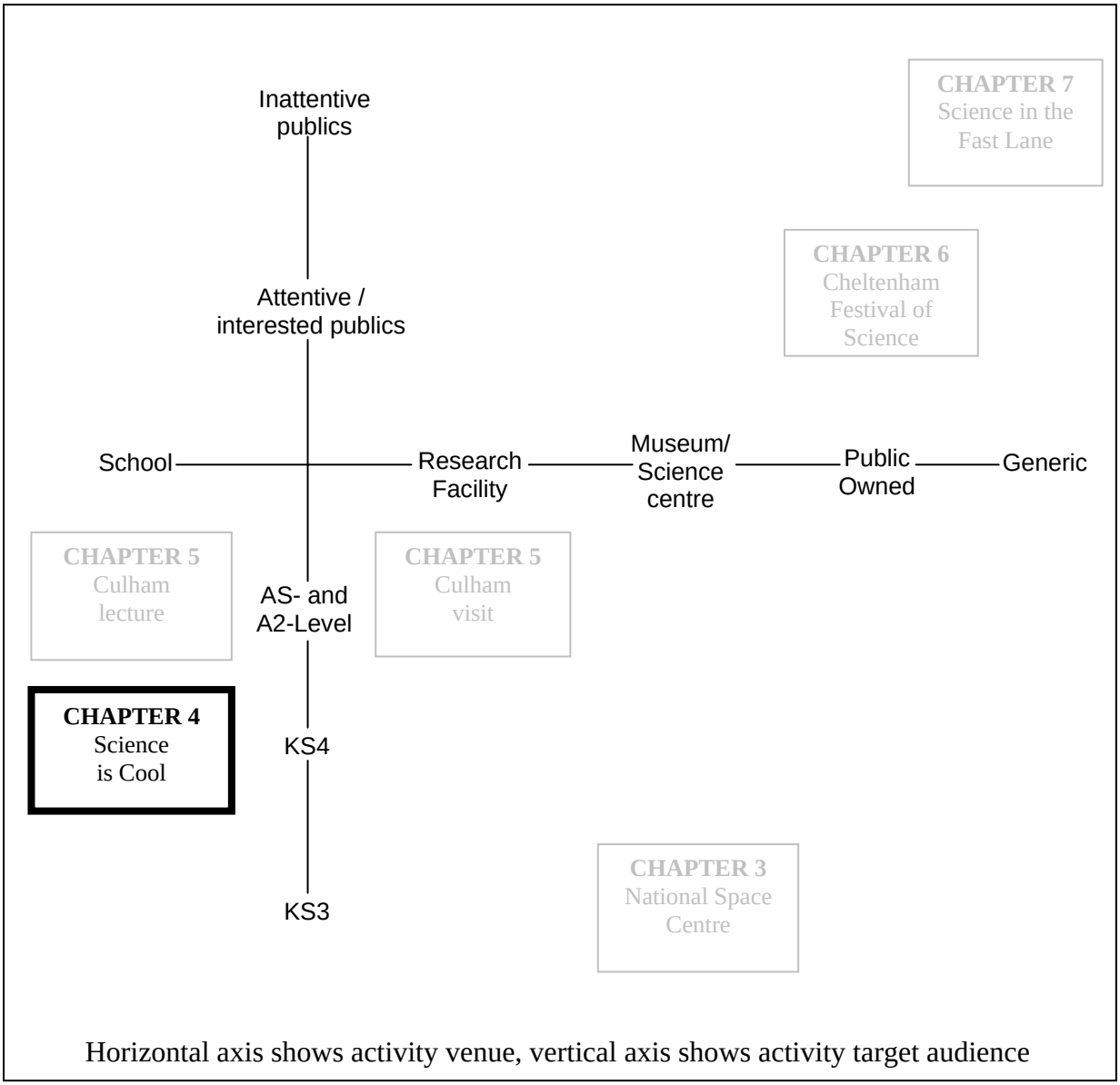
Chapter 4

EVALUATION OF THE IMPACT OF A DEMONSTRATION LECTURE ON THE COGNITIVE AND AFFECTIVE DOMAINS OF KEY STAGE 4 STUDENTS

Research axes



Horizontal axis shows activity venue, vertical axis shows activity target audience

