Jenesys
Associates

Evaluation of Impact of 2013 IET Shows

For science made simple

Report

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Contents

1 Executive summary

This report presents the findings from an evaluation of the impacts of four engineering shows delivered by *science made simple* to school students throughout 2013. Further detail on the evaluation aims and methodology is provided in Section 2 of the main report.

The target audiences were KS1 to KS4 school students. A total of 143 shows were presented to a total audience of 13,982 students. Post-show feedback data were collected from 1,952 students (14% of the total audience) and 136 teachers who had seen at least one of the shows. Data about attitudes towards engineering and science were collected from 1,319 KS3/4 students who had not seen a show.

The evaluation findings are positive. They found that the shows have had impacts against four categories of the Generic Learning Outcomes from the Inspiring Learning for All framework[1] (GLOs): experiences, knowledge, attitudes and behaviour. Evidence for each is summarised here:

Experiences: opportunities, enjoyment, inspiration, interest

Student and teacher feedback indicates that students enjoyed the shows, particularly the demonstrations, the interactive nature and the engaging style of the presenters. Reactions to the shows were positive with high levels of enjoyment and students and teachers expressing future interest in similar shows about engineering or science.

Students' descriptions of what they learnt and teachers' opinions provided evidence that memorable content, such as launching a rocket or a bird flying, helps to ensure greatest impact in terms of enjoyment and learning.

Knowledge and understanding

The GLO around knowledge and understanding was also well-evidenced from the evaluation. Student feedback revealed several outcomes around knowledge and understanding:

- KS2, 3 and 4 students recalled interesting or surprising facts about lasers, bridge structures and engines.
- KS2, 3 and 4 students described increased understanding of engineering and the jobs done by engineers.
- The shows provided ways of visualising particular scientific or engineering concepts, including some taught in the school curriculum.

Teachers agreed that the shows increased students' understanding of engineering and science generally and their relevance to everyday life. Learning was basic for KS1 students, but older students were able to cite scientific/engineering facts and ideas about the role of engineers.

Attitudes and beliefs

Attitudinal shifts were identified for KS2, KS3 and KS4 students that had seen the shows. The outcomes under this GLO can be summarised as follows:

- The shows made engineering seem more interesting to most students.
- The shows encouraged students to see that engineering was relevant to everyday lives.

[1] See www.inspiringlearningforall.gov.uk/toolstemplates/genericlearning

- The shows fostered a sense of surprise at the variety of jobs and roles performed by engineers.

The engaging presenters, plus the visual nature and interactive format of the shows were important factors here. Teachers' descriptions of success factors suggest that these characteristics were a contributing mechanism to this set of outcomes.

Behaviour: activity and progression

The GLO around progression was partially-evidenced from the evaluation. KS3/4 Students were more likely to report that they would want to study science then engineering. Comparison of post-show attitudes towards further study with those of KS3/4 students who had not seen a show suggest that Rough Guide and Engineering for Life have increased the number of students who want to study both science and engineering, although the reverse is true for Superhero, which is primarily targeted at KS2 and not KS3/4.

KS2 students were most likely to report that they want to be a scientist or engineer. KS3/4 students were more likely to report that they would want to be an engineer than a scientist. Comparison with the pre-test attitudes of KS3/4 students towards careers suggest that all shows have had a positive impact in terms of the number of students who want to be scientists or engineers.

Teachers indicated that KS3/4 students were more likely than younger students to be inspired by the shows to consider further study or careers in engineering or science.

Conclusions

The shows are successful. Having a variety of shows has enabled audiences in KS 1 to 4 to experience shows developed specifically for them. The presentation style, interactive format and memorable content have been very well received and identified as major success factors.

The evaluation provides data about the attitudes of KS3 and 4 students towards science and engineering, including gender variances. These findings can be used by *science made simple* when planning future activities and shows for these age groups.

This evaluation demonstrates that the *science made simple* engineering shows have effectively engaged their target audiences and delivered a range of positive impacts for students. They prove the concept of extending school shows beyond traditional science into other STEM subjects.

The significant sample sizes places a good level of confidence on the evaluation findings.

2 Introduction

Throughout 2013, *science made simple* delivered four engineering themed shows to students in key stages (KS) 1 to 4 at schools and events across the UK. The shows were subsidised by the IET (Institution of Engineering and Technology) and were described in *science made simple*'s funding proposal to IET as:

- *Izzy's Incredible Adventure* (hereafter Izzy), for KS1 and aimed at investigating engineering in relation to travel and explaining the science behind every day and more unusual transport.
- *Who wants to be a superhero?* (hereafter Superhero), for KS2 and aimed at introducing audiences to six real young scientists and engineers and explaining what they do.
- *A Rough Guide to Engineering* (hereafter Rough Guide), for KS3 and aimed at introducing secondary students to the wide range engineering careers and showing them that they can aspire to be engineers.
- *Engineering for Life – From Cradle to Grave* (hereafter Engineering for Life), for KS3 and 4 and aimed at demonstrating how engineering improves quality of life throughout all life stages, including before we are born.

The evaluation of the shows was supported by Jenesys Associates Ltd, who were commissioned to develop specific feedback forms and questionnaires and analyse the feedback from these questionnaires and forms. The results of their analysis are described in this report.

3 The evaluation

3.1 Evaluation objectives

The objectives of the evaluation were:

1. To evaluate the impacts of the engineering shows on KS1 to KS4 students
2. To assess opinions from teachers who had seen the shows
3. To capture information about the attitudes of KS3/4 students towards science and engineering prior to seeing shows

Further to the objectives above, the following broad questions were used to steer the evaluation:

1) What are the impacts on students? Do the shows stimulate interest and positive attitudes towards engineering and STEM?
2) What are the opinions of teachers? Do the shows improve their students' knowledge about and attitudes towards engineering?
3) What are any success or limiting factors?
4) What do KS3/4 students think about engineering and science? Do they want to pursue further study or careers in these subjects?

3.2 *Evaluation methodology*

Student and teacher feedback forms

Jenesys devised the following instruments to obtain feedback data:

- A post-show form to capture drawings and words from KS1 students
- A post-show questionnaire for KS2 students
- A pre-show questionnaire to capture information from KS3 and KS4 students about their attitudes towards engineering and science
- A post-show questionnaire for KS3 and KS4 students
- A post-show questionnaire for teachers

The post-show questionnaires incorporated some Generic Learning Outcomes (GLOs) which were already used by *science made simple* in their standard questionnaires for evaluating shows.

Data collection

The *science made simple* team was responsible for all data collection. The KS3/4 pre-show attitude questionnaire was sent to schools in advance and the sample who completed these questionnaires was not the same as that which completed post-show questionnaires. Presenters distributed the post-show forms and questionnaires to random samples of students at the end of shows. Teachers were able to book any show and some audiences included mixed age groups of students, including students outside the target groups mentioned in the description for each show. This is reflected in the mixed nature of the forms used for Superhero and Rough Guide (see section 4.2 below).

Data analysis and reporting

Quantitative questionnaire data are reported graphically. Scottish and Irish School Years have been converted to their English and Welsh equivalents for comparative purposes.

Qualitative data were coded and categorised for analysis. All data in this report have been anonymised. Quotes are written in italics using *blue* for teachers and *red* for students.

Smaller data sets are reported using absolute numbers. Larger data sets are reported using percentages and it should be noted that rounding can mean that percentages are sometimes greater or less than 100% in total. Not all respondents answered every question and the number of respondents 'n' is reported for each question.

Where sample sizes were sufficient (i.e. Superhero KS2 audience and Rough Guide KS3/4 audience), statistical analyses were performed to determine any gender differences in answers to questions. Statistically significant differences are described in the relevant sections of the report.

The next section presents the project and evaluation metrics. Sections 5 to 8 of the report contain analyses of the feedback for each show. Section 9 describes the findings from the KS3/4 pre-show questionnaire. Section 10 presents some conclusions.

4 Project metrics

4.1 Audience numbers

Data on the number of shows and audience sizes was collected by presenter. *science made simple* presented 139 shows over 57 full days in five different types of venues. 76% of these days were at secondary schools.

Type of venue	Number of show days per venue	% of total number of show days
Primary school	11	19%
Secondary school	43	76%
Higher Education, Museum, Festival	3 (1 at each)	5%
Total	**57**	

A total of 143 shows of all types were presented to a total audience of over 13,900.

Show Name	Number of show performances	Total audience size	Ave. audience per performance
Izzy	18	1,301	72
Superhero	24	2,038	85
Rough Guide	75	7,453	99
Engineering for Life	26	3,190	123
Total	**143**	**13,982**	**98**

4.2 Evaluation sample

The evaluation data set was substantial. 1,319 pre-show attitude questionnaires were collected from KS3/4 students. A total of 1,952 students (14% of the total audience) and 136 teacher post-show forms and questionnaires were collected as shown in the table below.

Show Name	**KS1 Drawing Form**	**KS2 Questionnaire**	**KS3/4 Post-show Questionnaire**	**Teacher Questionnaire**
Izzy	146*			11
Superhero		439	82	33
Rough Guide**			1,017	65
Engineering for Life		45	148	23
Show not specified			75	4
Total	**146**	**484**	**1,322**	**136**

*It has been assumed that all these forms refer to the Izzy show. An additional 30 letters and 9 drawings of an engineer were collected from KS1 students, some of who had seen more than one show.

