I'd like to be a scientist". A more positive attitude was seen pre-project by Year 5 pupils, whose attitude changed significantly compared to Year 6 children resulting in an even more positive attitude post-project. 38% of Year 5 children improved their attitude compared to 25% of Year 6 children. This might suggest that younger children are more malleable in terms of career choice in which case it supports a conclusion of the ASPIRES project, that children should be introduced to STEM careers at an earlier age (Archer et al., 2013). Significant regional differences were observed in response to the item "Industry causes pollution". Pre-project South East children had a slightly more positive attitude which changed significantly compared to that of children in the North East, giving them a significantly more positive attitude post-project. 39% of South East children improved their attitude compared to 30% of North East children. Perhaps the South East industries that were visited addressed how they alleviate their effect on the environment more clearly, and were industries generally less associated with pollution.

QUANTITATIVE DATA – 'ATTITUDES TO SCIENCE' SCALE

A reliability analysis carried out using Cronbach's alpha on the 11 items addressing children's attitudes to science, gave a score of just over 0.7 for both pre- and post-project responses. This indicates that each of the items can form part of an 'Attitudes to science' scale that has a high level of internal consistency. Similarly, Cronbach's alpha indicated acceptable reliability for items when both pre- and post-project data were split into North East, South East, Year 5 and Year 6 samples. The Cronbach's alpha statistic calculated for the sample of boys was also higher than 0.7, however the girls' post-questionnaire responses gave a Cronbach's alpha of just under 0.7. This was so close to an acceptable level that internal consistency was assumed.

The whole sample of children as well as the samples split by region, gender and year group, all had statistically significant improvements in the 'attitudes to science' score. Further details on the statistics, samples and mean scores can be found in Table 1. Factor analysis was also undertaken on the data gathered pre- and post-project, using principal component analysis and Varimax rotation (Tables 2-3). This enabled the questionnaire items to be grouped into smaller sub-sets (loaded onto factors) representing an underlying construct. These sub-sets are formed because items representing a similar concept have similar patterns of responses. An indication of how many stable factors exist can be obtained by calculating the eigenvalue of each and interpreting those greater than one. An analysis revealed two factors with eigenvalues greater than one for both pre- and post-project data, with the same six items loaded onto factor one, and the same four onto factor two. All items loaded onto factor one encompass positive attitudes towards science, whereas all items loaded onto factor two relate to negative attitudes towards science. One item, "Scientists are important in industry", does not load onto either factor, which is seemingly logical, being a statement regarding industry rather than science itself. It is worth noting that the placement of this item is different between pre- and post-project outputs, indicating that pre-project the item fits better with factor one whereas post-project it fits better with factor two.

Sample	Phase of project	Number of responses	Cronbach's alpha statistic	Mean score	Standard deviation	Score range	Paired t-test
Whole data set	Pre	445	0.740	4.43	4.19	-9 to +11	Improvement $t(444)=4.991$, $p<0.001$
	Post		0.719	5.24	4.03	-11 to +11	
North East	Pre	185	0.722	4.67	4.13	-8 to +11	Improvement $t(184)=2.064$, $p<0.05$
	Post		0.712	5.23	4.04	-8 to +11	
South East	Pre	260	0.752	4.26	4.23	-8 to +11	Improvement $t(259)=4.967$, $p<0.001$
	Post		0.727	5.24	4.03	-11 to +11	
Girls	Pre	232	0.709	4.44	4.00	-8 to +11	Improvement $t(231)=3.773$, $p<0.001$
	Post		0.697	5.28	3.70	-7 to +11	
Boys	Pre	212	0.764	4.42	4.40	-9 to +11	Improvement $t(211)=3.270$, $p<0.001$
	Post		0.742	5.19	4.37	-11 to +11	
Year 5	Pre	231	0.706	4.79	4.01	-8 to +11	Improvement $t(230)=3.996$, $p<0.001$
	Post		0.723	5.71	3.99	-8 to +11	
Year 6	Pre	214	0.763	4.04	4.35	-8 to +11	Improvement $t(213)=3.021$, $p<0.005$
	Post		0.710	4.72	4.02	-11 to +11	

Table 1. Attitudes to science scale: Statistics

Item	Component	
	1	2
I like reading science stories	0.746	
I'd like to be a scientist	0.680	
I like watching science programmes on TV	0.655	
I like doing science experiments at home	0.525	
School science clubs are a good idea	0.516	
I like science	0.485	
Scientists are important in industry		
We have to do too much work to do in science		0.761
We do too much science in school		0.726
We do too much writing in science		0.640
Science is too difficult		0.557

Table 2. Attitudes to science items: Rotated component matrix from factor analysis (pre-project data)
Extraction methods: Principal components analysis; rotation methods: Varimax and Kaiser normalisation.

