

SCEAG

Projecting Science

Evaluation report

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Executive summary

“I liked it coz it’s different to nearly everything else I’ve seen about science... ... in the dome with it all around you, you automatically felt like you are there, it’s happening to you and you’re learning all the time. And it kept us more focussed, more interested.” (Student, Cell biology show)

Introduction

Projecting Science is a collaboration between Thinktank Birmingham Science Museum, Techniquet@NEWI, and Inspire Discovery Centre. It developed three new interactive shows that utilised inflatable domes and 360° projection technology. The project aimed to create and deliver inspiring astronomy, physics and biology-based outreach programmes to KS2 and KS3 schools who find it difficult to visit the consortium member centres.

The evaluation

The evaluation used before-and-after questionnaires (n=318) and focus groups (n=36) to explore students’ experiences and project outcomes. The opinions of teachers (n=15) and project partners (n=7) were also included.

Findings: Experiences

- A large majority of students agreed that they **liked the shows** (97%, 93% and 86% for Astronomy show, Light and colour show and Cell biology show respectively);
- Most students also agreed that the show was a **fun way to do science** (92%, 82% and 86% for Astronomy show, Light and colour show and Cell biology show respectively).

Most students described the shows as useful, fun, cool, clever and exciting. Very few students described the level of the shows as either ‘too easy’ or ‘too hard’, which indicates that the science was pitched at an appropriate level for the audiences.

Teachers felt that the novel nature of the learning environment made for a fun and engaging experience for students.

“Everything different and visual seems to bring science alive for the children” (Teacher, Light and colour show)

Findings: Attitudes

- Over half of students, and more in the case of the Astronomy show, agreed that the show **made them like science more** (73%, 57% and 56% for Astronomy show, Light and colour show and Cell biology show respectively).

A significantly lower proportion of students agreed that ‘we have to do too much work in science’ after participating in the Astronomy show and Light and colour shows. On a similar note, students that participated in the Cell biology

show were significantly more likely to reject the notion that ‘*we do too much science at school*’ after they took part.

“It changed how I feel about science because I never knew you could have fun as well as learn that much in one lesson” (Student, Astronomy show)

Findings: Learning

- Most students agreed that the shows **helped them with their science** (78%, 68% and 81% for Astronomy show, Light and colour show and Cell biology show respectively);
- Over four-fifths of students agreed that they **learned lots from the show** (94%, 82% and 90% for Astronomy show, Light and colour show and Cell biology show respectively).

Students appear to have significantly improved their knowledge on one of the items tested for each show. The improvement was most marked in the final Cell biology show question where students were able to write the answer in their own words. These results indicate the educational value of the show when measured against quite narrow indicators; students were also encouraged to write down what they had learned later in the questionnaire. However, some misconceptions were also uncovered by the questions and supported by teacher feedback.

“Yes - we are doing a unit on Earth, Sun and Moon and it was reinforcing some of the work we had covered - in a much more 3D way than is possible with our own resources” (Teacher, Astronomy show)

Conclusions

The dome shows successfully addressed four of the five Generic Learning Objectives. Students enjoyed the dome activities, and significant learning and positive attitudinal shifts were measured using the questionnaires. The evaluation data noted some areas where the shows could be improved, however the evidence indicates that **the dome shows were an enjoyable way to support and enrich the curriculum.**

The project undoubtedly **enhanced the outreach service** of the three centres. All centres are now delivering the three shows as part of their outreach offerings. They also felt that the equipment would allow them to develop shows for a wider range of audiences, so diversifying their outreach and contributing to sustainability.

Development of the **pre- and post-visit materials** was not completed during the funding period, although they will be rolled out with the shows in future. The consortium member leading on this aspect left the centre suddenly which severely slowed development of the materials.

Consortium members felt that the **partnership was effective and beneficial.** They are planning to work together again in the near future having successfully bid for funding from STFC to develop a new dome show based on the atom.

1 Introduction

Projecting Science is a collaboration between Thinktank Birmingham Science Museum, Techniquet@NEWI, and Inspire Discovery Centre. It created three new interactive shows that utilised inflatable domes and 360° projection technology. The project aimed to create and deliver inspiring astronomy, physics and biology-based outreach programmes to KS2 and KS3 schools who find it difficult to visit the consortium member centres. The project had the following objectives:

- To provide and advocate a unique learning environment using state-of-the-art, versatile, digital mobile dome technology;
- To enhance overall sustainability of consortium member centres through and enhanced outreach service;
- To develop pre and post visit materials and CPD opportunities that meet teachers' needs;
- To foster relationships in a spirit of dissemination of best practice between centres with varying needs, skills and experience.

2 The evaluation

2.1 Evaluation questions

The evaluation explored the delivery processes and impact of the project with a view to identifying and sharing lessons and good practice.

The following evaluation questions were set at the start of the project to focus the work:

1. Did the project succeed in engaging schools that were unlikely to visit the consortium centres? Are the relationships between these schools and the centres likely to continue?
2. What were teachers' and students' experiences of the dome shows?
3. How did these experiences differ between the different shows (and areas of science) and different age groups?
4. What was the impact of the shows on students' knowledge of and attitudes towards science?
5. What was the impact of using the projection technology? Did it add value to the shows and if so in what way?
6. How widely used were the pre- and post-visit materials?
7. What were teachers' opinions of the pre-and post-materials in terms of both their content and format?
8. How did partners and the centre staff that delivered the shows feel the project had impacted on them as individuals and their centres, especially considering factors related to sustainability and collaboration?
9. What is the most useful learning and good practice to share with the wider science centre/museum community?

2.2 Methodology

The evaluation had several strands:

- Before-and-after student questionnaires
- Student focus groups
- Teacher questionnaires
- Telephone interviews with project partners

2.2.1 Student questionnaires

Before-and-after questionnaires were used to evaluate the shows. A ten-point smiley face attitude scale adapted from that developed by Pell and Jarvis (2001)¹ for use with 5-11 year-olds. An example questionnaire is given in the Appendix to this report.

Questions that tested students' knowledge of the scientific topics to be covered by the shows were included in the questionnaire to measure shifts in this knowledge.

In addition, a questionnaire containing closed (in the form of the smiley scale) and open items was included at the second stage to allow students to feed back their experiences of the shows and describe what they learned in their own words.

2.2.2 Student focus groups

Six focus groups were conducted at three schools that participated in the project. The three schools covered the three centres and the three different shows developed. This was an opportunity to further explore students' experiences of the shows, their learning and attitudinal change.

Centre staff involved in the project received focus group training near the start of the project, so the first groups were conducted by the evaluator, and the second by members of centre staff to help them develop their research techniques.

2.2.3 Teacher questionnaires

Teacher questionnaires explored teachers' opinions of the shows, and what they thought the impacts on students had been.

2.2.4 Telephone interviews with project partners

These interviews, conducted near the end of the project with two staff from each of the three centres (six in total), were an opportunity to reflect on the project's successes and challenges.