**Short essays were also collected from 17 students who had seen the Rough Guide show.

5 Findings: Izzy's Incredible Adventure

5.1 KS1 student feedback on Izzy

146 primary school students completed forms which asked them to *'please write some words or draw some pictures about the show you have just seen'*. Their drawings were categorised as shown in the following table:

Analysis of KS 1 drawing feedback of Izzy show (n=146)

Type of response	Number (%)
Drawing of multiple elements of the show with words	122 (79%)
Drawing of single element of the show	18 (17%)
Drawing of multiple elements without words	2 (26%)
Other	5 (4%)
Total	***47***

Drawings of single elements of the show were most likely to be of a bird or a rocket, suggesting these were the most memorable single elements of the show. Drawings of multiple elements were most likely to feature a bird, a rocket and a hovercraft. Labels and descriptions were accurate in a majority of cases and there were some descriptions about what the students had seen and learnt. Most of these mentioned individual elements of the show and what they did e.g. *he got the bird to fly, the rocket went really high, the balloon was flying everywhere.* A few students mentioned the shows were about science and some students said they had helped Izzy on her journey, e.g. *I helped Izzy with transport and to get to Jake's party*.

Comments about the show were positive and indicated that students enjoyed individual elements of the show as well as the whole show and learnt something from it, for example:

I liked the bird because it crash landed. (KS1 student)

There was a rocket and it went round the room. (KS1 student)

I liked it all it was fun and exciting. (KS1 student)

I learnt a hovercraft moves by air. (KS1 student)

You have to push that thing to make the rocket go high. (KS1 student)

We learnt what things sink and float. (KS1 student)

The 30 letters, which were written by KS1 pupils (Year 4) after they saw a show and sent to *science made simple* by a teacher, were also very positive. The students had clearly enjoyed the show and the presenters. Their letters suggested that the rocket, balloons and bubbles were the best remembered aspects of the show. There was also evidence that these students had learnt something.

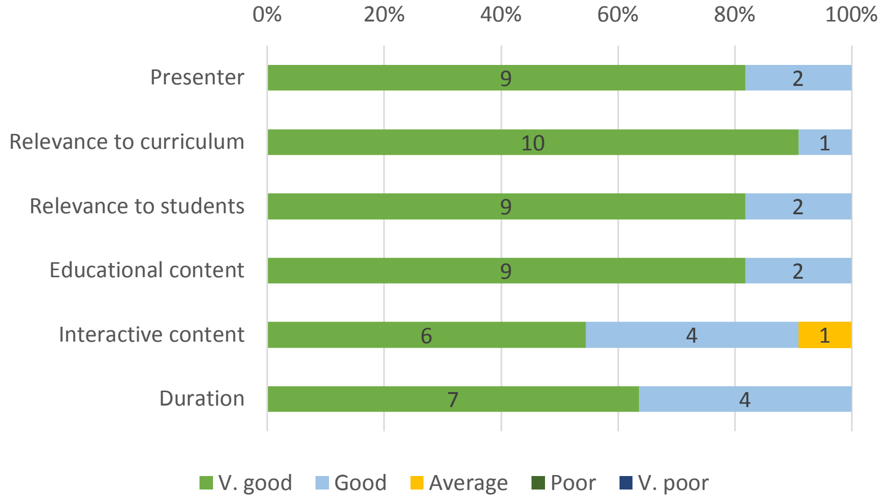
I now know how you make your rocket fly (fire, fuel, oxygen). (KS1 student)

I loved the experiment with the balloon where you put a pin in the balloon and expect it to pop and it didn't. (KS1 student)

5.2 *Teacher feedback on Izzy*

11 teachers who had seen Izzy provided positive feedback. All said they would book another similar show, 8 rated their overall impression of Izzy as 'very good' and 3 rated it as 'good'. They also rated individual elements highly as shown in the following graph.

Teacher ratings of Izzy (n=11)



Teachers reported that the show's engagement of the students was its most successful aspect, which they attributed to its interactive nature and use of a story, as shown by these comments.

> *Very interactive and exciting for younger children – shared lots of science theory in an interactive way. (Teacher)*
>
> *Teaching elements of science through a story was effective. (Teacher)*

Teachers said the least successful aspects were students being unable to see elements of the show, particularly the hover craft and them wanting the show to include even more student participation or interaction.

In terms of impacts on their students, all teachers agreed that Izzy had increased the students' knowledge of engineering and science generally and 8 agreed it had increased their students' knowledge of science or engineering in everyday life. A minority (4) agreed that Izzy had inspired their students to consider further study or careers in engineering, which is not unexpected given the age of the students.

The main other student impact described by teachers was the sense of excitement and enjoyment engendered by Izzy. For example:

> *It just made science fun. (Teacher)*
>
> *They were all excited about science. (Teacher)*

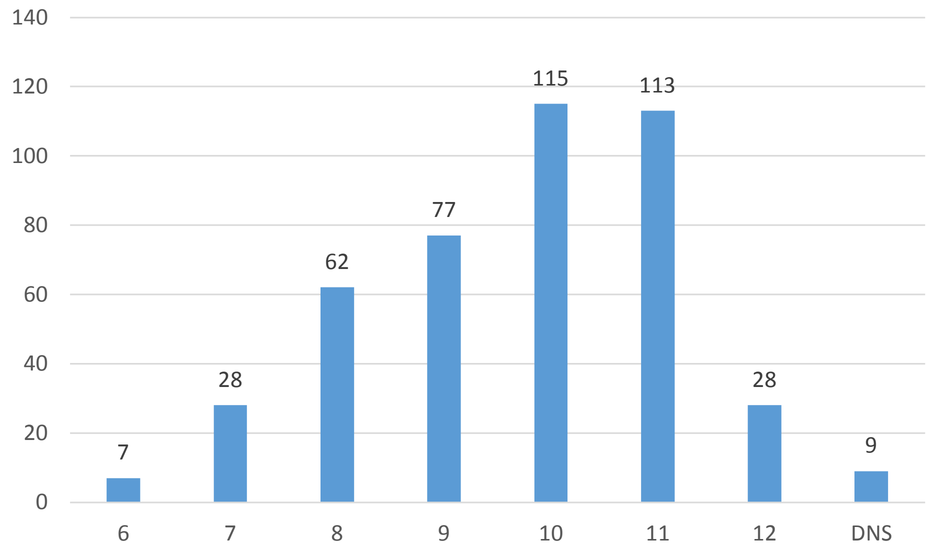
6 Findings: Who wants to be a superhero?

Feedback on Superhero was received using KS2, KS3/4 and teacher questionnaires.

6.1 KS2 student feedback on Superhero

KS2 questionnaires were completed by 439 students age 6 to 12 who had seen the Superhero show. 214 (49%) students were female, 201 (46%) were male and 24 (6%) did not state their gender. Over half (228, 52%) were age 10 or 11 and 139 (32%) were age 8 or 9, as shown below.

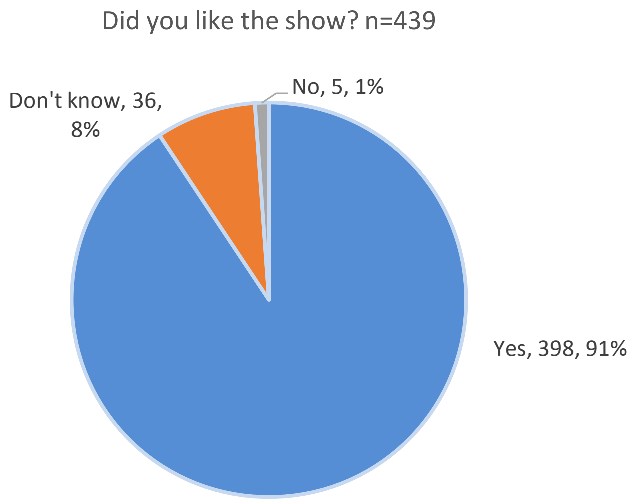
Age of KS2 students at Superhero (n=439)



6.1.1 Enjoyment

Students enjoyed Superhero. 398 (91%) answered ‘yes’ and 36 (8%) answered ‘don’t know’ when asked if they liked the show, with only 5 (1%) answering ‘no’.

KS2 students’ enjoyment of Superhero

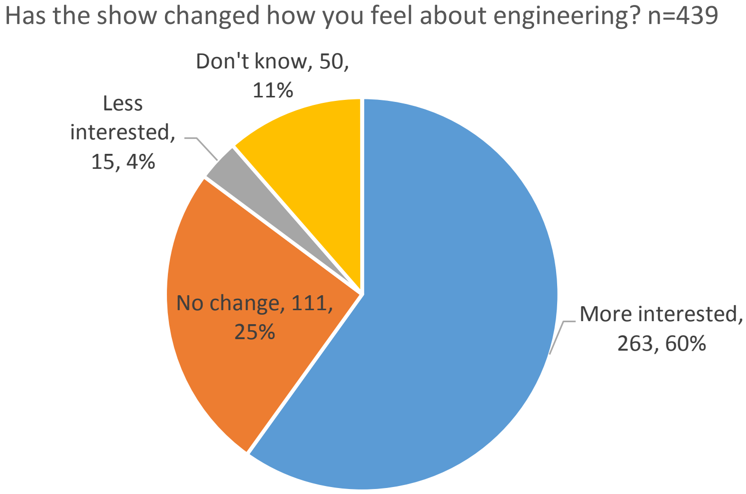


These positive opinions were confirmed when 278 students answered when asked if they would like to see another show about engineering or science. Of these, 214 (77%) selected 'yes', 48 (17%) selected 'don't know' and 16 (6%) selected 'no'.

6.1.2 Attitudes to engineering

Superhero had a positive impact on how students felt about engineering. Most students (263, 60%) selected 'more interested' when asked if Superhero had changed how they felt. 15 (4%) selected 'less interested', 111 (25%) reported 'no change' and 50 (11%) chose 'don't know'.