Item	Component	
	1	2
I like watching science programmes on TV	0.742	
I like reading science stories	0.712	
I'd like to be a scientist	0.628	
I like doing science experiments at home	0.594	
School science clubs are a good idea	0.518	
I like science	0.445	
We have to do too much work to do in science		0.702
We do too much writing in science		0.681
Science is too difficult		0.660
We do too much science in school		0.615
Scientists are important in industry		

Table 3. Attitudes to science items: Rotated component matrix from factor analysis (post-project data)
Extraction methods: Principal components analysis; rotation methods: Varimax and Kaiser normalisation.

QUANTITATIVE DATA – 'ATTITUDES TO INDUSTRY' SCALE

The 'Attitudes to industry' scale contained 15 items and for the sample as a whole both the pre- and post-responses gave a Cronbach's alpha of less than 0.7, indicating questionable reliability. Similarly, both pre- and post-project data split regionally, by gender and year group all gave a Cronbach's alpha of less than 0.6 (Table 4). Upon further inspection, it was found that removal of every item in turn would never increase the Cronbach's alpha score to above 0.7, and therefore reliability could not be improved in this way. This means that all of the questionnaire items could not be grouped together to form an overall 'Attitudes to industry' score before and after the project.

Sample	Phase of project	Cronbach's alpha
Whole data set	Pre	0.555
	Post	0.617
North East	Pre	0.588
	Post	0.627
South East	Pre	0.495
	Post	0.600
Girls	Pre	0.490
	Post	0.568
Boys	Pre	0.554
	Post	0.647
Year 5	Pre	0.562
	Post	0.669
Year 6	Pre	0.483
	Post	0.533

Table 4. Cronbach's alpha statistic testing reliability of an 'Attitudes to industry' scale

Factor analysis was performed to split the items into sub-sets that could possibly be used to gauge an overall attitude score. The underlying structure of the data was investigated for the whole sample, again using principal component analysis and Varimax rotation (Tables 5-6). For the pre-project data, originally eight factors were extracted with eigenvalues greater than one, however, after performing a series of factor analyses it was clear that six factors gave the most interpretable solution. Three items loaded onto factor one, all of which were related to potential negatives associated with industry. Three items also loaded onto factor two, addressing how industry benefits our lives, and the three items in factor five all referenced engineers. Two of the three items in factor four referred to the role of scientists, alongside "I learn about industry from my teachers", perhaps suggesting it is their teachers who informed them of this role. The remaining two factors overlap indicating a more tenuous connection that counted for only a small portion of the variance in the data.

For the post-project data, analysis yielded a four factor solution through the use of eigenvalues greater than one. The five items in factor one indicate the types of people who work in industry including young people, scientists, engineers and women. Three of the four items in factor two are the same as those in the pre-project analysis, concerning the benefits of industry, alongside "scientists have important jobs in industry". It may be the idea of industry benefiting our lives which makes the children believe scientists have important jobs. The three items loaded onto factor three are the same items appearing in factor one in the pre-project analysis, relating to potential negatives associated with industry. It is also interesting to note that the same subset of items was found in the previous report, indicating a strong relationship between these items. Two of the three items in factor four addressed where the children learn about industry, alongside "I could work in industry in the future". It could be the teachers and the TV that solidify the notion that the children could have a career in industry.

As outlined, no usable constructs could be formed to gauge an overall 'Attitudes to industry' score. Despite this, we can look at changes in response to individual questionnaire items (as above). In addition, we can say that the children's thinking becomes more organised over the course of the programme: in the pre-project questionnaire their responses are varied and scattered over six different constructs, whereas at the post-project stage their thinking seems to be more coherent and the underlying constructs are certainly simpler to interpret. This is especially noticeable in relation to the more factual statements about the people who can be seen in an industry setting, which were spread over three factors pre-project, and which have converged in one factor in the post-project data.