¹ Pell T & Jarvis T (2001) *Developing attitude to science scales for use with children of ages from five to eleven years* International Journal of Science Education 23, 847-862

3 About the project

3.1 *Partnership working*

The project involved seven representatives from the three partner science centres: two staff members from each centre plus the project coordinator, who was based at the lead centre. Most of the show content was developed over two sets of residential writing days that were held at venues equidistant between the three centres.

Partners felt that setting this time aside and taking time away from the centres in which they usually work meant that the show development was truly collaborative. By creating the time and space to discuss ideas, lots was achieved in a relatively short time. The days also allowed consortium members to get to know one another both professionally and socially, facilitating communications for the remainder of the project. These residential days allowed partners to share their experiences of delivering outreach, which was described as valuable by all.

A key benefit of working in partnership was that it allowed the material to be developed more quickly than it could have been at an individual centre. The sharing of ideas between a group of people with considerable outreach experience and knowledge of different areas of science also ensured a high quality product.

3.2 *Targeting schools*

Each of the three centres used a different approach to targeting schools for the project, based on their knowledge of local schools:

- **Thinktank** targeted schools in the Sandwell and Dudley area that were not on their database as having visited the centre or booked outreach. School headteachers were telephoned and offered a visit in a two-week time window.
- **Techniquiest@NEWI** targeted small rural schools where the higher cost per student for centre visits or outreach can be a barrier to participation. Schools were contacted by telephone.
- **Inspire** also targeted small rural schools or schools they had never worked with. An initial mailing was followed up with a telephone call.

All of the centres reached their target of seven visits. All have now incorporated the shows into their outreach programmes.

3.3 Delivery metrics

The tables below summarise the delivery metrics broken down by shows and centres. In total, 20 schools and one scout group were visited as part of the project. One school was visited twice to deliver different shows.

<i>Astronomy show</i>	<i>Shows</i>	<i>Children</i>	<i>Teachers</i>	<i>Support Staff</i>	<i>Contact Hours</i>
Inspire	12	351	12	8	177.5
TQ@NEWI	9	254	8	0	125.5
Thinktank	10	351	12	8	177.5
Total	31	956	32	16	480.5

<i>Light and Colour show</i>	<i>Shows</i>	<i>Children</i>	<i>Teachers</i>	<i>Support Staff</i>	<i>Contact Hours</i>
Inspire	3	90	3	3	45
TQ@NEWI	4	110	3	0	55
Thinktank	4	90	3	3	45
Total	11	290	9	6	145

<i>Cell biology show</i>	<i>Shows</i>	<i>Children</i>	<i>Teachers</i>	<i>Support Staff</i>	<i>Contact Hours</i>
Inspire	4	236	7	2	118
TQ@NEWI	4	120	4	0	60
Thinktank	2	236	7	2	118
Total	10	592	18	4	296

<i>All shows</i>	<i>Shows</i>	<i>Children</i>	<i>Teachers</i>	<i>Support Staff</i>	<i>Contact Hours</i>
Inspire	19	677	22	13	340.5
TQ@NEWI	17	484	15	0	240.5
Thinktank	16	677	22	13	340.5
Total	52	1838	59	26	921.5

A total of 52 shows were delivered as part of the project, reaching over 1800 students.

4 Opinions of students

After describing the evaluation sample, this section focuses on four of the five Generic Learning Outcomes from the Inspiring Learning For All Framework.

All five outcomes are:

- Knowledge and Understanding;
- Skills;
- Attitudes and Values;
- Enjoyment, inspiration and creativity;
- Activity, behaviour and progression.

The following report sections include the GLOs:

Experiences (4.2)

- This encompasses elements of the enjoyment, inspiration and creativity, as well as activity, behaviour and progression GLOs. We used the term 'experiences' to capture as wide a range of opinions from learners about the shows as we could.

Attitudes and Values (4.3)

- We explored changes in attitude using both quantitative and qualitative methods.

Knowledge and understanding (4.4)

- Learning was identified using qualitative and quantitative methods.

4.1 Samples

A total of 318 students completed questionnaires both before and after the shows. The breakdown of questionnaire samples is given below.

<i>Astronomy show</i>		<i>Light and colour show</i>		<i>Cell biology show</i>	
<i>Age</i>	<i>No. of students</i>	<i>Age</i>	<i>No. of students</i>	<i>Age</i>	<i>No. of students</i>
7	19	-	-	-	-
8	27	8	29	-	-
9	34	9	28	-	-
10	47	10	42	-	-
11	25	11	7	11	34
-	-	-	-	12	25
Total	152	Total	106	Total	59

<i>Astronomy show</i>		<i>Light and colour show</i>		<i>Cell biology show</i>	
<i>Gender</i>	<i>No. of students</i>	<i>Gender</i>	<i>No. of students</i>	<i>Gender</i>	<i>No. of students</i>
Males	81	Males	60	Males	31
Females	71	Females	47	Females	28
Total	152	Total	107	Total	59

The Astronomy show and Light and colour show samples include Key Stage 2 students, while the Cell biology show sample consists solely of Key Stage 3 students. All samples are mixed in terms of gender.

Six focus groups were conducted with a total of 36 students. A breakdown of the samples is given here:

Astronomy show (Thinktank)

- Group 1: 3 Year 3, 3 Year 4, 3 girls, 3 boys
- Group 2: 3 Year 5, 3 Year 6, 3 girls, 3 boys

Light and colour show (Techniquet @ NEWI)

- Group 1: 5 Key stage 1, 2 girls, 3 boys
- Group 2: 7 Key stage 2, 3 girls, 4 boys

Cell biology (Inspire)

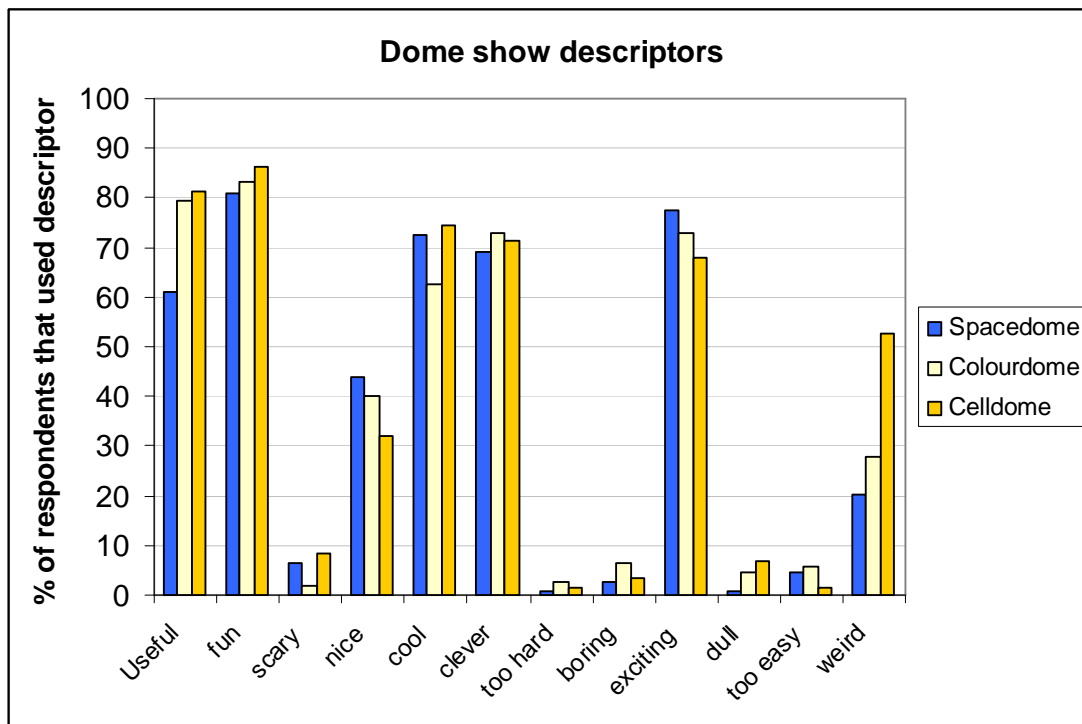
- Group 1: 6 Year 7, 3 boys, 3 girls
- Group 2: 6 Year 7, 3 boys, 3 girls