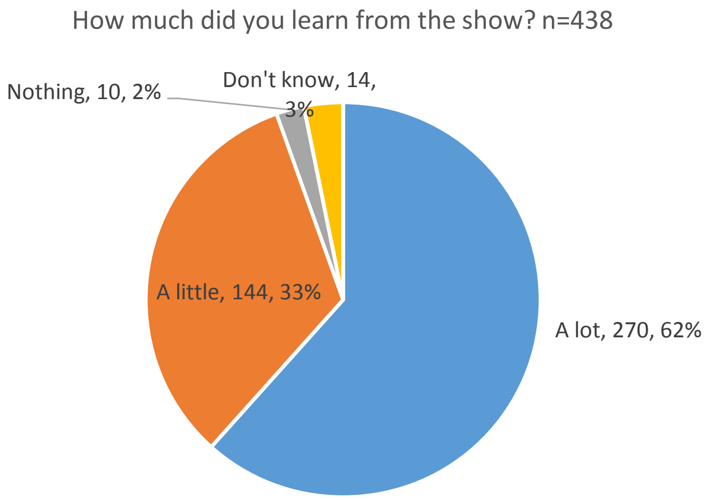
Impact of Superhero on KS2 students' interest in engineering



6.1.3 Learning

A majority of students (414, 95%) reported that they learnt something – either 'a lot' (270, 62%) or 'a little' (144, 33%) - from Superhero.

KS2 students learning from Superhero



404 (92%) students described something new they learnt from the show, including some who reported ‘no’ or ‘don’t know’ when asked how much they learnt. The most common answers indicated that students learnt something about lasers, including how lasers can be used in transfer of sound, for example:

> *Music from an i-pod can go through a laser to a music player. (KS2) student)*
>
> *That sound can travel though lasers. (KS2 student)*

The second most common descriptions demonstrated that students had learnt about bridge structures. Examples included:

> *I learnt that an arch is a better shape to build a bridge. (KS2 student)*
>
> *An arch is a really strong shape and spreads pressure. (KS2 student)*

The third most common descriptions were learning about the speed of light (occasionally incorrectly described as 300 million miles per second).

> *That light can go round the world 7 times in a second. (KS2 student)*

Other examples of learning were gravity, lift/flight and how varied engineering is.

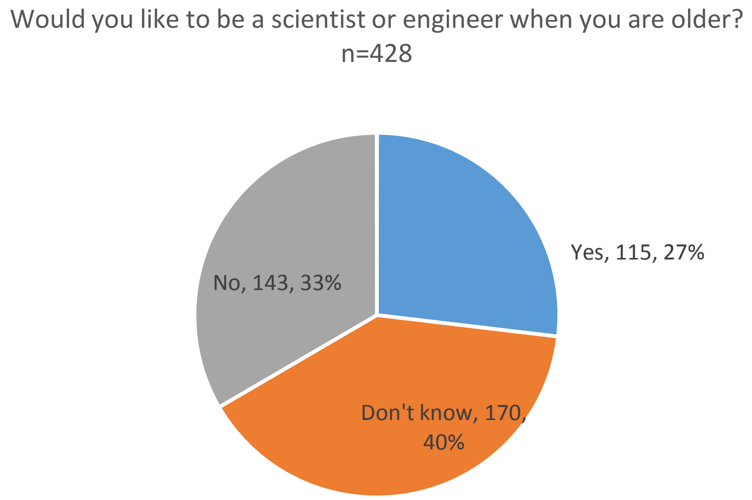
223 (51%) answered when asked what jobs engineers do. Almost half indicated that engineers build bridges. Other common answers indicated that students think that engineers design and test things, including solutions to problems. For example:

> *Engineers solve all sorts of problems. (KS2 student)*
>
> *They design and improve things. (KS2 student)*

6.1.4 Intentions

KS2 students were uncertain about wanting to be an engineer or scientist when they are older. 115 (27%) selected ‘yes’, 143 (33%) selected ‘no’ and 170 (40%) selected ‘don’t know’.

KS2 students wanting to become a scientist or engineer when older



6.1.5 Gender comparison

A two-sample t-test between proportions was performed to determine whether there was a significant difference between boys and girls with respect to the percentages who liked the show, were more interested in engineering, had learnt a lot or would like to be a scientist or engineer.

The t-statistic was significant at the 95% confidence level in one case i.e. those who learnt 'a lot', which was reported by 66% of male and 56% of female students and where $t=2.089$, degrees of freedom = 413, and $p= .0373$.

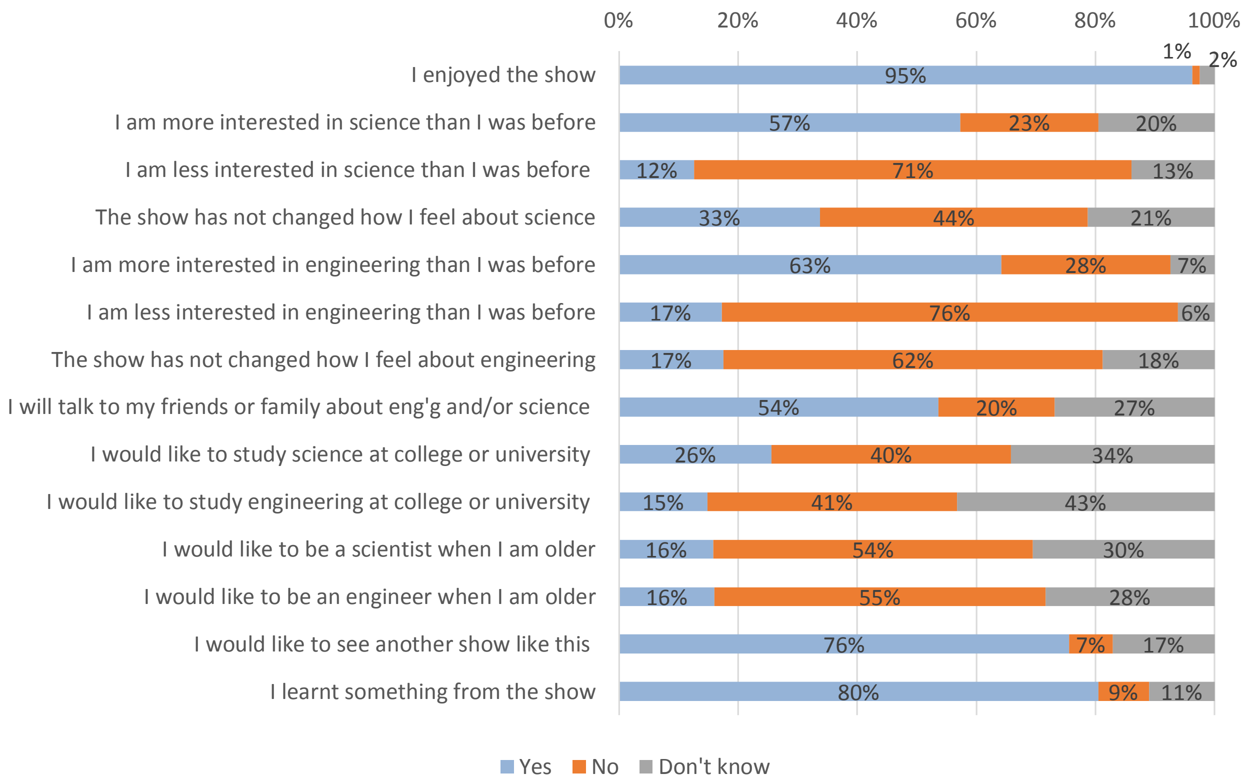
6.2 KS3/4 student feedback on Superhero

82 KS3 students who had seen Superhero completed KS3/4 post-show questionnaires. They were age 11 to 13 and in school years 7 and 8. 40 (49%) students were male and 41 (50%) were female with 1 student not indicating their gender.

6.2.1 Superhero impacts on KS3/4 students

Students were asked to select 'yes' 'no' or 'don't know' to indicate what they thought of fourteen statements about Superhero's impact on them and their interest in engineering or science. Their answers are displayed in the following graph.

KS3 students' reactions to Superhero (n=82)



Students were most positive in relation to their enjoyment of Superhero, learning something from the show and wanting to see another similar show, with 78 (95%) and 66 (80%) and 62 (76%) selecting 'yes' respectively for these statements.

Superhero had a positive impact on most students' attitudes to science and engineering, with 47 (57%) reporting that they were more interested in science than before the show and 52 (63%) reporting an increased interest in engineering. Similarly, most students respectively answered 'no' about being less interested science (58, 71%) or engineering (62, 76%) than before the show.

Another positive impact was over half of the students (44, 54%) reported that they would talk to friends or family about science and/or engineering after the show.

Impacts about further study or careers in science or engineering were less significant. 21 (26%) and 12 (15%) respectively said they would like to study science or engineering at college or university. In both cases, 13 (16%) students said they would like to be a scientist or engineer when they are older.

6.2.2 Superhero - learning for KS3/4 students

66 (80%) students selected 'yes' in relation to learning something new from Superhero and 63 described what they had learnt. The most common of these were facts about lasers in communication followed by facts about flight/aerodynamics. For example:

That you can play music through lasers. (KS3 student)

I learnt how lasers can help work the internet. (KS3 student)

About how airplanes fly. (KS3 student)

What things are aerodynamic and why. (KS3 student)

6.2.3 KS3/4 student experience of Superhero

Students were asked to write 3 words that described their experience of Superhero. They wrote a total of 226 words, a majority of which were positive. The most common were:

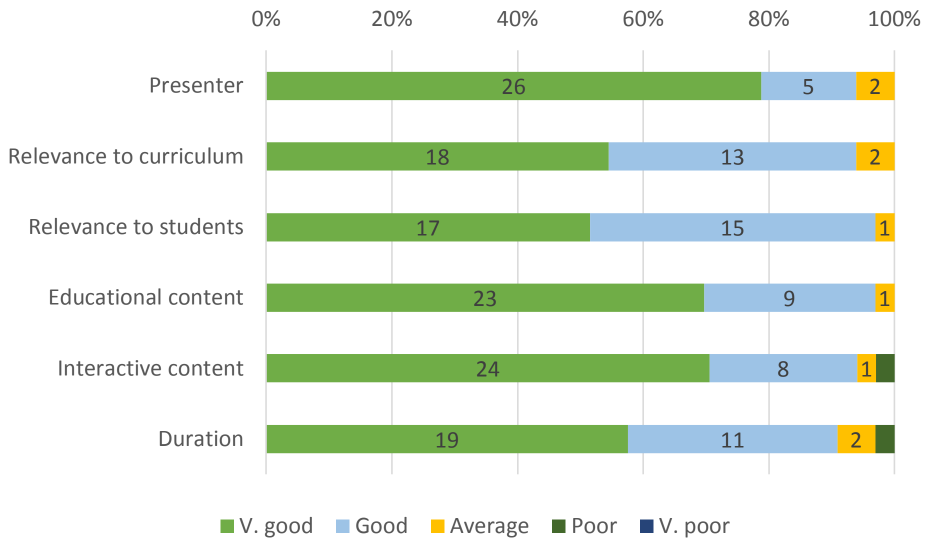
	n=
Fun/funny	53
Interesting	42
Good	18
Exciting	15
Cool	13
Amazing	13

6.3 Teacher feedback on Superhero

30 teachers and 3 home educators who had seen Superhero completed feedback questionnaires. A majority of their opinions were positive. All except one (a home educator) rated their overall impression of Superhero as ‘very good’ (23, 70%) or ‘good’ (9, 27%) and most (25, 76%) would definitely book another show about engineering or sciences.