Chapter 4 is an evaluation of a liquid nitrogen demonstration lecture, '*Science is Cool'* on the cognitive and affective domains of Year 10 students. The lecture was delivered in schools to audiences of up to 280 students. The lecture was found to offer educational value, and attitudinal shifts were measured although some were more desirable than others. Students rated the lecture as enjoyable and teachers felt it was valuable for their students both in terms of education and enjoyment.

4.1 INTRODUCTION

Demonstration lectures involving exciting science experiments are a potentially valuable source of situational interest for students, and increased interest has been linked to increased attention and deeper cognitive engagement (Pintrich and Schunk, 1996). Given the potential for arousing individual interest, the aim of the present study was to evaluate the cognitive and affective impact of a demonstration lecture on Year 10 students.

The *'Science is Cool'* lecture

'Science is Cool' is a demonstration lecture aimed at Year 10 (14 and 15 year-olds) students that explores the properties of matter at low temperatures using a variety of experiments and demonstrations involving liquid nitrogen. Some of the topic areas covered are: temperature; solids, liquids and gases; freezing and melting; properties of materials. Throughout the lecture there is an emphasis on the nature of scientific enquiry, and the types of activities scientists are involved in. The aim of the lecture is not to present students with too many new and unfamiliar ideas, but to enrich their understanding of National Curriculum science in an enjoyable manner, and stimulate a fresh desire to learn. The lecture was developed by a Reader in physics at the University of Liverpool, and has been delivered to a range of school and public audiences.

4.2 METHODOLOGY

4.2.1 Lecture tour

For the purposes of the present study, a lecture tour was organised between April and June 2004. The lecture was delivered to audiences of 50 – 280 Year 10 science students at eight secondary schools in the Merseyside region. All of the schools were mixed gender community comprehensive schools. Students at five of the schools completed the questionnaires before and after the intervention.

4.2.2 Data collection materials

A questionnaire-based survey of students and teachers was conducted to measure indicators of attitudinal and cognitive change. The present study was similar in format to the study conducted in Chapter 3. It used closed-form questionnaires before and after the lecture to survey its impact on the cognitive and affective domains of students. Evaluation questions were included at the second stage to explore students' opinions of the lecture. Cognitive and affective impacts were measured both directly, using multiple-choice physics questions and attitudinal indicators, and indirectly by asking students to assess how much they felt they had learned, or if they felt their attitudes had changed. Teachers were also surveyed using open questionnaires, in order to establish their opinions of the intervention and the perceived impact on their students. The content and format of the questionnaires is described in more detail in Chapter 2, and copies of the questionnaires are provided in Appendix 4.1.

4.2.3 Piloting

The attitudinal tracking statements were those developed and tested by Spall (2005) and are described in more detail in Chapter 2. The questions for the knowledge quiz section of the questionnaires were piloted with 57 Year 10 students. Analysis of the results showed that the questions appeared to be at the correct level for the target audience. A copy of the pilot data results is given in Appendix 4.2.

4.3 RESULTS

4.3.1 The study cohort

Five of the eight schools involved in the tour completed the questionnaires before and after the lecture. A total of 491 students and 11 teachers took part in the present study. In order to reduce heterogeneity in the sample, responses from students who were not 14 or 15 years old, and who had not seen the presentation, were removed, leaving 460 students. The final study cohort is described in Figure 4.3.

Figure 4.3 *The study cohort*

Sample	***n***	***Age %***		***Gender %***	
		14	*15*	*Male*	*Female*
Student	460	24	76	49	51
Teacher	11	-	-	78	22

Of the teachers surveyed, two taught non-science subjects while nine taught science subjects. Of these nine, four taught physics.