Item	Component					
	1	2	3	4	5	6
Industry is dangerous	0.819					
Industry is safe	0.768					
Industry causes pollution	0.593					
Our lives would be worse without industry		0.766				
Industry is useful		0.699				
Industry makes things we need		0.451				
Many engineers work in industry			0.734			
Engineers have important jobs in industry			0.617			
There are women scientists and engineers			0.515			
I learn about industry from my teachers				0.702		
Scientists have important jobs in industry				0.701		
Many scientists work in industry				0.544		
I could work in industry in the future					0.855	
I learn about industry from TV					0.521	0.468
Young people work in industry						0.816

Table 5. Attitudes to industry items: Rotated component matrix from factor analysis (pre-project data)
Extraction methods: Principal components analysis; rotation methods: Varimax and Kaiser normalisation.

Item	Component			
	1	2	3	4
There are women scientists and engineers	0.647			
Engineers have important jobs in industry	0.582			
Many scientists work in industry	0.556			
Many engineers work in industry	0.458			
Young people work in industry	0.436			
Our lives would be worse without industry		0.710		
Industry makes things we need		0.570		
Scientists have important jobs in industry		0.538		
Industry is useful		0.507		
Industry is dangerous			0.834	
Industry is safe			0.784	
Industry causes pollution			0.530	
I learn about industry from TV				0.782
I could work in industry in the future				0.615
I learn about industry from my teachers				0.487

Table 6. Attitudes to science items: Rotated component matrix from factor analysis (post-project data)
Extraction methods: Principal components analysis; rotation methods: Varimax and Kaiser normalisation.

QUANTITATIVE DATA – POST PROJECT EVALUATION

In the post-project questionnaire six items were used to gather information on the children's opinions of the project and its impact. Statistical analysis showed there were no significant differences in opinions between regions and year groups for any questionnaire item. However, a significant difference was seen between genders for the statement "I learned something new" with girls being more positive ($t(295)=-2.090$, $p<0.05$). Both genders had a very positive response to this question with 98% girls answering "yes" and 94% of boys. This is further supported by the qualitative data (below), with the girls mentioning learning new things more often than the boys. The proportion of children answering Yes/No/I don't know to these statements for the whole sample is detailed in Figure 6.

The same six items in the post-project questionnaire were then taken together as a scale to give a Cronbach's alpha of 0.766, indicating acceptable reliability. Each child was given a 'post-project evaluation score', however no significant difference in the attitudes towards the project was found between genders, regions or year groups, when considering the difference in this overall score.

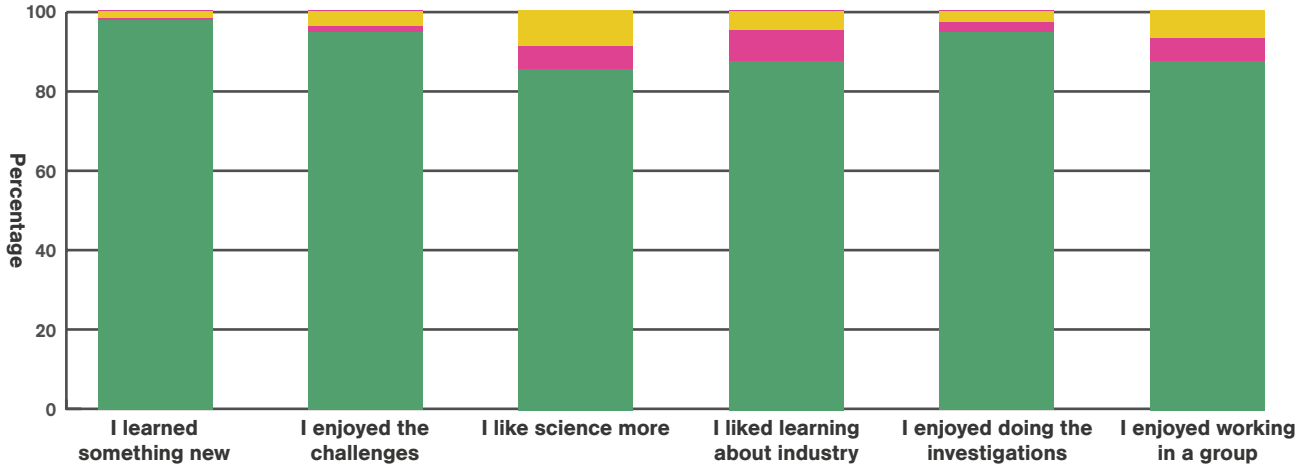


Figure 6. The proportions of children answering Yes/No/I don't know to six statements relating to their CCI experience.