4.2 Experiences

The dome shows were well received by students. Findings from the questionnaires included:

- A large majority agreed that they **liked the shows** (97%, 93% and 86% for Astronomy show, Light and colour show and Cell biology show respectively);
- Most students also agreed that the show was a **fun way to do science** (92%, 82% and 86% for Astronomy show, Light and colour show and Cell biology show respectively).

Students were asked to circle words from a set that they felt described their opinions of the shows. Findings are presented in the graph below:



Most students found the shows useful, fun, cool, clever and exciting. Some felt they were weird (especially the Cell biology show!). Few students found the shows dull or boring. Very few students described the level of the shows as either 'too easy' or 'too hard', which indicates that the science was pitched at an appropriate level for the audiences. Given that the samples for the Astronomy show and Light and colour show shows were quite varied in terms of age, the flexibility built into the way the shows could be tailored for different audiences is likely to have been a success factor here.

Students were asked about their experiences in greater detail during the focus group discussions. Some key findings are highlighted here:

4.2.1 Astronomy show (Thinktank)

- The experience of going into the dome was interesting for the students, they especially liked squeezing through the doors;
- Some commented that watching the 360° projection hurt their necks after a while;
- However they did feel it was more interesting than watching a video on a screen;
- Several students described the dome space as 'weird';
- The fact that the planets were animated was a success in the eyes of the students;
- Students liked the interactive elements of the show: the fact they could choose which planets to visit and the option to ask questions at any time;
- Some students that had been to Thinktank felt the centre was much better than the dome;

- All of the students recognised that the dome had come from Thinktank because the presenters wore branded T shirts;
- Most students felt that seeing the dome made them want to visit Thinktank.

“It was good because you could choose which stars you wanted to visit, not just what other people wanted to visit” (Year 6 female)

“She explained it, not in a boring way like you would see in a university. It really sounded like I wish I was there. She talked about things, it made it more fun” (Year 5 male)

“It’s like quite different because the dome only has one topic and in the Thinktank it has loads of different topics” (Year 6 male)

“I like all the big machines at Thinktank and there weren’t any in the dome” (Year 3/4 male)

4.2.2 Light and colour show (Techniquest@NEWI)

- The focus group school was very small – all twelve students in the school were interviewed!
- The students really enjoyed the dome experience;
- The fact that the presenters involved volunteers in the experiments was mentioned as a success factor;
- Students were excited when they saw the dome and wanted to go inside;
- The school where the focus group was conducted was a Welsh school, and some of the KS2 students found the show difficult;
- When probed they explained this was more to do with the language than the level of the science;
- Most of the students recognised that the Techniquest brand was linked to the dome;
- Some students had visited Techniquest in Cardiff as part of a school trip;
- Some had heard of or visited Techniquest@NEWI.

“I was quite excited because like [other student] I didn’t know what I was going to see and it was really dark”

“I think it was interesting coz even though they only chose the subject of light they chose stuff that was interesting and they got all the children to do things with them”

“I liked it when they had a CD and they shined a light on it and across all the dome there was different colours across the dome”

“They were using a lot of different words that we hadn’t heard before and we didn’t understand”

4.2.3 Cell biology show (Inspire)

- The key success factor was the visual nature of the show – many students said they hadn’t realised previously just how much ‘stuff’ is in a cell;
- The initial, realistic cell animation was very well received;

- Students felt that the cartoon cells were not so good in comparison;
- When asked how these could be improved, students would have liked them to be more detailed and more realistic;
- The fact that they could ask the presenter questions at any time was a real positive for the students, as they felt it made sure they could understand everything;
- Some of the students would have liked more time for questions, as there wasn't time to answer them all;
- Students felt the dome was cramped and somewhat uncomfortable, they suggested smaller groups and mats or cushions on the floor;
- Most students were already interested in science;
- They compared the dome to books and videos, and said it was a more interesting way to learn;
- None of the students made the link between Inspire and the dome;
- Several students knew about or had visited Inspire and had positive feedback about the centre.

"I liked it coz it's different to nearly everything else I've seen about science. It's different to videos and DVDs... coz usually with something like that you are looking at a screen in front of you and you just get the feeling, if it's really interesting you feel like you're in it. But in the dome with it all around you, you automatically felt like you are there, it's happening to you and you're learning all the time. And it kept us more focussed, more interested."

4.3 Attitudes and values

Students were presented with ten statements about school and science in the week before and the week after they participated in the dome shows. Responses were on a five-point Likert scale from 'strongly agree' to 'strongly disagree'. The table below shows the proportion of students that agreed or strongly agreed with each statement. The full data set is given in Appendix 2.

The Wilcoxon Signed ranks test was applied to the pairs of responses to identify where significant shifts in attitude had occurred. Such instances are denoted with one or two asterisks depending on the level of significance reached.

Statement	% that agreed					
	Astronomy show		Light and colour show		Cell biology show	
	<i>Pre</i>	<i>Post</i>	<i>Pre</i>	<i>Post</i>	<i>Pre</i>	<i>Post</i>
1. I like coming to school	62**	68**	63	60	59	58
2. We have to do too much work in science	28**	14**	25**	14**	26	24
3. I should like to be a scientist	25*	29*	15	15	15	9
4. Science is good for everybody	65	65	63	62	59	63
5. Science is just too difficult	13	15	17	13	3	3
6. Science makes me think	79	79	79	76	95	90
7. I like to watch science programmes on TV	39	39	36	35	39	37
8. We do too much science at school	19	13	15	11	38*	12*
9. I like science more than any other school work	21	19	19	18	17	19
10. We have to do too much writing in science	28	24	22	16	41	42

*denotes significance at the 95% confidence interval
 **denotes significance at the 99% confidence interval

These results are very interesting and suggest that the dome shows influenced the attitudes of the students in several areas. However, an important caveat is that the influence of other factors can't be completely ruled out.

A significantly lower proportion of students agreed that '*we have to do too much work in science*' after participating in the Astronomy show and Light and colour shows. This could be linked to students' perceptions of the dome as a fun way of learning. Further evidence for this is given in the next section.

On a similar note, students that participated in the Cell biology show were significantly more likely to reject the notion that '*we do too much science at school*' after they took part. This indicates an increased interest and/or motivation in science, as the actual amount of science covered in school would not have changed over the period of the study.