Most also rated individual elements of the show positively as shown in the following graph. The presenter, interactive content and educational content were the highest rated elements. Generally, homed educators rated all elements lower than the teachers.

Teacher ratings of Superhero (n=33)



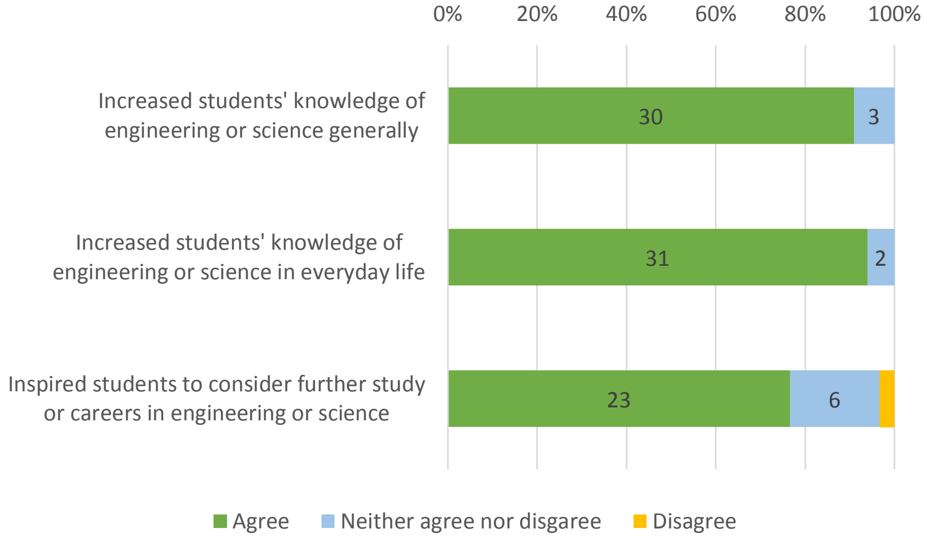
A majority of respondents reported the interactive nature of Superhero as its most successful aspect, as these comments show.

> *Children interacting with the activities – it’s always good for children to participate. (Teacher)*
>
> *The children were able to participate in numerous activities that were relevant to their current learning. (Teacher)*
>
> *Allowing children to take part in activities. (Home educator)*

16 respondents described least successful aspects of Superhero. These were not being able to see all demonstrations and students not being able to ask questions.

As shown overleaf, most respondents thought that Superhero had a positive effect on their students. All teachers agreed that Superhero had increased students’ knowledge of engineering and science generally, with 3 home educators answering ‘neither agree nor disagree’. All teachers and 1 home educator (94% of respondents) agreed the show had increased their students’ knowledge of science or engineering in everyday life. 23 teachers (70% of respondents) agreed that Superhero had inspired their students to consider further study or careers in engineering.

Teacher opinions of Superhero's impact on students (n=33)



13 teachers described other impacts on their students. The joint most common of these were making links between science/engineering and everyday life and stimulating interest in science as a subject to study at school. For example:

> *Understanding of how different aspects of engineering affect everyday life. (Teacher)*
>
> *A wonder and fascination about the science behind everyday situations. (Teacher)*
>
> *Fitted in with light, forces and science topics. (Teacher)*
>
> *Increased their overall enthusiasm to study science. (Teacher)*
>
> *Provide better information for year 7 and 8 pupils when making their curriculum choices. (Teacher)*

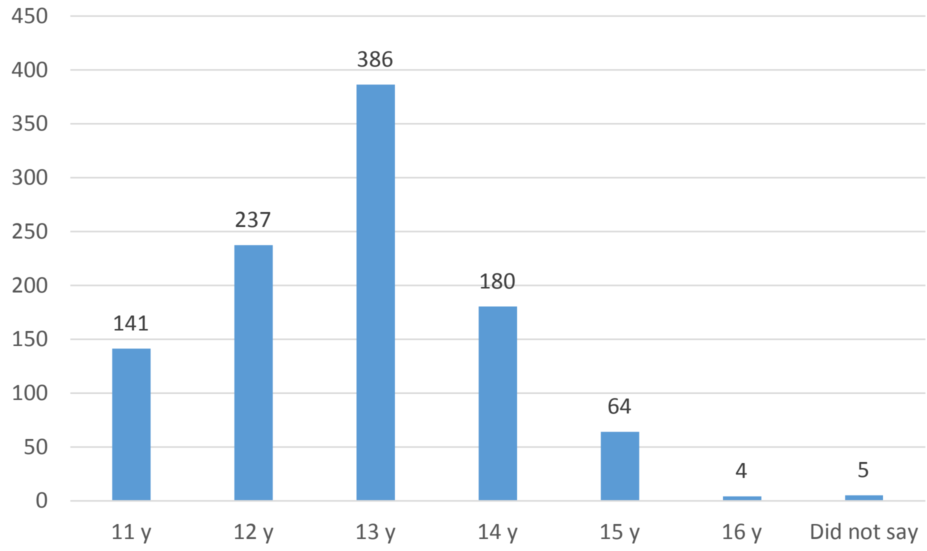
7 Findings: A Rough Guide to Engineering

Feedback was received from 1,017 KS3/4 post-show questionnaires and 65 teacher questionnaires. There were also 17 written essays from a group of students who had seen the show.

7.1 KS3/4 student feedback on Rough Guide

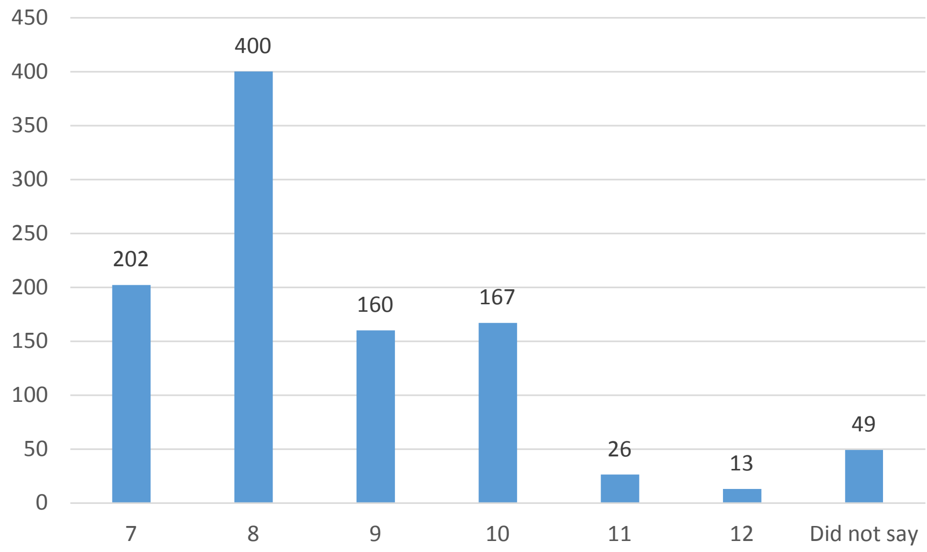
474 (47%) students were male and 535 (58%) were female, with 8 students not indicating their gender. They ranged in age from 11 to 16 and in school years from 7 to 12, with most (623, 61%) being age 12 and 13.

Age of KS3/4 students who saw Rough Guide n=1017



Year 8 was the most represented school year with 400 (39%) of students.