QUALITATIVE DATA

Qualitative data were collected in the pre-project questionnaire, intended to further analyse the children's initial attitudes to science and industry (Table 7). For the 'attitudes to science' portion of the questionnaire, the most common aspect the children referred to was experiments (32%), followed by them finding science fun (28%) and stating that they like science (25%). Only 4% of children said they found science boring and hard. Attitudes to industry were not as positive, with 11% of children highlighting how it causes pollution and/or is harmful to the environment. The majority of comments made were quite general, for instance referencing making medicine or plastic bags. However, 26% of children acknowledged it was important and 16% useful. A large minority of children (18%) stated that they did not know about industry and/or wanted to learn more about it. This emphasises how primary school children are not always taught about industry in their studies, stressing the importance of the CCI programme.

	Total sample	
	N	%
Attitudes to science (N=242):		
Experiments	78	32
Fun	68	28
Like it	60	25
Important	24	10
Interesting	18	7
Explosions	9	4
Want to do more	9	4
Boring	10	4
Writing	10	4
Hard	10	4
Attitudes to industry (N=137):		
Important	36	26
Useful	22	16
Pollution/harmful to the environment	15	11
Unsafe	7	5
Don't know what it is/should learn more about it	25	18

Table 7. Children's thoughts on science and industry before taking part in the CCI project. N=number of pupils

Analysis of the qualitative data from the post-project questionnaire revealed patterns in children's responses to questions enquiring which aspects of the programme they enjoyed most and least (Tables 8-9). In the answers highlighting positive aspects of the project, many children mentioned the experiments and the site visit in their answers, emphasising both general and specific aspects of each. The specific aspects differed regionally due to the children visiting different sites and undertaking varied classroom sessions.

Little difference in children mentioning experiments more generally was seen between the regions. However, children from the South East mentioned the site visit or an aspect of the site visit more often than children from the North East (44% and 34% respectively). North East children were more likely to describe enjoying the challenge (8% compared to 1%) and seeing things in person (13% compared to 4%). They also seemed to allude marginally more to teamwork and learning new things. South East children mentioned liking everything about the programme slightly more (8% compared to 4%).

In terms of gender, differences were observed in the specific aspects of the site visits mentioned. For instance, boys were more likely to mention machines (17%) than girls (11%). This could be due to different interests between males and females. It is worth remarking that there are similar numbers of SE children in the boys' and the girls' samples, therefore more boys visiting the sites with these machines is not the reason for the difference. A higher proportion of girls mentioned making soap (9% compared to 4%) and also experiments more generally (16% compared to 11% of boys). They also referred to learning new things more often (19%) than the boys (12%).

Some differences in the responses given by the Year 5 and Year 6 samples were identified. Again differences in specific experiments and activities during the classroom sessions and site visits may reflect how the programme varied between year groups. Year 5 children alluded to the site visit or an aspect of it more than Year 6 children (42% and 37% respectively). Year 6 children were slightly more likely to mention enjoying everything (9% compared to 4%), the challenge (7% compared to 1%), and teamwork (8% compared to 3%).