There were statistically significant shifts for two other statements within the Astronomy show sample. More students agreed with the ideas 'I like coming to school' and 'I should like to be a scientist' after the shows than before. This

suggests a positive impact not only in terms of science, but school more generally.

Further questionnaire data supports these shifts in attitude.

- Over half of students, and more in the case of the Astronomy show, agreed that the show **made them like science more** (73%, 57% and 56% for Astronomy show, Light and colour show and Cell biology show respectively).

Students were asked to explain whether or not the show had changed how they feel about science in one of the open questionnaire items and during the focus group discussions. Findings are presented for each show in the sections below:

4.3.1 Astronomy show

Questionnaire responses

“Yes I never knew it could be so exciting”

“Yes because it made me really get interested when we saw different planets”

“No I’m still not into science!”

“Because it makes me think about the life up in space”

“It changed how I feel about science because I never knew you could have fun as well as learn that much in one lesson”

“Yes because it really felt like you were flying through space”

“I like science already so it didn’t change my mind”

Focus group findings

- In the year 5/6 focus group, most of the students already liked science. However a few said it had increased their enthusiasm for the subject still further;
- In the Year 3/4 focus group, most of the students disliked science and described it as boring;
- The younger students liked the dome but were unsure whether it had changed their feelings about science;

“In school you have to do a lot of writing but in the Thinktank and the Science Bus you have fun and you learn because you see things” (Year 5 male)

“I like science and when I saw that it was 2 miles up the happy scale” (Year 5 male)

4.3.2 Light and colour show

Questionnaire responses

“Yes science can be funny and weird, not just formulas and lots of weird words”

"The show made science a lot more interesting it was very fun"

"It made me feel more confident. My work will now get better because I understand about it more"

"Definitely I never knew you could do all those things with a light"

"It changed how I feel because it was fun and the experiments were cool"

"I didn't really change how I feel about science"

"More happy around science"

Focus group findings

- Students had generally positive opinions of science before they participated in the dome shows;
- They said that they 'still liked science' after the shows.

4.3.3 Cell biology show

Questionnaire responses

"No because I already loved science"

"Yes it did because I did not know that so many things can fit into such a small space"

"Yes, because I realised how fun science can be"

"A bit cause it looked well cool inside the cells"

"It made me feel very scientific and how it would be to be a science worker/teacher"

"It didn't change how I feel about science"

Focus group findings

- The Year 7 students were generally quite positive about science;
- They liked the practical element of the subject and mentioned that their teacher made it enjoyable;
- However they felt that the dome was a more interesting way of learning;
- Some students felt that the dome made cell biology more interesting, but not science generally.

"I thought it really changed it because before we just thought one of the only ways to learn about science is sitting down with books... So we thought there's different ways of learning science. And we thought if they can do that stuff themselves then what other science can they do?"

4.4 Knowledge and understanding

Students' knowledge of the relevant science content was tested before and after each of the shows using the questionnaires. Results are summarised in the tables below.

Astronomy show			
Question	Max. mark	Mean mark	
		<i>Pre</i>	<i>Post</i>
1. Put the following in order from largest to smallest: Person, galaxy, moon, star, planet	5	2.09**	2.75**
2. Complete the sentence: Stars give out light, but planets don't. We can see the Moon because it reflects light from the Sun.	3	2.84	2.86
3. Complete the sentence: The Earth goes round the Sun . Each orbit takes one year . The Earth spins on its axis once a day . This gives us day and night when different sides of the planet face the Sun. The Moon orbits (goes round) the Earth .	4	3.06	3.10

*denotes significance at the 95% confidence interval

**denotes significance at the 99% confidence interval

Light and colour show			
Question	Max. mark	Mean mark	
		<i>Pre</i>	<i>Post</i>
1. Complete the sentence: Light is needed for our eyes to see. Light normally travels in straight lines. But lenses can be used to bend light. There are two main types of lens. These are called concave and convex .	4	3.44*	3.70*
2. Complete the sentence: White light can be split into the colours of the rainbow. The scientific name for the rainbow is a spectrum .	2	1.96	1.99
3. Complete the sentence: Something that makes light is called a light source . Some objects may seem bright, but that is only because they reflect light. A mirror is a very good reflector of light.	3	2.60	2.75
4. Complete the sentence: A material you can't see through can be used to make shadows . We call this material opaque . A material that lets light through is called transparent and one that only lets some light through is called translucent.	3	1.74	1.98

*denotes significance at the 95% confidence interval

**denotes significance at the 99% confidence interval

Cell biology show			
Question	Max. mark	Mean mark	
		<i>Pre</i>	<i>Post</i>
1. Label the following on a diagram of a cell: Nucleus, cell membrane, mitochondria	3	2.22	2.59
2. Is the diagram a plant or an animal cell?	1	0.72	0.74
3. What are the main differences between plant and animal cells?	3	0.45**	0.98**

**denotes significance at the 95% confidence interval*

***denotes significance at the 99% confidence interval*

Students appear to have significantly improved their knowledge on one of the items tested for each show. The improvement was most marked in the final Cell biology show question where students were able to write the answer in their own words. These results indicate the educational value of the show when measured against quite narrow indicators; students were also encouraged to write down what they had learned later in the questionnaire.

For some items, there was a high level of knowledge before the shows, so it was difficult to register an improvement. For other items, such as students knowing the difference between opaque and transparent materials, there was little change following the shows.

Responses to some questions highlighted common misconceptions among students. For example, the order in which many students placed the sizes of different objects was: galaxy – planet – moon – star – person; this indicated that they were ordering objects according to their *apparent* sizes rather than their actual sizes. While a significant number of students improved their mark in this question following the show, the mean mark was still less than 3 out of 5.

Students were also asked to rate their own learning later in the questionnaire:

- Most students agreed that the shows **helped them with their science** (78%, 68% and 81% for Astronomy show, Light and colour show and Cell biology show respectively);
- Over four-fifths of students agreed that they **learned lots from the show** (94%, 82% and 90% for Astronomy show, Light and colour show and Cell biology show respectively).

Students were asked to describe something they had learned from the shows in an open question at the end of the questionnaire and during the focus group discussions. Some of their comments are given in the next sections.

4.4.1 Astronomy show

Questionnaire responses

There were some common learning points, including:

“That Neptune’s rings are made of ice dust and rock”

“Stars can make pictures if they join up. Pluto is a dwarf planet”

“I learned that when there is blue stars the stars are young, but red ones are old.”