4.3.2 Correlations between attitude, perceived ability and museum visits

Figure 4.4 shows associations between students' pre-existing attitudes towards physics and their perceived ability and frequency of visits to museums and science

centres. The p values were obtained using Kendall's tau-b measure of association; the table presents both the correlation coefficients and the p values.

Figure 4.4 *Associations between attitude, perceived ability and museum visits*

	Rate physics ability as good		***Often visit museums and science centres***	
	τ	***p***	***τ***	***p***
Nature of the subject				
Like physics	0.54*	0.00	0.24*	0.00
Interesting	0.48*	0.00	0.28*	0.00
Boring	-0.42*	0.00	-0.19*	0.00
Relevant to everyday life	0.23*	0.00	0.16*	0.00
Academic demands of subject				
Easy	0.37*	0.00	0.04	0.38
Remembering facts rather than understanding ideas	-0.07	0.10	-0.05	0.21
Good at maths	-0.09*	0.04	0.13*	0.00
Types of student				
More a boys' subject	-0.06	0.14	-0.05	0.21
More a girls' subject	-0.04	0.30	-0.04	0.32
People who don't mix well	-0.13*	0.00	-0.10*	0.02
Communication of subject				
Uses lots of difficult words	-0.23*	0.00	-0.05	0.19
Uses everyday words with different meanings	0.12*	0.00	0.05	0.27

** Denotes correlation significant at the 95% level or above*

These associations indicate that students who rate their physics ability highly are likely to have positive opinions of the nature of the subject: they like physics, agree that it is interesting and relevant, and reject the notion that it is boring. The same is true for students who often visit museums and science centres. Unsurprisingly, students who perceive their physics ability as good were more likely to agree that physics is an easy subject. These students were more likely to reject the notion that mathematical ability was required for success in physics. The opposite association

was observed for students who often visited museums; they were more likely to agree that mathematical ability was important. There was an association between students who thought their physics ability was good and those who felt physics used easy, and not difficult, language.

4.3.3 Impact of the lecture on students' affective domain

Figure 4.5 shows the responses to the attitudinal tracking questions before and after the lecture. The Wilcoxon ranking test was applied to explore significant shifts in the data. The percentages shown in Figure 4.5 merge the responses for '*strongly agree'* and '*agree'* under the '*affirm'* heading, and the responses '*strongly disagree'* and '*disagree'* under the '*reject'* heading. The statistical analysis was conducted on the data before the responses were merged, i.e. where responses were given on a 5-point scale.

Figure 4.5 *Differences between responses before and after the lecture*

	Before %			***After %***			***p***
	Affirm	*Neutral*	*Reject*	*Affirm*	*Neutral*	*Reject*	
Nature of the subject							
Like physics	36	33	31	37	30	34	0.94
Interesting	37	40	23	41	37	22	0.31
Boring	32	36	32	32	36	33	0.71
Relevant to everyday life	35	33	32	39	37	24	0.01*
Academic demands of subject							
Easy	9	34	58	10	36	54	0.13
Remembering facts rather than understanding	23	37	40	22	44	34	0.79
Good at maths	56	30	14	47	31	22	0.00*
Types of student							
More a boys subject	9	32	60	9	39	52	0.04*
More a girls subject	2	33	65	4	37	59	0.05*
People who don't mix well	8	22	71	12	25	63	0.00*
Communication of subject							
Uses lots of difficult words	36	38	26	36	43	21	0.65
Uses everyday words with different meanings	18	50	31	24	49	28	0.03*

** denotes a difference significant at the 95% level or higher*

Respondents were more likely to agree that '*the things I learn in physics relate to my everyday life'* after watching the lecture than beforehand and were significantly less likely to agree that mathematical ability was necessary for studying physics when questioned after the talk than before. Despite the fact that the lecturer was male, the responses to the questions regarding the gender bias of the subject were more similar after students had seen the lecture, with more students giving the neutral response to both questions the second time. There was a correlation between the gender of the

students and their responses to the questions; the details are explored more fully in Chapter 8. Students were more likely to agree with the statement '*physics uses easy, everyday words with different meanings'* after watching the lecture. These results indicate a positive impact in the affective domain. However there was one negative shift in that students were more likely to agree that '*people who like physics don't mix very well with other people*' after seeing the lecture.