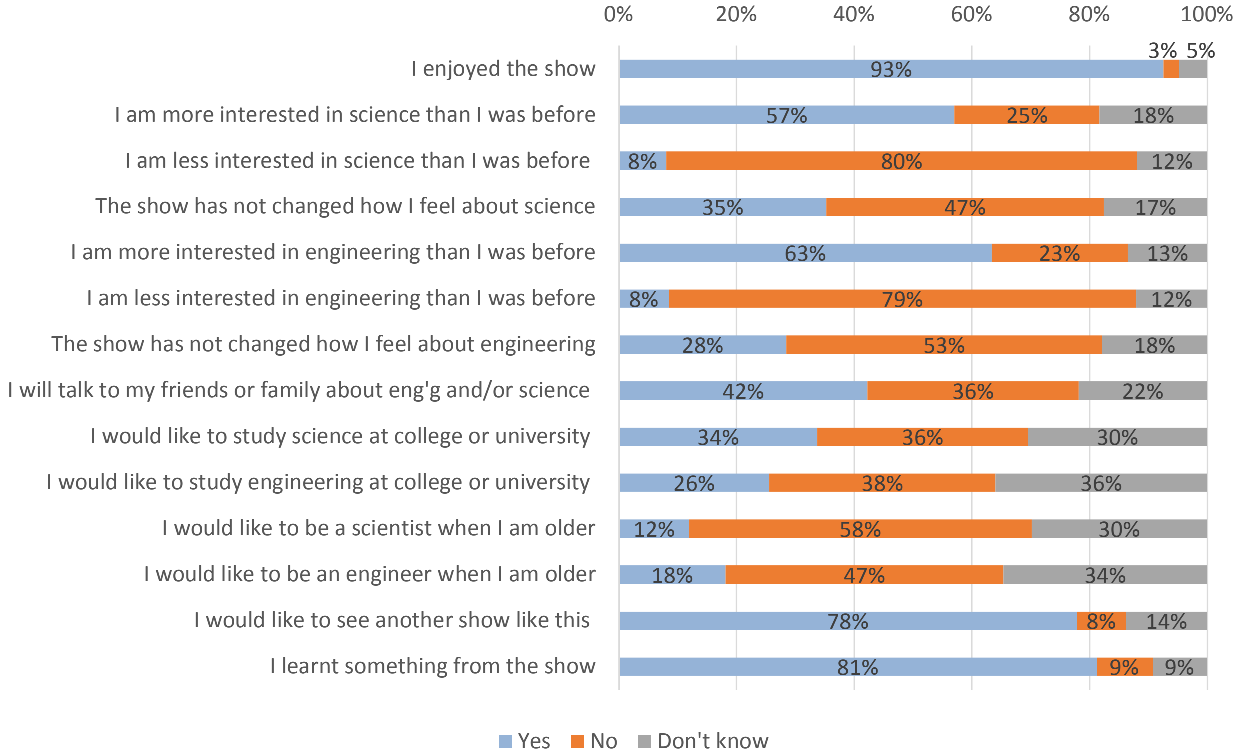
School year of KS3/4 students who saw Rough Guide n=1017



7.1.1 *Rough Guide impacts on KS3/4 students*

Students were asked to select 'yes' 'no' or 'don't know' to indicate what they thought of fourteen statements about Rough Guide's impact on them and their interest in engineering or science. Their answers are displayed in the following graph.

KS3/4 students' reactions to Rough Guide (n=1017)



Students were most positive in relation to their enjoyment of Rough Guide, learning something from the show and wanting to see another similar show, with 941 (93%) and 820 (81%) and 790 (78%) selecting 'yes' respectively to these statements.

Rough Guide had a positive impact on most students' attitudes to science and engineering, with 580 (57%) reporting that they were more interested in science than before the show and 642 (63%) reporting an increased interest in engineering. Similarly, a majority of students respectively answered 'no' about being less interested in science (810, 80%) or engineering (806, 79%) than before the show.

429 (42%) students reported that they would talk to friends or family about science and/or engineering after the show. This was higher than the 34% of KS3/4 students who indicated that they talk to their friends or family about science or engineering in the pre-show questionnaire (see section 9), although direct comparisons are not possible because the samples were different.

Impacts about further study or careers in science or engineering were less significant. 342 (34%) and 260 (26%) students respectively indicated they would like to study science or engineering at college or university. 121 (12%) and 183 (18%) respectively indicated that they would like to be a scientist or engineer when they are older. Again, these percentages were slightly higher than the equivalent figures for the pre-show questionnaire, where 32% and 20% respectively indicated they would like to study science or engineering at college or university, and 7% and 13% respectively indicated that they would like to be a scientist or engineer when they are older.

7.1.2 Rough Guide - learning for KS3/4 students

820 (81%) students selected 'yes' in relation to learning something new from Rough Guide and 715 described what they had learnt. 72% of this number described one of 4 categories of learning. The most common category was facts about engines and combustion followed by learning about future possible engineering developments, such as tunnels connecting continents and an elevator to another planet. Examples of such descriptions include:

> *SUCK SQUEEZE BANG BLOW is how a piston engine works. (KS3 student)*
>
> *In a diesel engine they use pressure to create heat. (KS3 student).*
>
> *Diesel doesn't get ignited – it is compressed. (KS4 student)*
>
> *It was engineers who thought up the tunnel connecting England and France and they now want to connect England and America. (KS4 student)*
>
> *I learnt that there is going to be a space elevator. (KS3 student)*

These categories were followed equally by learning about alternative fuels and forms of power and understanding the variety of different types of engineering. For example:

> *The good and bad about hydroelectricity and solar power. (KS3 student).*
>
> *I learnt about fossil and renewable fuels. (KS3 student)*
>
> *About various types of engineering and how important it is. (KS4 student)*
>
> *Engineering is lots of things – it's not just about cars. (KS3 student)*

Other reported categories of learning were knowledge about what engineering actually is; facts about flight and aerodynamics; and finding out how buildings can be protected from earthquake damage.

7.1.3 KS3/4 student experience of Rough Guide

Students were asked to write 3 words that described their experience of Rough Guide. They wrote a total of 2,630 words, almost all of which were positive. The most common words were:

	n=
Fun/funny	592
Interesting	472
Exciting	172
Cool	110
Amazing	72
Enjoyable	72

7.1.4 Gender comparison

The following table presents the results of two-sample t-tests performed to determine whether there was a significant difference between males and females with respect to their post-show attitudes towards engineering and science.

	% selecting 'yes'			
	Male	**Female**	**t= (1007)**	**P=**
I am more interested in science than I was before the show	60%	54%	1.920	0.5481
I am less interested in science than I was before the show	10%	6%	2.354	0.0551
The show has not changed how I feel about science	36%	34%	0.665	0.5062
I am more interested in engineering than I was before the show	70%	56%	4.586	0.0000***
I am less interested in engineering than I was before the show	9%	8%	0.569	0.5692
The show has not changed how I feel about engineering	27%	29%	0.706	0.4805
I will talk to my friends or family about engineering and/or science after the show	47%	38%	2.889	0.0040**
I would like to study science at college or university	38%	30%	2.682	0.0074**
I would like to study engineering at college or university	41%	12%	10.531	0.0000***
I would like to be a scientist when I am older	15%	9%	2.946	0.0033**
I would like to be an engineer when I am older	32%	6%	10.680	0.0000***

**denotes that the difference between % of males and females was significant at the 95% confidence level.
***denotes that the difference between % of males and females was significant at the 99% confidence level.

7.1.5 Other student feedback

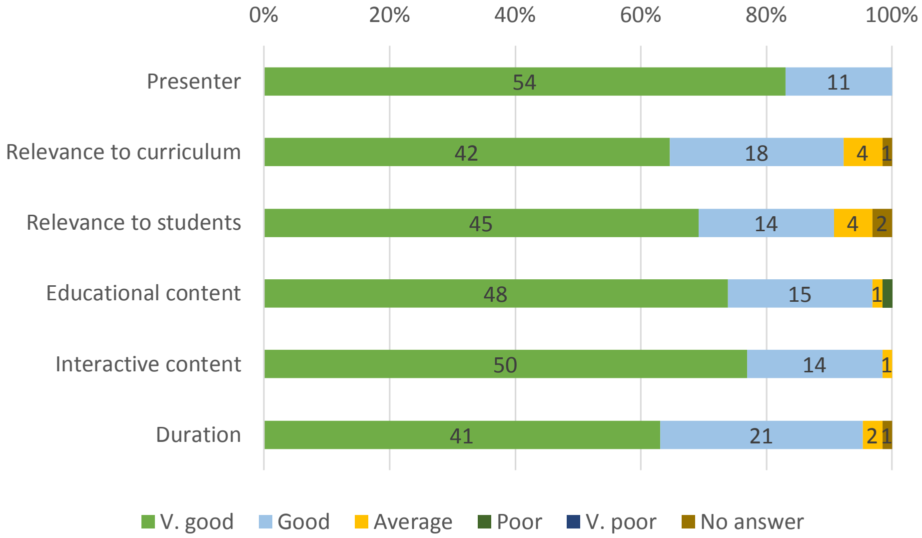
17 positive essays were written by students who had seen Rough Guide. They confirmed the findings from the questionnaires and indicated that students enjoyed the show and presenter and had learnt new facts and information about engineering.

7.2 *Teacher feedback on Rough Guide*

65 teachers who had seen Rough Guide completed feedback questionnaires. All except one (who did not answer this question, but rated other elements positively) rated their overall impression of Rough Guide as 'very good' (51, 79%) or 'good' (13, 20%) and a majority (53, 82%) indicated that they would definitely book another show about engineering or science.

All teachers rated the presenter as 'very good' or good' and a majority rated individual elements of the show positively as shown in the following graph. Other than the presenter, the interactive content and educational content were the highest rated elements, with respectively 64 (98%) and 63 (97%) rating these elements as 'very good' or 'good'.