“The sun is a big ball of fire”

“The North Star stays centre in the sky”

“I learnt that a storm on Jupiter has been raging for 400 years”

But there were also some misconceptions, such as:

“There are 9 planets in our universe”

“That in another 32 years the sun is going to get smaller and could eat the planet up”

Focus group findings

- They were quite articulate about what they had learned, and recalled lots of facts from the show;
- The most common learning point was that Pluto is a dwarf planet;
- Some also talked about how the sun will die out and the lifetimes of stars;
- Some of the students had misconceptions e.g. ‘stars and planets are the same’;
- One student that normally finds science difficult felt she learned lots from the dome;

“I still find [science] hard but I’ve learnt a lot. I want the dome to come back. We’ll learn a lot about science” (Year 3/4 female)

4.4.2 Light and colour show

Questionnaire responses

“There is no such thing as dark”

“I learnt that if you point a laser at something and then pour powder on the light you can see the light”

“Light cannot go through your hand”

“There is no such thing as dark. Light travels in straight lines”

“White light can be made into colours of the rainbow”

“I learned how fast light travels 186000 miles per second and dark doesn’t exist. Convex separates concave goes in”

“That you can mix colours of light to make different colours just like paints”

By far the most common learning point was that *'there is no such thing as dark'*. This appears to have been particularly memorable for the students.

Focus group findings

- We spoke to some KS1 students that had been in the dome. Although they are younger than the target age group they could remember elements of the show and that light travels in straight lines;
- Older students could recall many of the experiments and several learning points.

"They showed us how light travels. It can travel in, like, different ways"

"They had a torch and they had contact lenses and the light turns in different directions"

4.4.3 Cell biology show

Questionnaire responses

"I learnt the difference between animal and plant cells"

"That DNA was inside the nucleus"

"I learnt most of the parts of the cell how cool cells are"

"I learnt that an animal cell doesn't have a cell wall"

"I learnt that it's so easy to take out cheek cells"

"I learnt that mitochondria gives us energy"

Focus group findings

- The students in the focus group had already covered cells, but the dome helped enrich their learning;

"We thought it would just be a round nucleus and just a few dots of other stuff but when we went inside the dome and saw inside it, it gave us a lot on view. We did make models before we went inside it but if we were to make models now it would have taken us a lot more time and it would have been a lot more interesting models."

"There was stuff that we did learn before but it was a new way of learning it again. I remember a lot more from the dome than from sitting around looking at books."

5 Opinions of teachers

5.1 Sample

Sixteen teacher questionnaires were collected. The sample can be broken down as follows:

Show	Sample size
Astronomy show	9
Light and colour show	5
Cell biology show	2
Total	16

5.2 Rating the shows

Teachers were asked to rate various elements of the show on a five point scale from 'very good' to 'very bad'. Results for each of the three shows are summarised below.

Element	Astronomy show	Light and colour show	Cell biology show
Overall impression	9 x very good	3 x very good 2 x good	1 x very good 1 x good
Science content	8 x very good 1 x good	4 x very good 1 x good	2 x OK
Presenter/s	8 x very good	3 x very good 2 x good	2 x good
Images	8 x very good 1 x good	1 x very good 2 x good	2 x OK
Videos (if used)	2 x very good		1 x very good
Interactive element	4 x very good 1 x OK	1 x very good 2 x good	1 x good

Results for each show are now discussed in greater detail.

5.3 Astronomy show

The Astronomy show received the highest overall ratings from teachers. All of the nine in the sample rated their overall impression as 'very good'.

Teachers generally felt that the science was pitched at an appropriate level for the students and that it built on aspects of the curriculum they had already

covered. The use of accessible language was also highlighted as a success factor:

“Yes, drew on knowledge some had already and extended knowledge just enough so they could still understand”

“Yes - we are doing a unit on Earth, Sun and Moon and it was reinforcing some of the work we had covered - in a much more 3D way than is possible with our own resources”

“Presenter used language that made the science accessible to the children”

However one teacher picked up on the fact that students may not have fully understood the difference between stars and planets, supporting the findings of the student questionnaire study:

“Difference between planets / stars less well understood”

The pictures and videos were well received by teachers, who felt they appealed strongly to students:

“Excellent star / pictures and graphics effects”

“The build up from stars to constellations and then zodiac signs was a definite 'wow' moment”

Teachers were asked whether they felt dome shows made science more exciting for students and whether they felt there were any other impacts on students. Several factors were raised in the responses. The first was the **novelty** of the dome:

“Definitely more exciting as it is a safe / controlled environment to look at night sky and stars. Very inspiring for small children”

“The novelty of location and an outside speaker help make it special. The presentation format was so different to normal lessons [which] made it exciting. It was not a stereotypical lesson style / science teaching”

“It's pitched at the right level and a very different way / environment for them to learn in”

Teachers also highlighted the fact that the dome appeals to students with a **range of learning styles**:

“Yes because of lack of writing etc. They get more from 'shows' all in one go”

“Visual stimulus - some children retain more facts than using textbooks”

The **educational value** of the show was also commented on:

“Space so vast that a resource like this enables children to understand how things on this scale interact with each other”

“Increases their understanding of scientific principles. Is a memorable event for them to recall and reflect on in future science topics”

Some teachers also described the way the show could **inspire** students:

"It might be aspirational for the curious / more able, raising questions that they might want to follow up later. It counteracts their perceptions of science"

"Some children are asking for telescopes for xmas"

Towards the end of the questionnaire, teachers were asked to suggest improvements for the dome. Ideas included:

"Pre-visit notes for teacher/pupils. Follow up activity sheet for pupils. Leaflet for parents - to take home and share their child's learning"

"The presentation had a predetermined pace and had no 'down time' for them simply to look and wonder. If they could have chatted about what they saw, I feel they might have listened more attentively during the 'instruction' time. It was such a unique presentation, it seemed a pity we couldn't stay longer."

"Larger dome or smaller groups"

"Maybe ask children to find specific things on the dome or encourage children to give their own ideas more"

5.4 Light and colour show

All of the five teachers in the sample rated the Light and colour show as 'good' or 'very good' for all of the elements listed in the closed form part of the questionnaire.

Their comments in the open questions indicated that the dome was popular with students. All but one of the teachers felt that the science was pitched at an appropriate level; although it is interesting to note that one teachers perception of KS3-level content is similar to what another teacher feels is appropriate for Year 3 and 4:

"A good level for 3 / 4"

"Bit high - more KS3 with the language and learning"

"Children enjoyed it. Had a great conversation with class afterwards, but mostly about space because of 'light speed'"

"Pace and pitch very suitable for year of children; interest level high"

"I thought it was pitched just right"

"Yes - it also had some wow factor. They were able to answer questions and ask sensible ones of their own."

When asked about the impact of the dome, teachers felt it offered an **enjoyable and memorable learning experience** for students:

"Everything different and visual seems to bring science alive for the children"

"Because it takes them out of the classroom into a new environment and the darkness helps focus the mind on the show"

"Gives them an experience beyond what can be offered by teachers in the classroom"

"Puts the knowledge into an environment they can remember. Teacher can say 'Remember the dome'"

"For many it was highlight of week - looking forward to the visit. For one or two who previously unimpressed by science began to see it as something [more] amazing than what experienced before"

The main suggestion for improvement was to let students participate in the demonstrations. This was incorporated into the show that the focus group students saw and they enjoyed that aspect.

"Let children have a go at making the rainbow or holding the objects. Have a question and answer session - Have vocab to learn in lights!"

"Although it is difficult with 30 pupils on the floor - but some pupil interaction would be good - show some effects twice so pupils know what they are looking for"

5.5 Cell biology show

Only two teachers (from the same school) returned questionnaires about the Cell biology show, so the feedback here is not as detailed. Both teachers rated the show as 'good' or 'very good' overall.