A common theme in the responses was the opportunity to see the application of what they had learnt in a real-life setting:

'At the powerstation our learning was visual and we didnt have to write pages after pages' Girl, 4383, Year 6, NE

'...I enjoyed having a look at the real thing for myself rather than looking off a picture...' Girl, 4383, Year 6, NE

'I really enjoyed using…and seeing the machines working in action' Boy, 8013, Year 6, SE

Many children enjoyed the practical nature of the programme and how this enhances learning:

'I enjoyed the parts where we got involved and when we got to do experiments.For me, this is the best part of science… When you don't get to have a go, you get less understanding and it's not as fun.' Girl, 4384, Year 5, NE

'I enjoyed [the practical aspects] because they helped our education but in a fun way.' Boy, 4388, Year 5, NE

'Seeing the whole making of the catalyst and the experiments. Because it was interesting and the experiments really explained it.' Girl, 8008, Year 6, SE

'…if they just talked it would be a little boring but with experiments it makes it more fun' Girl, 8008, Year 6, SE

Girls from the North East in particular, referred to enjoying the "challenges", liking the element of problem solving and having to decide what to do for themselves:

'…I like challenges and it was a challenge making sure you had everything in place and was all connected and when a light bulb didn't light up then you had to solve the problem.' Girl, 4383, Year 6, NE

'…I found it a challenge and I find that challenges make me think. I really enjoy it.' Girl, 4383, Year 6, NE

'I enjoyed making a water sensor. Because if you didn't do it right first time you'll have to create a new design and see if it worked.' Girl, 4386, Year 6, NE

Children liked how they could learn new things and experience things that they had not before:

'I enjoyed doing every aspect of the topic. It was very fascinating as I always learnt something new.' Boy, 4383, Year 6, NE

'I liked all of it. Because it was fun and I learnt lots of news things' Girl, 4389, Year 5, NE

'Seeing how they made catalitic converters and the robots. Because first i did not know how to make a catalitic converter so it was interesting.' Girl, 8008, Year 6, SE

'I enjoyed doing the experiments most. I don't usually do experiments with some of the chemicals we used.' Boy, 8018, Year 5, SE

The group work aspect of the experiments was referenced in multiple responses, more often by girls:

'I enjoyed working together. Because if just one person did everything it wouldn't turn out as well.' Girl, 8018, Year 5, SE

'…it involved working in groups and teamwork and I like doing both of those things.' Girl, 8013, Year 6, SE

'all of the practical work. Because I got to work with different people' Girl, 4385, Year 6, NE

Children, particularly those from the South East, seemed grateful, understanding that not everyone gets to visit industry and have the experience they have had:

'going under the car and making the washcoat. Because some people have never been under a car like me.' Girl, 8009, Year 5, SE

'Pouring the platinum into the pot. Because i never thought that i would ever pour platinum into anything and i don't think that i will do it again.' Boy, 8008, Year 6, SE

A few children mentioned how the programme had increased their confidence when it comes to science:

'it taught me that i can do things in science and that science is not as complex as it first seems' Girl, 4383, Year 6, NE

'it allowed me to learn more about the industry and made me feel more confident in science' Girl, 4383, Year 6, NE

The programme even motivated some children to consider pursuing a career in science or industry:

'It has inspired me to be a scientist.' Girl, 8004, Year 6, SE

'I liked the whole thing SO much, and the whole experience has made be want to be an electrical engineer!' Boy, 8004, Year 6, SE

'i like chemistry and would not mind working as a chemist in areas like the wash coat area' Boy, Year 6, 8008, SE

A much higher percentage of children referenced learning new things in the 2016-2017 sample (16%) compared to those from the preceding report (4%) (Turkenburg & Hanley, 2017). A larger proportion of children also used 'fun/enjoyable/exciting' in their responses (29%) than previously observed (9%). The children's and teachers' feedback enable the continuing development of the programme so that it becomes both a more valuable and enjoyable experience – see section 8 (Recommendations).

Specific classroom challenges:	Total Sample (445) %	North East (185) %	South East (260) %	Boys (212) %	Girls (232) %	Year 5 (231) %	Year 6 (234) %
Making soap	6	11	3	4	9	4	8
Circuits	4	9	0	4	4	0	8
Bubbles	3	3	3	4	2	3	3
Making toothpaste	2	5	0	2	2	2	3
Site visit/Aspect of the site visit	40	34	44	39	40	42	37
Specific activities on industry site visit:							
Machines (including robots, computers, Ambr15)	14	2	22	17	11	17	10
Turbine	3	7	0	4	2	0	6
Cars	3	0	5	4	1	4	1
Catalyst	3	1	4	3	3	2	3
Making wash coat	2	0	4	2	2	1	3
Fun/enjoyable/exciting	29	30	29	27	32	29	30
Learnt new things	16	18	14	12	19	15	17
Experiments (no detail)	14	14	14	11	16	12	15
Interesting	14	15	12	12	15	13	14
Seeing it in person	8	13	4	7	9	7	9
Enjoyed everything	6	4	8	7	6	4	9
Group/team work	5	8	4	2	8	3	8
Doing it myself	4	4	4	3	6	3	6
Enjoyed the challenge	4	8	1	2	5	1	7
Using new materials/equipment	3	3	2	2	3	3	2
No response	9	10	9	11	8	10	9