A small proportion of students (14%) felt that the lecture had changed the way they feel about physics. Nearly two-thirds (63%) felt the lecture had not changed their opinion, and the remaining 23% were not sure. To follow up this question, students were asked to describe the way in which their feelings about science had changed. Of the 62 responses, 60 were positive. Some of the students' comments on the way in which the lecture changed the way they feel about science are given below:

> *"Science can be useful and presented in a fun way"*
> (14 year-old female)
>
> *"I enjoy science more now and approach it in a different way"*
> (15 year-old male)
>
> *"I feel more excited about science"* (15 year-old male)
>
> *"More interesting to see the effects not read about it"*
> (15 year-old male)
>
> *"It makes me see that we can use physics in lots of things"*
> (14 year-old female)
>
> "*Science is amazing*" (15 year-old male)

Chi-square tests were used to examine whether students who reported a positive shift in attitude were those who liked or were interested in physics before the intervention. No significant associations between the variables were identified.

4.3.4 Impact of the lecture on students' cognitive domain

Figure 4.6 shows the percentages of students answering the knowledge test questions correctly and incorrectly before and after the lecture. The McNemar test was applied to the data to explore significant changes in responses to the questions.

Figure 4.6 *Significant differences in responses before and after the lecture*

Question	*% Correct Before*	*% Correct After*	*p*
Control – knowledge unrelated			
What is the chemical symbol for nitrogen?	66	66	0.57
Which of the following substances has the highest melting point?	72	67	0.03*
How many nitrogen atoms are there in a nitrogen molecule?	42	42	1.00
In which of the following substances are the particles furthest apart?	94	92	0.35
Lecture-related questions			
Approximately how much nitrogen is in the air around us?	55	61	0.01*
Which of the following is the correct unit for density?	61	62	0.62
Which of the following is ***not*** a reversible change?	81	81	1.00
What is the name of the process of a gas changing to a liquid?	87	88	0.62
What temperature is absolute zero?	40	58	0.00*
Which of the following is most likely to slow down a chemical reaction?	64	65	0.60

** denotes a difference significant at the 95% level or higher*

Two of the questions relating to material covered in the lecture showed a significant improvement in knowledge. It appears that two of the other questions relating to the lecture were too easy, over 80% of the students answered correctly before the lecture, leaving little room for improvement. This was not the case in the pilot study, as can be seen from the results in Appendix 4.2. One of the control questions demonstrated a negative shift in knowledge. The question was '*Which of the following has the highest melting point?*' and the possible responses were: '*Water'*, '*Nitrogen'*, *Wax'*,

and '*Aluminium'*. Some 20% of students answered '*Nitrogen'* before the lecture, and 24% responded this way after the lecture. This could be related to the fact that the lecture involved liquid nitrogen, so students assumed that this was the correct response.

Students perceived the lecture as educational, a large majority (94%) felt they had learned at least '*a little'* science from the lecture, while 59% felt they had learned at least '*some'* science and 12% felt they had learned *'a lot'* of science.

> *"I learnt something new and it was fun while learning it*" (15 year-old female)
>
> *"It was good, and interesting and a fun way to learn"* (15 year-old male)
>
> *"I think that these presentations should take place about twice a week because I found out that I learned more and remembered more"* (15 year-old female)

4.3.5 Evaluation of lecture by students

The majority of students (81%) who saw the presentation felt it was interesting, and a similar proportion (83%) felt that the scientific level of the lecture was '*about right'*. Two thirds of students (66%) rated the length of the lecture as '*about right'*, but a quarter (26%) felt it was '*too long'*. Most students (80%) were satisfied with the pace of the lecture.