Teacher ratings of Superhero (n=65)



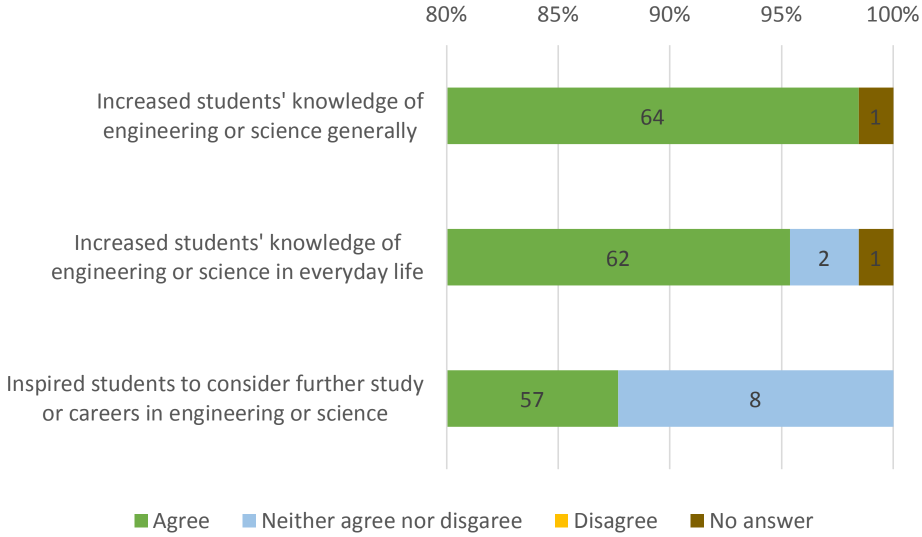
Teachers' most successful aspects of Rough Guide fell into 3 categories. They were: the demonstrations; the presenter's style; and the show's interactive elements. For example:

> *The practical demonstrations kept pupils engaged. (Teacher)*
>
> *Experiments and demonstrations grabbed students' attention. (Teacher)*
>
> *The involvement of pupils and the enthusiasm of the presenter. (Teacher)*
>
> *The pupils enjoyed getting involved in the show. They were engaged throughout. (Teacher)*
>
> *Presenter enthused all the students. They were learning whilst having fun, which was very inspirational. (Teacher)*

13 teachers reported least successful aspects of Rough Guide. These were in 2 categories: some demonstrations not working; and content levels being too high or too low for some students, in particular solar power being too high a level for KS3 and some other concepts not being explained in sufficient depth to retain the attention of older students.

As shown overleaf, most teachers thought that Rough Guide had positive impacts on their students. All who answered this question agreed that it had increased the students' knowledge of engineering and science generally. A majority (62, 95%) agreed the show had increased their students' knowledge of science or engineering in everyday life and 57 (88%) agreed that Rough Guide had inspired their students to consider further study or careers in engineering.

Teacher opinions of Rough Guide's impact on students (n=65)



26 teachers described other impacts on their students. The most common of these were links between science/engineering and everyday life and inspiring students to continue to study science. These impacts are summed-up in the following comment:

> *The show portrayed engineering as a fun and interesting career path and helped pupils to realise the huge role it has to play in their lives and in the world around them. Absolutely first class. (Teacher)*

8 Findings: Engineering for Life – From Cradle to Grave

Feedback on Engineering for Life was received using KS2, KS3/4 and teacher questionnaires

8.1 KS2 student feedback on Engineering for Life

Questionnaires were completed by 45 KS2 students age 9 to 12 in years 5 to 7 who had seen the show. 26 (58%) were male, 13 (29%) were female and 6 (13%) did not state their gender.

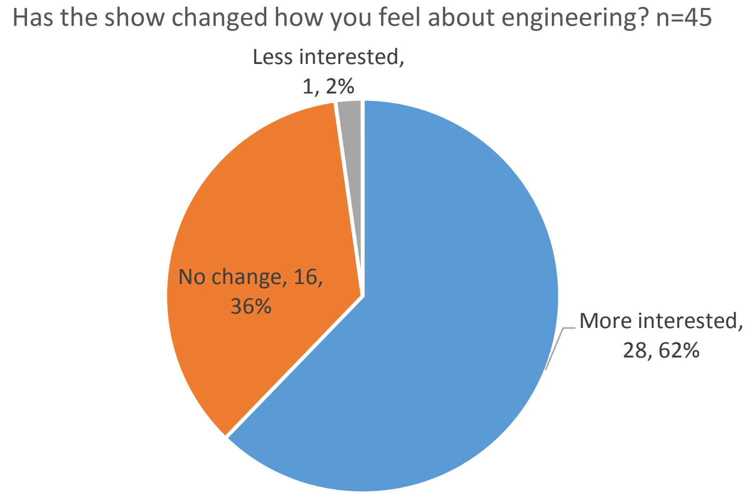
8.1.1 Enjoyment

Students enjoyed Engineering for Life. 43 (96%) answered 'yes' and 2 (4%) answered 'don't know' when asked if they liked the show, with none answering 'no'.

8.1.2 Attitudes to engineering

Engineering for Life had a positive impact on how students felt about engineering. Most (28, 62%) selected 'more interested' when asked if the show had changed how they felt. 1 (2%) selected 'less interested' and 16 (36%) reported 'no change'.

Impact of Engineering for Life on KS2 students' interest in engineering



8.1.3 Learning and intentions

All students reported that they learnt something from Engineering for Life. 25 (56%) selected 'a lot' and 20 (44%) selected 'a little'. All students described something new they learnt from the show. The most common answers indicated that students learnt about cryogenics and the absorbent nature of sodium polyacrylate.

> *That you can have your body frozen and conserved when you die if scientists in the future discover a way to bring you back to life they will try. (KS2 student)*
>
> *That Sodium Polyacrylate is very absorbent and was put in nappies top absorb pee. (KS2 student)*

All students described the jobs engineers do. The two most common answers were that engineers make things and that they help make lives easier. For example:

> *Engineers make and fix things. (KS2 student)*
>
> *Engineers do repairs, designing and creating. (KS2 student)*
>
> *Engineers make new hips for people and invent things that are going to make our lives easier. (KS2 student)*

Over half (26, 58%) KS2 students selected 'yes' when asked if they wanted to be an engineer or scientist when they are older.

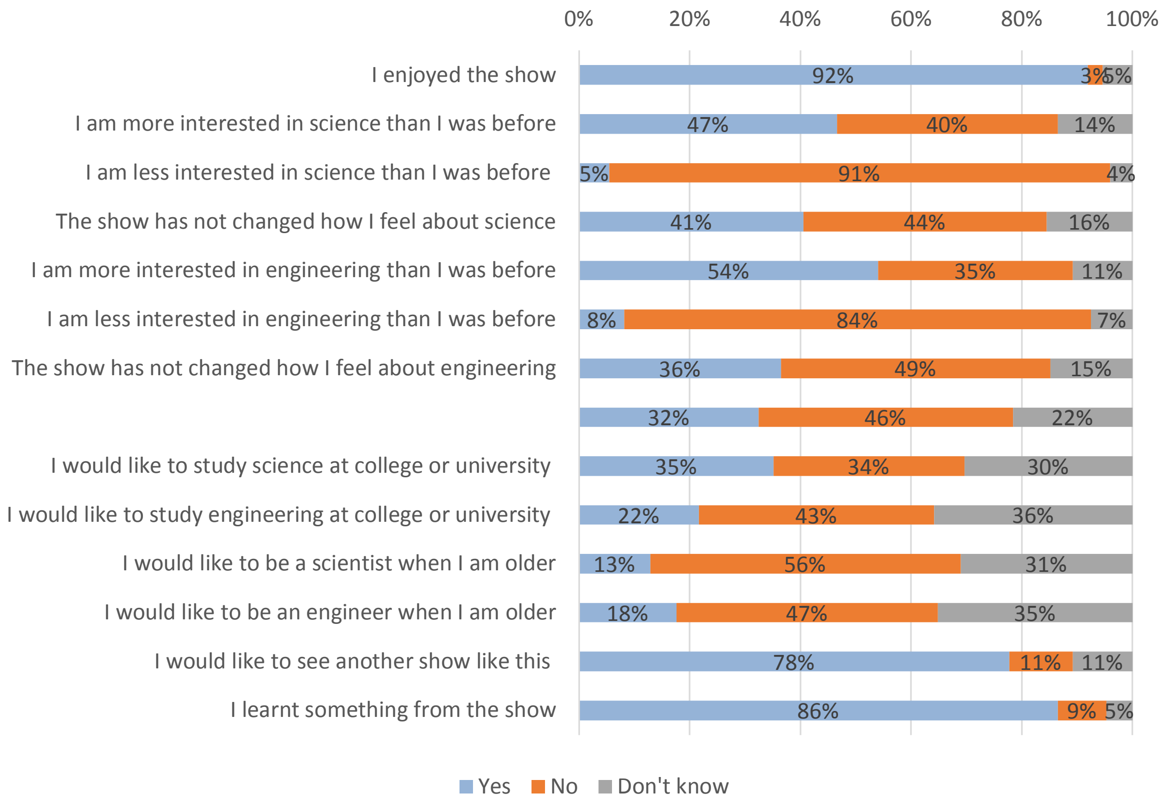
8.2 KS3/4 student feedback on Engineering for Life

148 students who had seen Engineering for Life completed KS3/4 post-show questionnaires. All were in KS3. They were age 11 to 14 and in school years 7, 8 and 9. 85 (57%) students were male and 63 (43%) were female.

8.2.1 Engineering for Life impacts on KS3/4 students

Students were asked to select 'yes' 'no' or 'don't know' to indicate what they thought of fourteen statements about Engineering for Life's impact on them and their interest in engineering or science. Their answers are displayed in the following graph.

KS3 students' reactions to Engineering for Life (n=148)



Students were most positive in relation to their enjoyment of the show, learning something from it and wanting to see another similar show, with 136 (92%) and 128 (86%) and 115 (78%) selecting 'yes' respectively for these statements.

Engineering for Life had a positive impact on just under half of the students' attitudes to science and engineering, with 69 (47%) reporting that they were more interested in science than before the show. However, just over half (80, 54%) reported an increased interest in engineering. Most students respectively selected 'no' about being less interested science (134, 91%) or engineering (124, 84%) than before the show.

Impacts were variable in terms of students talking about science or engineering after the show or wanting to pursue further study or careers in science or engineering. 48 (32%) students selected 'yes' and 68 (46%) selected 'no' about talking to friends or family about science and/or engineering.

52 (35%) and 32 (22%) students respectively said they would like to study science or engineering at college or university. 19 (13%) and 26 (18%) respectively said they would like to be a scientist or engineer when they are older.