Table 8. Aspects of the project enjoyed most by the children and mentioned by at least 5% of one of the sub-samples (N=number of pupils)

For the question asking children what their least favourite part of the project was, 45% of the sample responded that they enjoyed every aspect, much higher than the previous year (33%). The proportion of South East children saying this was much higher (50%) compared to the North East (37%). Certain criticisms related to the site visited, such as the site where 39% of the class complained about the time-consuming security checks. Although superficially trivial, these experiences can greatly affect the children's overall

view of the visit. Otherwise regions, genders and year groups were mostly similar, except a higher number of boys (10) referred to walking/standing than girls (1). Many children alluded to various aspects of the experiments (18%), although each particular aspect was mentioned by fewer than 5% of the sample. A few children even mentioned that leaving was their least favourite part.

Although some children had previously mentioned the group work as a factor that they enjoyed the most, other children enjoyed this the least due to problematic group dynamics. This influenced their whole view of the experiment they were doing:

'I enjoyed the soap making the least. Because my team didn't work well when we where doing it.' Boy, 4377, Year 6, NE

'I didn't really enjoy the soap experiment… because I didn't have a very good group and no one was listening to each other.' Girl, 8018, Year 6, SE

Some children also disliked having to do writing after they had completed the experiments:

'Writing about electricity in our books. I would rather create circuits' Boy, 4383, Year 6, NE

'the experiments are already memorable and we are having to re write them over again.' Girl, 8008, Year 6, SE

	Total Sample (445) %	North East (185) %	South East (260) %	Boys (212) %	Girls (232) %	Year 5 (231) %	Year 6 (234) %
Nothing	45	37	50	42	47	47	43
Experiments (Various)	18	20	16	17	18	16	20
Aspect of site visit	6	5	7	5	7	8	5
Writing	3	5	2	3	4	2	5
Walking/Standing	3	2	2	5	0	3	2
Security checks	3	6	0	1	3	0	5
No response	14	16	12	14	13	13	14

Table 9. Aspects of the project enjoyed least by the children and mentioned by at least 5% of one of the sub-samples (N=number of pupils)

Children taking part in the CCI programme have generally had a positive experience, particularly enjoying the practical aspects that are a focus of both the site visit and classroom activities. Taking into consideration the quantitative data alongside the qualitative data, children seem to have learnt a great deal about industry and have improved their opinions of both science and industry considerably. Judging by these data, the CCI programme is achieving its aims in impacting the children.

7. TEACHERS' DATA

7.2 Sample

The teachers involved in the classroom project part of the CCI programme were asked to fill in a questionnaire before participating in the project and then again after its completion. Not all teachers answered all the questions in the pre- and post-project questionnaires leading to variable sample sizes per question. Teachers who only filled in the pre-questionnaire were removed before analysis. Only 13 teachers in total answered both the pre- and post-project questionnaire, six from the North East and seven from the South East region.

7.2 Results

QUANTITATIVE DATA

The average amount of science CPD undertaken by the teachers in the past three years was only 1.6 days, with half the teachers having done one. From these findings it seems the CCI programme is playing a crucial role, with teachers receiving little science CPD outside the programme. Only four teachers had previously organised visits to industry and 11 of the schools did not have any policy relating to industry links. Few schools reported having links with industrial companies or link organisations. Where these had been established, schools had worked with: STEM ambassadors (3 schools), local industry (2) and STEMNET (1). Two of the teachers reported having previously been involved in the CCI programme.

Teachers' main objectives for getting involved in the CCI programme were to increase their pupils' awareness of science and industry rather than their own professional development. However, this does not mean the science CPD is unimportant to the success of the programme.