Interestingly, the two teachers had opposite opinions about the level of the science in the show, possibly because they teach different sets. When asked whether the science was pitched at an appropriate level, their responses were:

"Yes. With top set a little more explanation of organelles would have been good"

"No - a little too high"

The teachers agreed with the students in the focus group that the initial realistic animation of the cell was very good. However they felt the quality of the remaining slides in the presentation were poor and that this detracted from the overall learning experience. Their comments included:

"The animation inside the dome makes it exciting but that alone does not make a good learning experience"

"Some images poor (fuzzy)"

"The animation generates a lot of interest. The slides are poor"

Two teachers commented on the interest in cell biology stimulated by the show – one of these also saw the Light and colour show, and commented on the Cell biology show in that questionnaire:

"Excited about science especially what they will learn in upper school on cells"

"I have been in the 'cell' and liked the way they interwove the learning by doing a drama/story. The cell was way over the heads of the Y7 I took, but they remembered loads and enjoyed the topic more when we did 'cells' in class - more than the ones who didn't see it."

6 Science centre staff development

Seven science centre staff were directly involved in the project. All were interviewed near the end of the project to reflect on their experiences. A number of successes and challenges were identified, which are summarised here:

6.1 Successes

Project outputs

- Partners were pleased with the **project outputs** – the shows, domes and technology. There is also the potential to develop further shows with the equipment.
- The project allowed the centres to **diversify their outreach** offerings. As well as allowing one centre to now offer dome shows, centres can offer outreach to a wider range of audiences, including secondary schools and adults. This has the potential to greatly contribute to the sustainability of individual centres.
- The **animation** commissioned for the cell show was cited as a successful output of the project.

Partnership

- Many aspects of partnership working were described as successes. The opportunity to offer **staff development** for partners was valuable: consortium members were able to share ideas and experiences.
- The **positive working relationship** between partners was highlighted as a success by many. This was facilitated by a **good coordinator**.
- The **complementary backgrounds** of those involved in the partnership worked well – all were experienced deliverers with different areas of scientific expertise. Comparing experiences from different centres was also valued.
- The **writing days** provided the time and space to have ideas and discuss them together, ensuring the show outlines were developed in collaboration. The days also allowed consortium members to get to know one another, facilitating communications for the remainder of the project.
- The **consortium** will continue to work together – they have just successfully bid for STFC funding to develop a new dome show based on the atom.

Raising profile

- The project acted to **promote the centres** and their outreach services with schools. One staff member described it as ‘a good reason to remind schools about our outreach service’.
- Receiving SCEAG funding was also felt to **raise the profile** of the centres within the wider professional community.

6.2 Challenges

Working collaboratively

- Many partners realised that **collaborative working is a slower process** than working autonomously. The extent to which this could delay elements of the project was underestimated in some cases.
- Linked to the above point, many partners were involved in delivery and all had **different working patterns**. So communication could sometimes be slow.

Logistics

- **Cashflow** was an issue because of the large proportion of the grant that was to be spent on equipment. Show development stalled because the first grant claim wasn't sufficient to cover the costs of the domes and projectors.
- **Sourcing the domes** was problematic. There are few suppliers and the one chosen was based in Australia, which made communication difficult. This meant it took longer to actually buy the domes than anticipated.
- More time was needed to **develop the shows** than was budgeted for in the project proposal.

Staff change

- A **key member of staff left during the project**. He was responsible for developing the pre- and post-visit materials. This meant that these were not completed during the funded period, which was frustrating. In future partners felt they might outsource such work. However they will be completed in the near future and rolled out with the dome shows.

6.3 Learning points

In the interviews, partners mentioned a number of learning points that they would take forward into future projects:

- Thinking carefully about which aspects of the project can be realistically delivered by centres and which might be better outsourced.
- Ensuring that time spent on development is sufficiently covered by the funding procured (by asking for more funding if necessary!) This could be either by funding more staff time or funding a part-time post in each centre.
- Allow extra time for communications and decision-making when working collaboratively.
- Including another time for everyone in the consortium to get together midway through or later in the project would enhance communication.
- Using suppliers in the same country or continent where possible would help sourcing materials run smoothly.
- Communicate with funders earlier about potential cashflow issues.

7 Conclusions

This section will refer to the project's initial aims and comment on how they have been addressed.

7.1 To provide and advocate a unique learning environment using state-of the-art, versatile, digital mobile dome technology

The dome shows successfully addressed four of the five Generic Learning Objectives. Students enjoyed the dome activities, and significant learning and positive attitudinal shifts were measured using the questionnaires.

Teachers identified the fact that the dome brings a **non-classroom learning environment** into the school. The immersive nature of the dome was achieved either by using 360° projection or by using the dome as a darkroom. Both techniques successfully created engaging learning environments, and teachers highlighted the **visual nature of the shows** as appealing to students with a range of learning styles. They also created **memorable experiences** that teachers felt they could draw on later when covering similar material in class. One teacher that had taught a group that had seen the cell show said their knowledge was significantly higher than a group that had not seen the show when they came to cover the material in class.

Students themselves also articulated the visual nature of the dome shows as **helpful with their learning**. One student explained how she usually finds science difficult, but found the Astronomy show an accessible and therefore enjoyable way to learn. Year seven students were very clear about the way that the cell biology show had extended the material they had covered in class.

As well as helping students learn about the topics covered by the shows, they appear to have had an impact on students' **attitudes towards science**. Several significant shifts were measured using the before-and-after attitude scales. The most consistent across the three shows were shifts on the sub-scale defined by Pell and Jarvis (2001) as 'what I really think about science'. Students were more likely to reject the notions that lots of work was required, or that they do too much science at school, after the shows. This was supported by feedback that showed students liked the shows and found them fun and useful. A popular response when asked if the show had changed how they felt about science could be described as '*it made science fun*'. In addition, significant increases in the number of students agreeing that they 'liked school'; and 'should like to be a scientist' were recorded after the Astronomy show.

The evaluation data noted some areas where the shows could be improved, however the evidence indicates that the dome shows were an enjoyable way to support and enrich the curriculum.

7.2 To enhance overall sustainability of consortium member centres through an enhanced outreach service

The project undoubtedly **enhanced the outreach service** of the three centres. Two already had mobile domes, however one dome was on loan from another centre and the other was unreliable leading to problems with some shows. So a valuable output identified by partners was the equipment the grant afforded. All centres are now delivering the three shows as part of their outreach offerings. Several partners felt that developing the Cell biology show was particularly useful as it allowed them to extend their work with secondary schools. They also felt that the equipment would allow them to develop shows for a wider range of audiences, so diversifying their outreach and contributing to sustainability.

All centres successfully targeted schools they had **not worked with previously**. It is too soon to tell whether this will lead to centre visits or repeat bookings from the schools, but the students in the focus groups felt motivated to visit the centres after experiencing the dome shows.

Working collaboratively also added significant value here. One consortium member summed this up as '*we worked on one show but gained three*'. While each centre acknowledged that they could have developed shows alone, the shows would not have been developed so quickly to roll out to schools.