4.3.6 Students' impressions of the lecture

Students were asked to write down three words that described their impressions of the lecture. The 1106 responses from 429 students were grouped into categories. ***Positive*** responses expressed a generally positive reaction to the talk, and responses in the ***negative*** category contained generally negative statements. Students described

the lecture with words and phrases indicating they had found it ***interesting*** or ***boring***, and many responses described the show as ***entertaining***. Some responses indicated a ***neutral*** response to the lecture, for example 'average'. Some students remarked on the ***educational*** value of the lecture, and some described it as ***different.*** Responses indicating that the lecture was ***too long*** or ***too slow*** have been categorised together. A number of responses included reference to the ***content*** of the lecture, often the scientific content. Responses that fell in none of the above categories were grouped in the ***other*** category. The results of the category analysis are summarised in Figure 4.7.

Figure 4.7 *Students' impressions of the lecture*

Category	***Number of responses***
Positive	265
Interesting	257
Entertaining	245
Negative	58
Different	53
Educational	51
Too long/too slow	48
Neutral	45
Boring	34
Content	33
Other	18

These data show that most responses (69%) indicated a positive impression of the lecture. There were many responses describing the lecture as interesting and entertaining, although some students found it boring.

Students were more likely to perceive the talk in an entertainment or interest context than an educational one. The evaluation section of the questionnaire also gave students the opportunity to leave unstructured feedback by asking them to provide any additional comments. Responses included:

> *"It made me think that they must do fun stuff at university, not just lectures"* (15 year-old female)
>
> *"The liquid nitrogen stuff was good when you did the experiments, but all the rest was boring"* (14 year-old male)
>
> *"I feel that the presentation should of* [sic] *lasted for two lessons so that we learnt more!"* (15 year-old male)
>
> *"It was quite good but I still don't like science very much"* (15 year-old male)
>
> *"There were too many people in the hall so I couldn't see the presentation which made it far too long"* (14 year-old female)

4.3.7 Evaluation of lecture by teachers

All eleven teachers rated the lecture as '*interesting'* or '*very interesting'*, with just over half (six) rating it as the latter. Most felt the length of the lecture was '*about right'* although two felt it was '*too long'*; one of these qualified the response by commenting that the lecture took place on a hot afternoon and the students were restless as a result. All of the teachers surveyed agreed that the lecture was pitched at an appropriate scientific level. All but two teachers felt the lecture offered educational value for their students. The survey asked if the teachers felt that a lecture such as this was an effective means of communicating science to their students. Four respondents mentioned the visual nature of the lecture as a positive aspect here, one with a specific reference to its appeal to visual learners. Three respondents referred implicitly to the situational interest generated by the lecture:

> *"Many visual learners may be inspired"* (female history teacher)

> *"They always respond to an outside visitor and love new things"* (male chemistry teacher)
>
> *"Any external influence is likely to be positive. Lively presentation is likely to stick with them"* (male physics teacher)

All of the teachers agreed that the lecture was an enjoyable way of presenting science to their students, and three commented that students had spoken about their positive opinions of the lecture during subsequent lessons.

4.4 DISCUSSION

4.4.1 Summary of results

Overall, students responded well to the lecture, with many describing it as interesting and entertaining. Several attitude shifts were indicated, although the design of the study means these represent a short-term impact. It is unclear whether the shift in attitude would be sustained over the medium and long term. The lecture was shown to have some impact on students' factual knowledge; the measurement of this could have been improved, however. Teachers rated the lecture highly. When probed about why the lecture was a positive experience for students, teachers' responses included references to the lecture's visual nature and the fact that it was something '*different'*, indicating that the situational interest generated by the lecture may contribute to its impact on students.

4.4.2 Affective impact

The most interesting shift in student attitude was that they were more likely to agree that physics holds relevance to everyday life after watching the lecture than beforehand. Although liquid nitrogen is not in itself an everyday substance, the experiments in the lecture were often related to experiences that would be familiar to

students, for example the way in which refrigerators use low temperatures to slow down the chemical reactions that cause food to rot. This finding is reinforced by several of the students' quotes in which they reported that they could see how science related to everyday life. Students were also less likely to perceive physics as either a 'boys' or 'girls' subject following the lecture, which was an interesting finding since no explicit references to gender were included in the lecture. This shift is explored in more detail in Chapter 8, where the impact of different interventions on males and females is considered.