8.2.2 Engineering for Life - learning for KS3/4 students

128 (86%) students selected 'yes' in relation to learning something new from Engineering for Life and 123 described what they had learnt. The most common learning was facts about the properties of liquid Nitrogen, followed by gaining knowledge about cryogenics. For example:

> *Liquid nitrogen is -197 C. (KS3 student)*
>
> *Objects go hard in liquid nitrogen, don't put your hands in it. (KS3 student)*
>
> *Don't put your hand in liquid nitrogen. (KS3 student)*
>
> *When some people die they are frozen in liquid nitrogen to be brought back in the future. (KS3 student)*

8.2.3 KS3/4 student experience of Engineering for Life

Students were asked to write 3 words that described their experience of Engineering for Life. They wrote a total of 410 words, a majority of which were positive. The most common were:

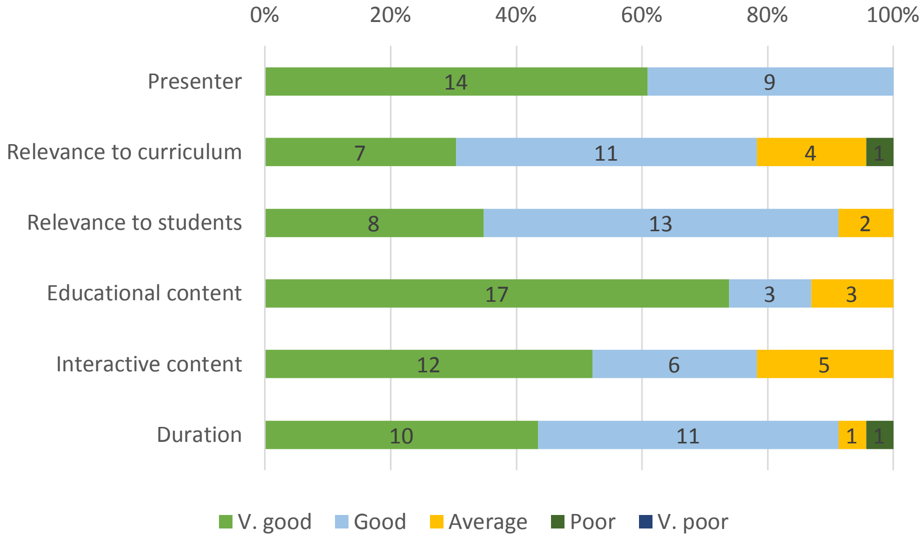
	n=
Interesting	97
Fun/ny	83
Exciting	28
Cool	18
Good	12

8.3 Teacher feedback on Engineering for Life

23 teachers who had seen Engineering for Life completed feedback questionnaires. Their opinions were positive. All rated their overall impression of the show as 'very good' (13, 57%) or 'good' (10, 43%) and all said they would definitely book another show about engineering or sciences. Two teachers said they would only book a show with 2 presenters for the same number of students (148).

Most teachers also rated individual elements of the show positively as shown in the following graph. All rated the presenter as 'very good' or 'good'. Other than this, relevance to students and interactive content were the highest rated elements.

Teacher ratings of Engineering for Life (n=23)



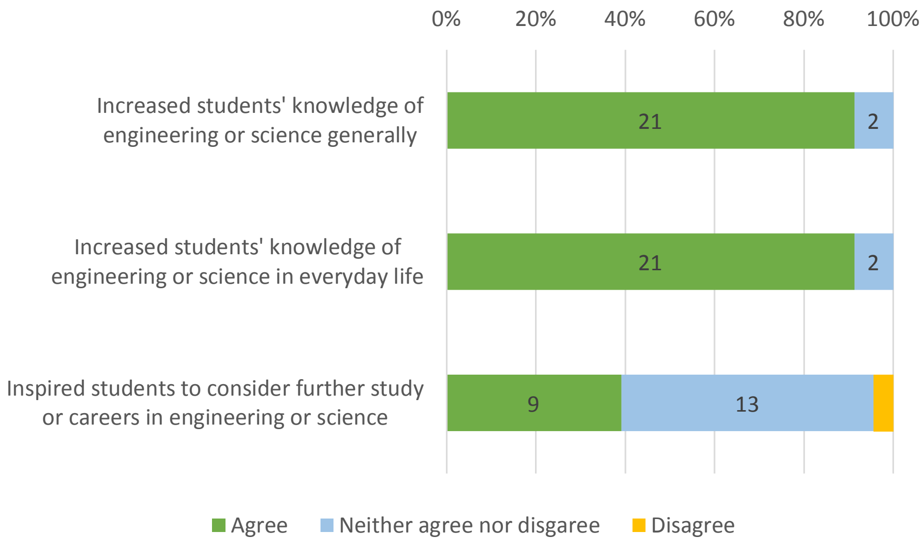
10 teachers reported most successful aspects of Engineering for Life. They highlighted the engaging nature of the demonstrations and the interactive content, as these comments show.

> *The N_2 demos with balloons and flowers. (Teacher)*
>
> *Interactive demos. Pupils like to participate. Pupils enjoyed it when the balloons suddenly exploded. (Teacher)*
>
> *The demos and student involvement made it interesting for the students. (Teacher)*

5 teachers described least successful aspects of the show. These were not being able to see all demonstrations and insufficient links made to subjects studied at school.

As shown overleaf, most teachers thought that Engineering for Life had a positive effect on their students. 21 (91%) teachers agreed that the show had increased students' knowledge of engineering and science generally, with 2 answering 'neither agree nor disagree'. The same % agreed the show had increased their students' knowledge of science or engineering in everyday life. 9 teachers (39%) agreed that Engineering for Life had inspired their students to consider further study or careers in engineering.

Teacher opinions of Engineering for Life's impact on students (n=148)



3 teachers described other impacts on their students:

> *They enjoyed it. It was quite biology based, but that's what life and death is really about – the body. (Teacher)*

> *This introduced the wow factor to science and engineering. Showed how they are all linked and clearly illustrated their applications and implications. Absolutely well done. (Teacher)*

> *[Students saw] More hands on experiments with a wow factor! (Teacher)*

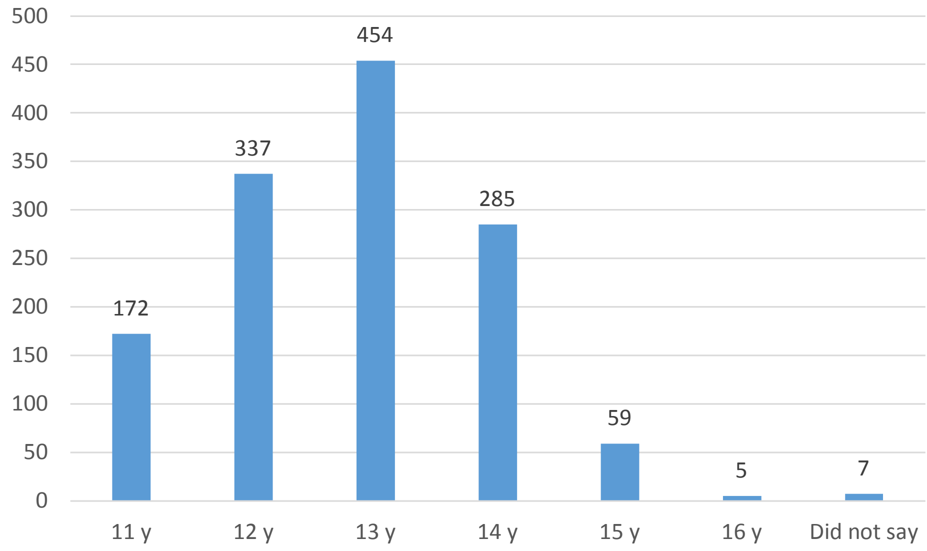
9 Findings: KS3/4 students' attitudes to science and engineering

1,319 KS3/4 students completed questionnaires about science and engineering before seeing a *science made simple* show.

9.1 Demographics

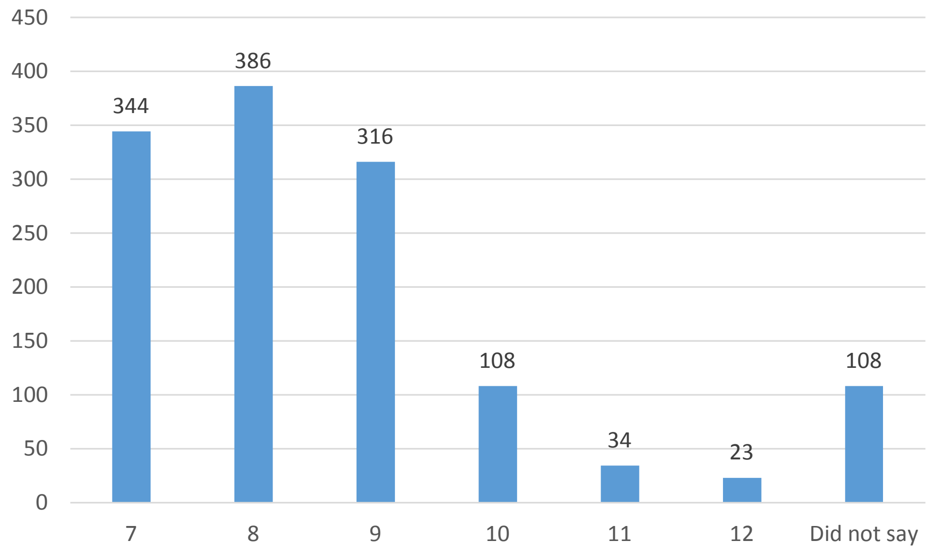
643 (49%) respondents were male, 673 (51%) were female and 4 did not report their gender. The students ranged in age from 11 to 16, with 791 (60%) being age 12 or 13.

Age of KS3/4 students who completed pre-show attitude questionnaires n=1319



1046 (79%) students were in KS3 school years and 165 (13%) were in KS4 school years with 108 (8%) not reporting a school year.