7.3 To develop pre and post visit materials and CPD opportunities that meet teachers' needs

This aim was not met during the funding period, although the materials are still under development and will be rolled out with the shows in future. The consortium member leading on this aspect left the centre suddenly which severely slowed development of the materials.

In future, consortium members felt they could outsource development of some of these materials to avoid a similar situation.

7.4 To foster relationships in a spirit of dissemination of best practice between centres with varying needs, skills and experience

Consortium members felt that the partnership was **effective and beneficial**. It allowed different centres to share the ways in which they worked and gave staff members a sense of how outreach is delivered in other centres. The fact that different consortium members had different areas of scientific expertise was valuable in developing the different shows.

The consortium is planning to work together again in the near future: they have just successfully bid for funding from STFC to develop a new dome show based on the atom.

Appendix 1


- Example questionnaire – Astronomy show second stage questionnaire
- Teacher questionnaire
- Focus group schedule

What do you think about science?

We are doing a study to find out what children think about science. Please tell us what you think by answering these questions.

Please  write your name.....

Circle one: are you... male  female 

Please  write your age years

Please  write your year group

What do you think about science at school?

Colour in the smiley face that shows how you feel.

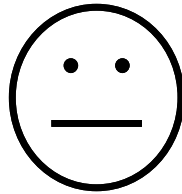
Practice: I like eating ice cream



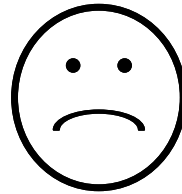
Strongly agree



Agree



Neither agree nor disagree



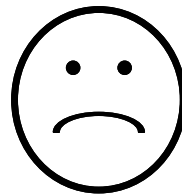
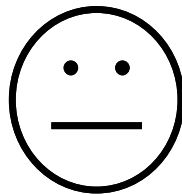
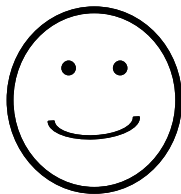
Disagree



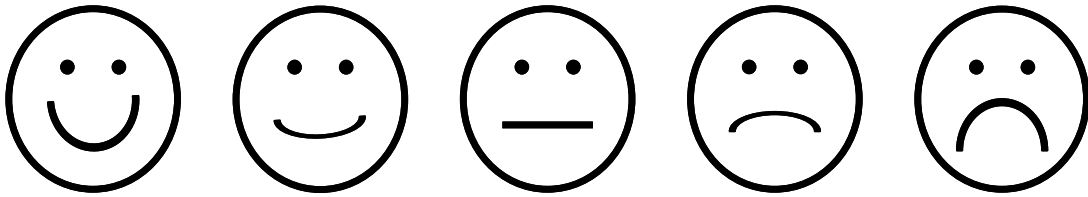
Strongly disagree

Now for the questions

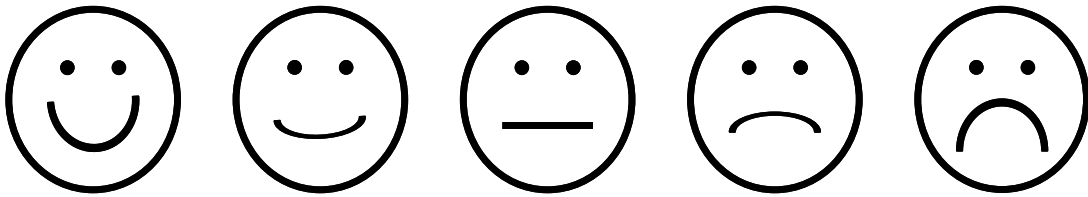
1. I like coming to school



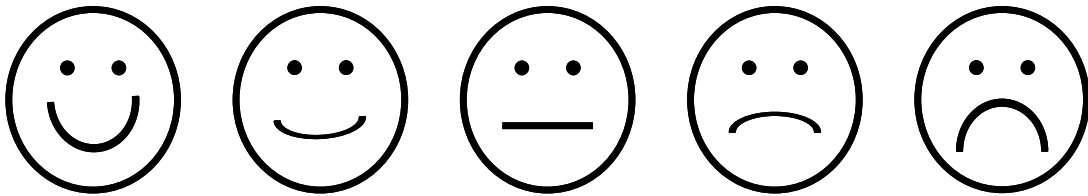
2. We have to do too much work in science



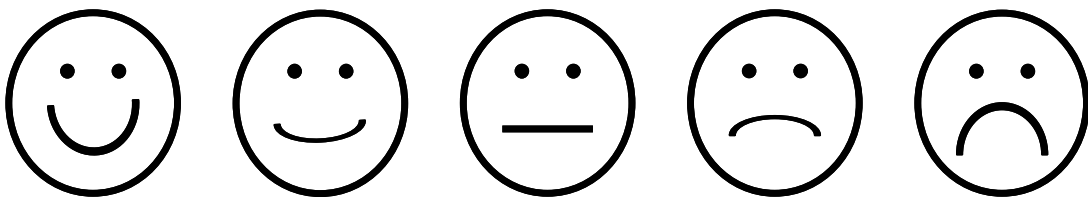
3. I should like to be a scientist



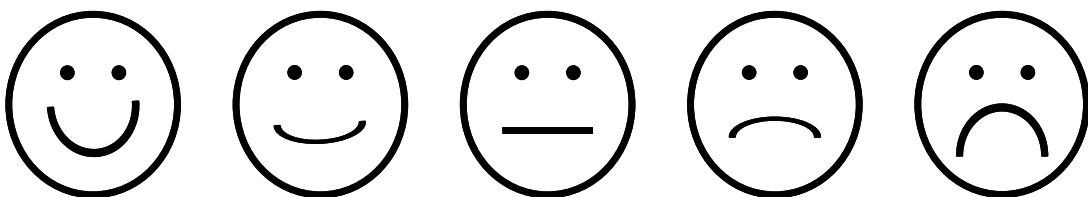
4. Science is good for everybody



5. Science is just too difficult

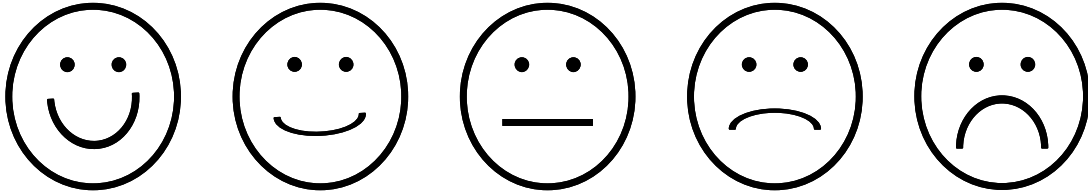


6. Science makes me think

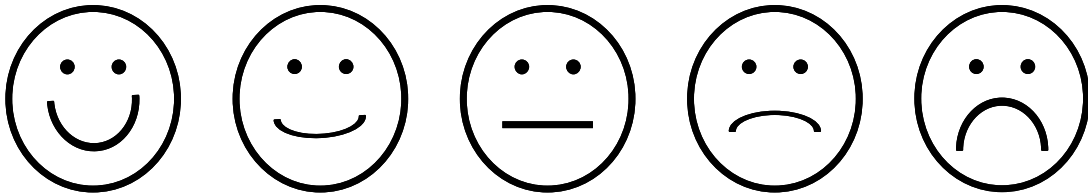


Empty rectangular box for student name or ID.