Students were more likely to agree that the language used in physics was easier following the lecture. This is likely to be due to the lecturer's experience in communicating with these groups – his awareness of National Curriculum content meant that little technical terminology was used during the lecture, and any such terms were introduced with an appropriate explanation. This finding highlights the importance of the presenter's role in an intervention such as this; had the presenter not pitched the language at the right level scientifically this shift could have been negative as opposed to positive. There was one negative change in attitude; students were more likely to agree that '*people who like physics don't mix very well with others*'. This, again, may have been related to the presenter of the lecture, a Reader in Physics at the University of Liverpool, substantially older than the target audience. The presentation of the lecture was in the style of an enthusiastic scientist, which clearly entertained the audience (according to the evaluation data), but was perhaps not the role model that the target audience would identify with.

Responses to the evaluation questions indicated that the lecture had generated a high level of situational interest in the students, and that this had led some to reckon their attitude towards the subject had shifted, and indeed the quantitative data bore this out. In order to maximise the impact of an intervention such as this, ways in which engagement with the intervention can be extended and maximised should be explored in order to increase the probability of this situational interest developing into the longer-term individual interest.

4.4.3 Cognitive impact

Significant positive cognitive shifts were measured for two of the six lecture-dependant tracking questions. Shifts may have been measured for other questions if the difficulty level of the questions had been higher; for two of the questions over 80% of students answered correctly the first time so there was little room for improvements to be measured. This could be improved if a similar study were to be repeated.

Students perceived the lecture as educational; a large majority felt they had learned some science from the lecture, and a number described the lecture as educational in the open questionnaire responses. The frequency of responses in the educational category was, however, considerably lower than the number of responses that described the lecture as interesting or fun. This indicates that students perceived the intervention in terms of its entertainment and interest value ahead of any educational value. Interestingly, several students commented on preferring the lecture to lessons, due in part no doubt to time pressures in lessons and stringent health and safety regulations meaning that liquid nitrogen demonstrations are rarely carried out in the

classroom. Students made a few references to different learning styles, with comments that watching demonstrations was a more interesting way to learn than, for example, reading. Using interventions such as the demonstration lecture can help broaden the range of teaching styles employed in a school, allowing science to appeal to students with a variety of learning styles and preferences. Some students also commented that they learned better this way, and that they would remember more science. Teachers expressed similar sentiments, feeling that the lecture was educationally valuable for the students, and an effective means of communicating science to them.

Although the students appeared to respond positively to the lecture, the impacts measured were not as strong as those measured for the National Space Centre visit in Chapter 3. This could be due to the nature of the different activities or a function of the target audience or, most likely, a combination of these and other factors. The next study was designed to explore the influence of taking students out of the classroom, and evaluates the impact of both a lecture and a visit on AS- and A2-Level Physics students.

Appendix 4.1

Data collection materials

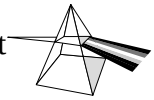
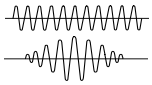
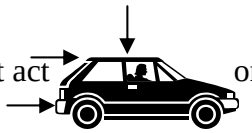
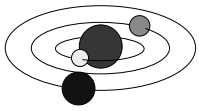
- Student questionnaires, pre- and post-intervention (NB attitudinal questions and quiz questions were identical at both stages – these pages of the questionnaire are only included once)

- Teacher questionnaires

Physics Questionnaire

We are doing a big study to see what people think of some of their school subjects, like Science. We are especially interested in what you think about Physics.

Physics is about all of the below:

- Electricity  and circuits
- The way light  and sound work and travel 
- Gravity and other forces that act  on things and how things move
- Magnets  and electric motors
- Space, stars  and planets

Now for the questions…

Please take a few moments to answer the following questions

Firstly, some information about yourself…

Your First Name…… Your Surname……..