When asked to consider the main strengths of the classroom sessions, all 13 teachers agreed on the practical science activities, and 12 the development of the children's investigative skills and the equipment provision. The industrial context in lessons and expert knowledge of science was also thought to be a strength by 11 of the 13 teachers.

The teachers' opinions on industry before and after the project were analysed. For the positive statements, an improvement in attitude was observed for the majority of items. On average, responses were found to be positive overall for all statements both pre- and post-project, falling between agree and strongly agree on the scale. For the statement "Industry produces a wide variety of useful products", all the teachers strongly agreed both pre- and post-project. Post-project all 13 teachers strongly agreed that "Industry offers interesting and rewarding jobs", and a high score was also seen for "Industry provides many career opportunities". Informing teachers of such opportunities will enhance their ability to engage with children about the importance of industry and the career paths it has to offer.

For the negative statements, an improvement in attitude was seen for the statements "Industry causes pollution" and "Industry has a negative impact on the environment". However, the average scores post-project were still rather negative. This may be explained by how industries do, of course, still cause pollution, even though this project helped explain how many try to alleviate their effect on the environment. Attitudes to the statement "I feel more negative about industry" became more negative post-project, however overall the average attitude score was still positive. It is worth noting that it was only the responses of two individuals that became more negative, and reflects the small sample size.

All 13 teachers who completed the post-project questionnaire rated the programme as 'excellent'. Evaluation of the teachers' experience and the effect of the CCI programme found that teachers were positive about all aspects of the programme. On average teachers' scores fell between agree and strongly agree for all statements. All 13 teachers strongly agreed with the statement "my expectations of the programme were met", illustrating how well-received the programme was by all of the teachers. Both the site visit and the classroom session were viewed positively and most teachers agreed that they could now arrange their own visits to industry. Teachers also agreed that their knowledge of industry and their confidence in teaching science had improved, which will enable teachers to better engage children with the importance of STEM and industry.

QUALITATIVE DATA

Few responses were given by teachers when asked to give any further comments about the programme post-project. Comments complimented both the classroom part of the programme and the site visit, particularly focusing on how inspiring they found it:

'The children and the school have thoroughly enjoyed the entire experience and as a result, their science education has been hugely enhanced. It is an experience that they will remember for a very long time.' T8013, SE

'Fabulous programme that really motivated and inspired my students.' T4387, NE

'Such a valuable and enjoyable programme, enthusing both children and staff…' T8004, SE

Responses also highlighted how well the project was organised and how the classroom activities helped support the children's learning during the site visit:

'The whole programme was fantastic the staff involved were knowledgeable about the topic and passed this on well to the children. All sessions had a challenge which the children could work out this excited the children and kept them engaged. The sessions…in the classroom helped scaffold the children's learning for when they visited the factory…will be taking to my next school' T4393, NE

'Superbly run. Very well organised and structured. Good resources.' T8008, SE

'The organisation [of the site visit]…was faultless… and was planned thoroughly to maximise the practical opportunities for the children. T8013, SE

Suggestions on how to improve the programme were again only given by two teachers. One teacher requested further guidance on the steps the children must make to become an engineer or scientist, while the other mentioned how the viscosity experiment was difficult to manage in class.

Overall, the responses to the open-ended questions were overwhelmingly positive. Both the qualitative and quantitative data show how well received the CCI programme was. It has also helped teachers understand the benefits and importance of industry, a message they can now pass onto their pupils. Similarly to the children, the teachers seemed to like the variety of activities and practical work, and the teacher focussed aims of the CCI programme also seem to have been met.

8. RECOMMENDATIONS

DETAILS OF THE TRIP

Children from one school highlighted a problem with the amount of time it took for multiple security checks to enter the site to be conducted. Alterations to the programme should be considered, such as splitting the children into smaller groups, or having some form of activity while the children wait. A few children also complained about walking or standing for too long, however this was not for any particular site visit, and fewer children brought this up compared to previous years.

DETAILS OF CLASSROOM ACTIVITIES

There were children in one class who did not enjoy the circuit experiments because they had performed them previously. However, other children in the class found this experiment 'difficult' and 'frustrating', emphasising how not all children had the same level of understanding. As with any pedagogical decision, it is important to consider a mix of pupils' existing knowledge and understanding before choosing whether or not to repeat it (Shulman, 1986). On the more practical side, one teacher highlighted difficulties with the viscosity experiment, and a couple of children mentioned how it was messy and difficult to clean up. Sharing best practice in how to avoid this might reduce the problem in future.