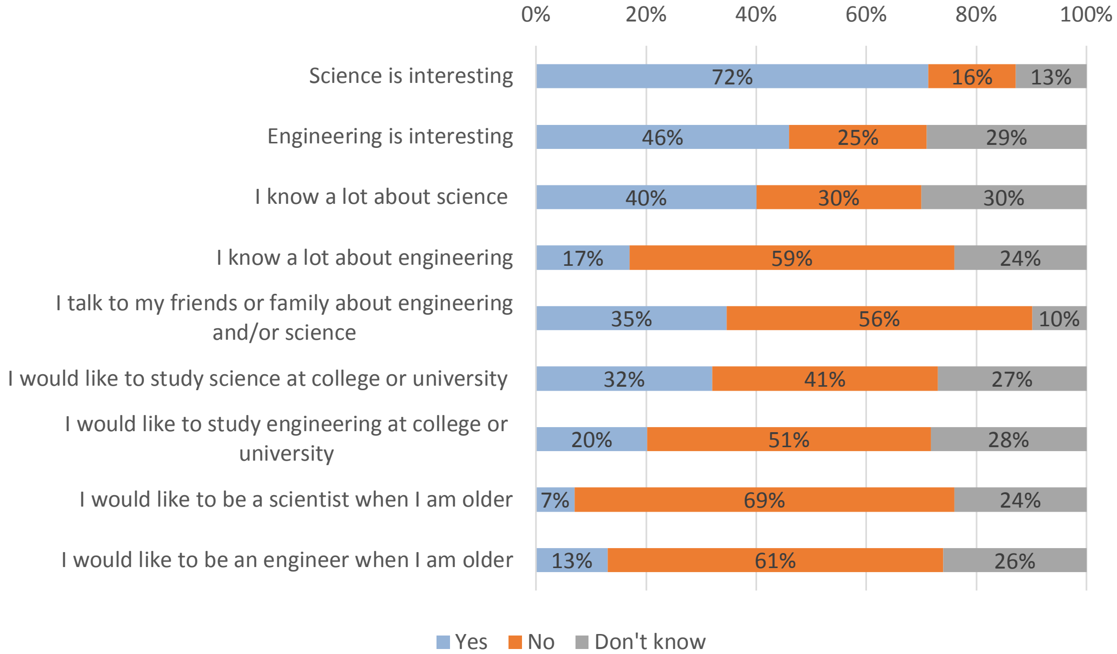
School year of KS3/4 students who completed pre-show attitude questionnaires n=1319



9.2 *Attitudes to science and engineering*

Students were asked to select 'yes', 'no' or 'don't know' to indicate what they thought of nine statements about engineering or science. Their answers are displayed in the following graph. A majority (945, 72%) indicated that they thought science is interesting. Fewer than half (608, 46%) thought engineering is interesting. Students' responses indicated that they know more about science than engineering. A higher percentage want to study science than engineering at college or university. Conversely a higher proportion want to be an engineer than a scientist when they are older.

KS3/4 students' pre-show opinions about science and engineering (n=1320)



Students were asked to write 3 words that they think of when they hear the word 'engineering'. They wrote a total of 3,663 words. The top 10 were categorised as shown in the following table.

Category	**n=**
Car/cars	593
Engine/engines	259
Building/buildings	203
Mechanic/mechanics	191
Tool/tools (e.g. spanner, hammer screws)	190
Fix/fixing something	152
Metal/metalwork	112
Other vehicle (e.g. bus, lorry, bike, truck)	101
Machine/machine/machinery	87
Technology	80

Most words were positive or descriptive. However, there were 57 occurrences of the word 'boring'. Family members were reported on 12 occasions (11 male and 1 female) and teachers (all male) were mentioned 3 times. There were 24 references to masculine/man/or manly. 3 students mentioned Brunel and 3 mentioned the fictional character Howard Wolowitz.

9.3 Gender comparison

The following table presents the results of two-sample t-tests performed to determine whether there was a significant difference between males and females with respect to their attitudes towards engineering and science.

	% selecting 'yes'			
	Male	**Female**	**t= (1314)**	**P=**
Science is interesting	78%	65%	5.214	.0000***
Engineering is interesting	68%	25%	15.537	.0000***
I know a lot about science	47%	33%	5.300	.0000***
I know a lot about engineering	26%	8%	8.732	.0000***
I talk to my friends or family about engineering and/or science	41%	28%	5.077	.0000***
I would like to study science at college or university	34%	30%	1.867	0.622
I would like to study engineering at college or university	34%	7%	11.958	.0000***
I would like to be a scientist when I am older	9%	6%	2.391	.0170**
I would like to be an engineer when I am older	23%	4%	10.071	.0000***

**denotes that the difference between % of males and females was significant at the 95% confidence level.
***denotes that the difference between % of males and females was significant at the 99% confidence level.

10 Conclusions

The evaluation drew on several sources of evidence to explore the shows' impacts on school students. Findings from student and teacher questionnaires indicated that the shows have had significant impacts against three categories of the Generic Learning Outcomes from the Inspiring Learning for All framework[2] (GLOs): experiences, knowledge, and attitudes. Evidence for each is drawn together in this Section along with an exploration of impacts in relation a fourth GLO: behaviour, which are less clear.

10.1 Experiences: opportunities, enjoyment, inspiration, interest

Student and teacher feedback indicates that students enjoyed the shows, particularly the demonstrations, the interactive nature and the engaging style of the presenters. All drawings and letters submitted by KS1 students demonstrated their enjoyment. KS2, 3 and 4 students enjoyed the shows and the humour as evidenced by the most common word KS3/4 students used to describe Superhero and Rough Guide, which was 'fun/ny'. This was also the second most common word used to describe Engineering for Life.

Reactions to the shows were positive with high levels of enjoyment and students and teachers expressing interest in seeing similar shows about engineering or science in the future.

% of students who enjoyed or liked each show

Category	%
Superhero KS2	91%
Superhero KS3/4	95%
Rough Guide KS3/4	93%
Engineering for Life KS2	96%
Engineering for Life KS3/4	92%

Students' descriptions of what they learnt and teachers' opinions provided evidence that memorable content, such as launching a rocket or flying a bird helps to ensure greatest impact in terms of enjoyment and learning.

10.2 Knowledge and understanding

The GLO around knowledge and understanding was also well-evidenced from the evaluation. Student feedback revealed several outcomes around knowledge and understanding:

- KS2, 3 and 4 students recalled interesting or surprising facts about lasers, bridge structures and engines.
- KS2, 3 and 4 students described increased understanding of engineering and the jobs done by engineers.

[2] See www.inspiringlearningforall.gov.uk/toolstemplates/genericlearning

- The shows provided ways of visualising particular scientific or engineering concepts, including some taught in the school curriculum.

Teachers agreed that the shows increased students' understanding of engineering and science generally and their relevance to everyday life. Learning was basic for KS1 students, but older students were able to cite scientific/engineering facts and ideas about the role of engineers.

% of students who learnt something from each show

Category	%
Superhero KS2	95%
Superhero KS3/4	80%
Rough Guide KS3/4	81%
Engineering for Life KS2	100%
Engineering for Life KS3/4	86%

10.3 Attitudes and beliefs

Attitudinal shifts were identified for KS2, KS3 and KS4 students that had seen the shows. The outcomes under this GLO can be summarised as follows:

- The shows made engineering seem more interesting to most students.
- The shows encouraged students to see that engineering was relevant to everyday lives.
- The shows fostered a sense of surprise at the variety of jobs and roles performed by engineers.

% of students who were more interested in engineering after each show

Category	%
Superhero KS2	60%
Superhero KS3/4	63%
Rough Guide KS3/4	63%
Engineering for Life KS2	62%
Engineering for Life KS3/4	54%

The engaging presenters, plus the visual nature and interactive content and format of the shows were important here. Teachers' descriptions of success factors suggest that these characteristics were a contributing mechanism to this set of outcomes.

10.4 Behaviour: activity and progression

The GLO around progression was partially-evidenced from the evaluation. Students were more likely to report post-show that they would want to study science then engineering. Comparison with the pre-show attitudes of KS3/4 students towards further study suggest that Rough Guide and Engineering for Life have increased the number of students who want to study both subjects, although the reverse was true for Superhero, which is primarily targeted at KS2.

% of students who would like to study science* or engineering at college or university (*only asked of KS3/4 students)

Category	Science %	Engineering %
Superhero KS2		
Superhero KS3/4	26%	15%
Rough Guide KS3/4	34%	26%
Engineering for Life KS2		
Engineering for Life KS3/4	35%	22%
KS3/4 pre-show	***32%***	***20%***

KS2 students were the most likely age group to report that they want to be a scientist or engineer. KS3/4 students were more likely to report that they would want to be an engineer than a scientist. Comparison with the pre-test attitudes of KS3/4 students towards careers suggest that all shows have had a positive impact in terms of the number of target age group students who want to be scientists or engineers.

% of students who would like to be a scientist or engineer

Category	Scientist or engineer %	Scientist %	Engineer %
Superhero KS2	27%		
Superhero KS3/4		16%	16%
Rough Guide KS3/4		12%	18%
Engineering for Life KS2	58%		
Engineering for Life KS3/4		13%	18%
KS3/4 pre-show		***7%***	***13%***

Teachers indicated that KS3/4 students were more likely than younger students to be inspired by the shows to consider further study or careers in engineering or science.

10.5 Other conclusions

Having a variety of shows has enabled audiences in KS 1 to 4 to experience shows developed specifically for them. Teachers and students appreciated the engaging style and memorable content of the shows. They suggested that large audiences may benefit from more than one presenter and/or having staging that ensures all demonstrations are visible to every audience members.

The evaluation provides data about the attitudes of KS3 and 4 students towards science and engineering, including gender variances. These findings can be used by *science made simple* when planning future activities and shows for these age groups.

This evaluation demonstrates that the *science made simple* engineering shows have been successful in engaging their target audiences and delivering a range of positive impacts for students in KS1 to KS4. They prove the concept of extending school shows beyond traditional science into other STEM subjects.