Age …… School Year group ……

Male/Female …….. School ……

How do you feel about Physics?

☐	☐	☐	☐	☐
I really like Physics	I quite like Physics	I neither like nor dislike Physics	I don't like Physics much	I really don't like Physics

Outside school, do you ever visit Museums or Science Centres?

☐	☐	☐	☐	☐
Lots of Times	Often	Sometimes	Very Occasionally	Never

How good do you think you are at Physics?

☐	☐	☐	☐	☐
Really Good	Quite Good	About Average	Quite Bad	Really Bad

KS4SiC/PRE

These questions are about Physics

Physics is an **interesting** subject

☐	☐	☐	☐	☐
I strongly agree	I agree	I neither agree nor disagree	I disagree	I strongly disagree

You need to be **good at maths** to do physics

☐	☐	☐	☐	☐
I strongly agree	I agree	I neither agree nor disagree	I disagree	I strongly disagree

Physics is more of a **boys** subject

☐	☐	☐	☐	☐
I strongly agree	I agree	I neither agree nor disagree	I disagree	I strongly disagree

Physics is a **boring** subject

☐	☐	☐	☐	☐
I strongly agree	I agree	I neither agree nor disagree	I disagree	I strongly disagree

Physics is more to do with **remembering facts** than understanding ideas

☐	☐	☐	☐	☐
I strongly agree	I agree	I neither agree nor disagree	I disagree	I strongly disagree

The things I learn in physics **relate to my everyday life**

☐	☐	☐	☐	☐
I strongly agree	I agree	I neither agree nor disagree	I disagree	I strongly disagree

People who really like physics **don't mix very well** with other people

I strongly agree	I agree	I neither agree nor disagree	I disagree	I strongly disagree
☐	☐	☐	☐	☐

Physics is more of a **girls** subject

I strongly agree	I agree	I neither agree nor disagree	I disagree	I strongly disagree
☐	☐	☐	☐	☐

Physics uses **difficult, complicated** words

I strongly agree	I agree	I neither agree nor disagree	I disagree	I strongly disagree
☐	☐	☐	☐	☐

Physics is an **easy** subject

I strongly agree	I agree	I neither agree nor disagree	I disagree	I strongly disagree
☐	☐	☐	☐	☐

Physics uses **easy, everyday words** but with a **different meaning**

I strongly agree	I agree	I neither agree nor disagree	I disagree	I strongly disagree
☐	☐	☐	☐	☐

Quick Quiz

All of the following questions are about Physics. Answer the questions by ticking the box that you think is the right answer.

Here is an example of how to answer the questions:

Which of the following television soap operas is about life in Liverpool?

Eastenders	☐	Coronation Street	☐
Brookside	✓	Neighbours	☐

And now for the quiz…

What is the chemical symbol for Nitrogen?

Ni	☐	N	☐
n	☐	NT	☐

Approximately how much Nitrogen is in the air around us?

10%	☐	25%	☐
50%	☐	75%	☐

Which of the following substances has the highest melting point?

Water	☐	Nitrogen	☐
Wax	☐	Aluminium	☐

Which of the following is the correct unit for density?

Kilograms per metre squared (kg/m^2)	☐	Kilograms per metre cubed (kg/m^3)	☐
Metres per kilogram (m/kg)	☐	Kilograms squared per metre (kg^2/m)	☐

How many Nitrogen atoms are there in a Nitrogen molecule?

1	☐	2	☐
3	☐	4	☐

In which of the following substances are the particles furthest apart?

Metal	☐	Air	☐
Wood	☐	Orange juice	☐

Which of the following is ***not*** a reversible change?

Denaturing an enzyme	☐	Ice melting	☐
Dissolving salt in water	☐	Heating the air in a room	☐

What is the name of the process of a gas changing to a liquid?

Evaporation	☐	Condensation	☐
Perspiration	☐	Sublimation	☐

The lowest possible temperature is called ***Absolute Zero***. Which of the following is it?