QUESTIONNAIRE CONTENT

When asked to share if the school has previously had industrial contacts or link organisations, some teachers mentioned participating in the CCI project in the past. However, no question directly asks teachers whether the school has previously participated, and although it can be found out through records of the schools, it may be helpful to include this information within the questionnaire. As mentioned before, some teachers responded negatively towards the statement 'I feel negative about industry'. Perhaps including an open-question at the end of this section would enable further analysis of why the teachers feel this way. This could also fruitfully be explored in a more qualitative project with teacher participants.

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10. APPENDIX – DETAILS OF STATISTICAL ANALYSIS

Statement	Change for whole sample (paired t-test)
I like science	Improvement ($t(443)=2.182$, $p<0.05$)
I'd like to be a scientist	Improvement ($t(442)=8.536$, $p<0.001$)
Scientists are important in industry	Improvement ($t(439)=4.074$, $p<0.001$)
We do too much science in school	Improvement ($t(441)=2.588$, $p<0.05$)
We have to do too much work to do in science	Improvement ($t(440)=3.157$, $p<0.005$)
Industry is useful	Improvement ($t(416)=4.323$, $p<0.001$)
Industry is safe	Improvement ($t(418)=2.749$, $p<0.01$)
Many scientists work in industry	Improvement ($t(420)=7.217$, $p<0.001$)
Industry is dangerous	Improvement ($t(419)=2.199$, $p<0.05$)
Industry causes pollution	Improvement ($t(412)=6.064$, $p<0.001$)
Many engineers work in industry	Improvement ($t(418)=6.075$, $p<0.001$)
Young people work in industry	Improvement ($t(419)=7.462$, $p<0.001$)
I learn about industry from my teachers	Improvement ($t(419)=9.574$, $p<0.001$)
Scientists have important jobs in industry	Improvement ($t(421)=4.133$, $p<0.001$)
Our lives would be worse without industry	Improvement ($t(420)=4.880$, $p<0.001$)
There are women scientists and engineers	Improvement ($t(421)=4.943$, $p<0.001$)
Industry makes things we need	Improvement ($t(414)=3.429$, $p<0.001$)
Engineers have important jobs in industry	Improvement ($t(418)=5.501$, $p<0.001$)
I could work in industry in the future	Improvement ($t(416)=5.914$, $p<0.001$)

Table A1. Results of the statistical analysis showing significant differences in individual Attitudes to science and Attitudes to industry items for the whole sample

Statement	Gender differences	Regional differences	Year group differences
I like science	–	(t(395)=-2.489, p<0.05) pre-project the North East had a very positive attitude, with the South East having a positive change and the North East a 1% negative change to give similar attitudes post-project.	–
I'd like to be a scientist	–	–	(t(440)=2.547, p<0.05) pre-project Year 5 had a more positive attitude which changed significantly compared to Year 6 to give an even more positive attitude post-project.
We have to do too much work in science	(t(434)=-2.144, p<0.05) pre-project boys had a slightly more positive attitude. Girls attitudes changed significantly compared to boys, giving them a slightly more positive attitude post-project.	–	–
Industry causes pollution	–	(t(413)=-2.233, p<0.05) pre-project SE children had a slightly more positive attitude. The SE children's attitudes changed significantly compared to NE, giving them a more positive attitude post-project.	–
Scientists have important jobs in industry	–	–	(t(407)=-2.135, p<0.05) pre-project Year 5 children had a slightly more positive attitude. Year 6 children's attitudes changed significantly compared to Year 5, giving them a slightly more positive attitude post-project.
There are women scientists and engineers	(t(418)=2.227, p<0.05) pre-project girls had a more positive attitude. Boys attitudes were also positive but changed significantly compared to girls, giving them a slightly more positive attitude post-project.	–	–
Industry makes things we need	(t(412)=-2.191, p<0.005) pre-project boys had a slightly more positive attitude. Girls attitudes changed significantly compared to boys, giving them a slightly more positive attitude post-project.	–	–

Table A2. Significant differences in Attitudes to science and Attitudes to industry items between the genders, regions and year groups.

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