-115ºC	☐	-196ºC	☐
-273ºC	☐	-998ºC	☐

Which of the following is most likely to slow down a chemical reaction?

Adding a catalyst	☐	Increasing reactants' surface area	☐
Reducing the temperature	☐	Increasing reactant concentration	☐

School Talk Questionnaire

We are doing a big study to see what people think of some of their school subjects, like Physics. We would also like to know your opinions on the presentation "Science is Cool".

Please take a few moments to answer the following questions

Firstly, some information about yourself…

Your First Name…… Your Surname……..

Age …… School Year group ……

Male/Female …….. School ……

How do you feel about Physics?

☐	☐	☐	☐	☐
I really like Physics	I quite like Physics	I neither like nor dislike Physics	I don't like Physics much	I really don't like Physics

KS4/SiC/POST

These Questions are about the Presentation "Science is Cool"

Did you see the "Science is Cool" Liquid Nitrogen presentation?

☐ Yes ☐ No

What did you think of the presentation?

☐	☐	☐	☐	☐
Very Interesting	Interesting	Neither Interesting nor Boring	Boring	Very Boring

What did you think of the length of the presentation?

☐	☐	☐	☐	☐
Much Too Long	Too Long	About Right	Too Short	Much Too Short

What did you think of the pace (speed) of the presentation?

☐	☐	☐	☐	☐
Much Too Fast	Too Fast	About Right	Too Slow	Much Too Slow

What did you think about the Science in the presentation?

☐	☐	☐	☐	☐
Much Too Easy	Too Easy	About Right	Too Difficult	Much Too Difficult

What did you think of the presentation slides?

☐	☐	☐	☐	☐
Very Good	Good	Neither Good Nor Bad	Bad	Very Bad

How much Science do you think you learned from the presentation?

☐	☐	☐	☐
A Lot	Some	A Little	None

Tell us three words that you would use to describe the presentation:

Do you think that the presentation has changed the way you feel about Science?

Yes No Don't Know

If YES, in what way?

If you have any other comments about the presentation, please write them in the box below. Please write as much as you can:

Thanks!

Teacher Questionnaire

We are interested in your thoughts about the **Science is Cool** presentation.

Please take a few moments to complete this questionnaire - your comments will help us tailor future events to your needs.

Firstly, some information about yourself…

School ……

Which subject do you teach?…….…….

Student Year group involved in presentation……

Male/Female ……..

These questions are about the Presentation

Did you see the "Science is Cool" Liquid Nitrogen presentation?

☐ Yes ☐ No

What did you think of the presentation?

☐ Very Interesting ☐ Interesting ☐ Neither Interesting nor Boring ☐ Boring ☐ Very Boring

What did you think of the length of the presentation?

☐ Much Too Long ☐ Too Long ☐ About Right ☐ Too Short ☐ Much Too Short

Do you think that the presentation was at the right level for your students? If not, in what way?

Do you think that your students learned much Science from the presentation?

Do you think that a presentation such as this is an effective means of communicating Science to your students? Why?

Do you think that the talk was enjoyable for your students? Why?

What were your aims and expectations for the talk?

Have your aims been fulfilled? Why?

If you have any other comments about the presentation, please write them below.

Thanks!

KS4/SiC/TEACHER

Appendix 4.2

Pilot study results for knowledge quiz questions

Question	*% Correct*
Control – knowledge unrelated	
What is the chemical symbol for nitrogen?	52
Which of the following substances has the highest melting point?	44
How many nitrogen atoms are there in a nitrogen molecule?	27
In which of the following substances are the particles furthest apart?	91
Lecture-related questions	
Approximately how much nitrogen is in the air around us?	26
Which of the following is the correct unit for density?	36
Which of the following is ***not*** a reversible change?	64
What is the name of the process of a gas changing to a liquid?	66
What temperature is absolute zero?	13
Which of the following is most likely to slow down a chemical reaction?	36

The pilot was conducted at the same point in the school year as the main data collection exercise. The highest percentage of correct answers for the lecture-dependent questions was 66%.