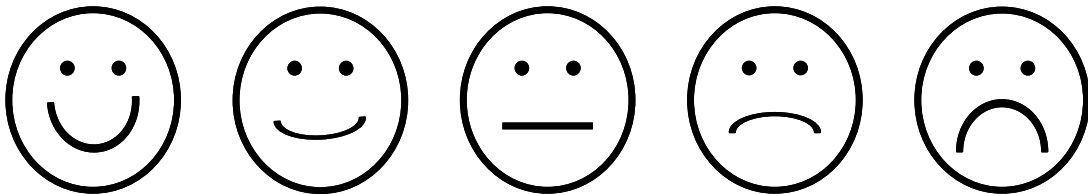
7. I like to watch science programmes on TV



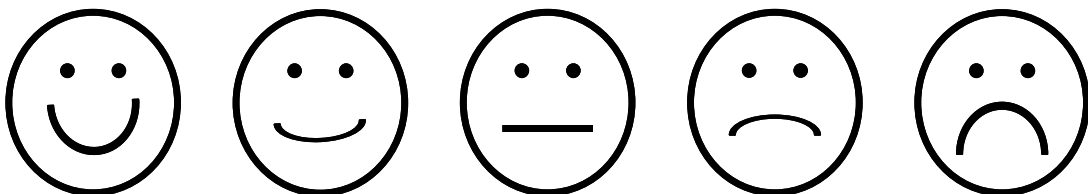
8. We do too much science at school



9. I like science more than any other school work



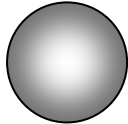


10. We have to do too much writing in science





What do you know about space?

Put these objects in order of size. The first one is done for you:

Galaxy	Universe	Person	Planet	Star	Moon
 BIGGEST smallest					
Universe _____	_____	_____	_____	_____	_____

Use the words to complete the sentences:

reflects	stars	planets
----------	-------	---------

..... give out light, but don't. We can see the Moon because it light from the Sun.

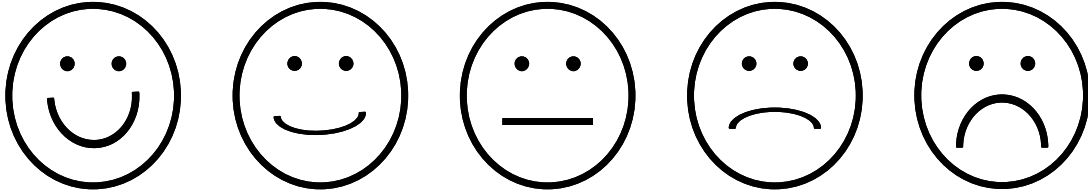
year	day	the Sun	the Earth
------	-----	---------	-----------

The Earth goes round Each orbit takes one
 The Earth spins on its axis once a
 This gives us day and night when different sides of the planet face the Sun. The Moon orbits (goes round) the

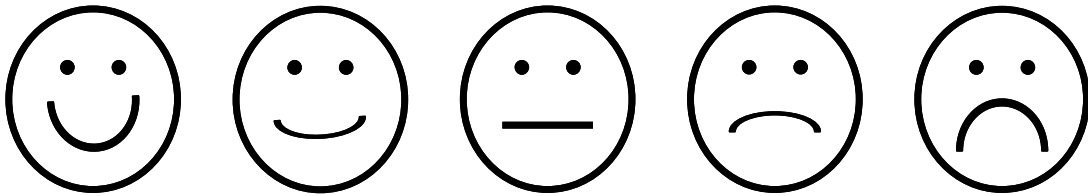
What did you think of the dome show?

These questions are about the dome show. Colour in the smiley that shows what you think.

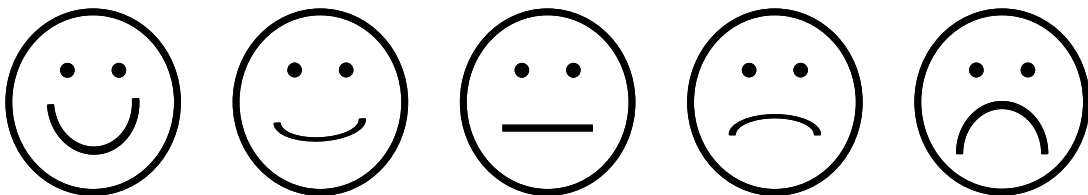
11. I liked the show



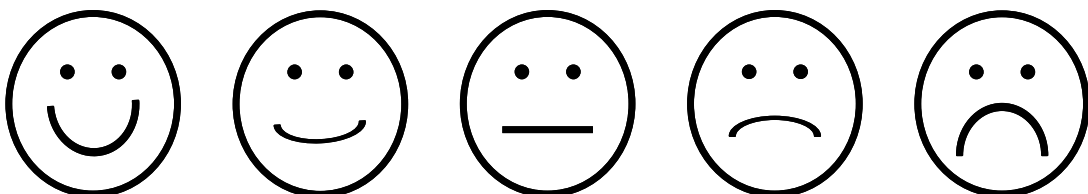
12. I learned lots from the show



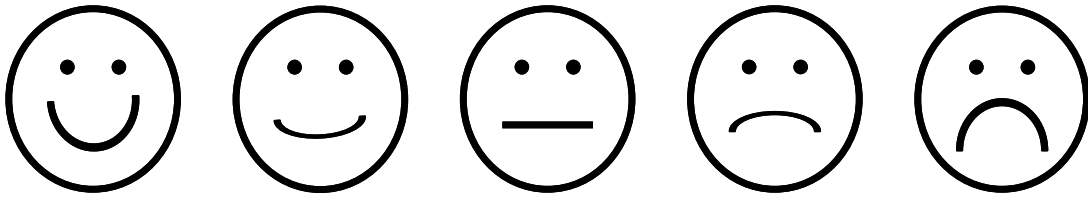
13. The show helped me with my science



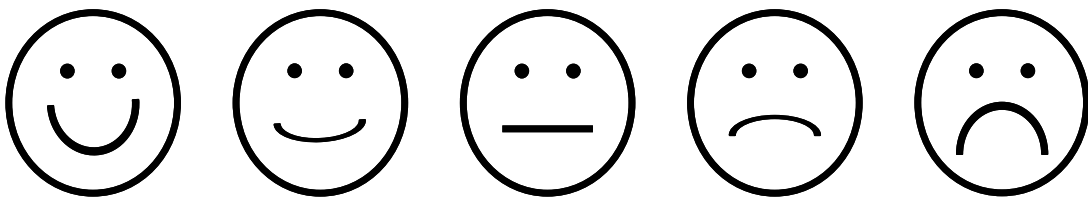
14. I liked the pictures and videos



15. The show was a fun way to do science



16. The show made me like science more



Here are some **words about the show.**

Circle the ones you agree with:

- useful
- fun
- nice
- scary
- cool
- clever
- too hard
- boring
- exciting
- dull
- too easy
- weird



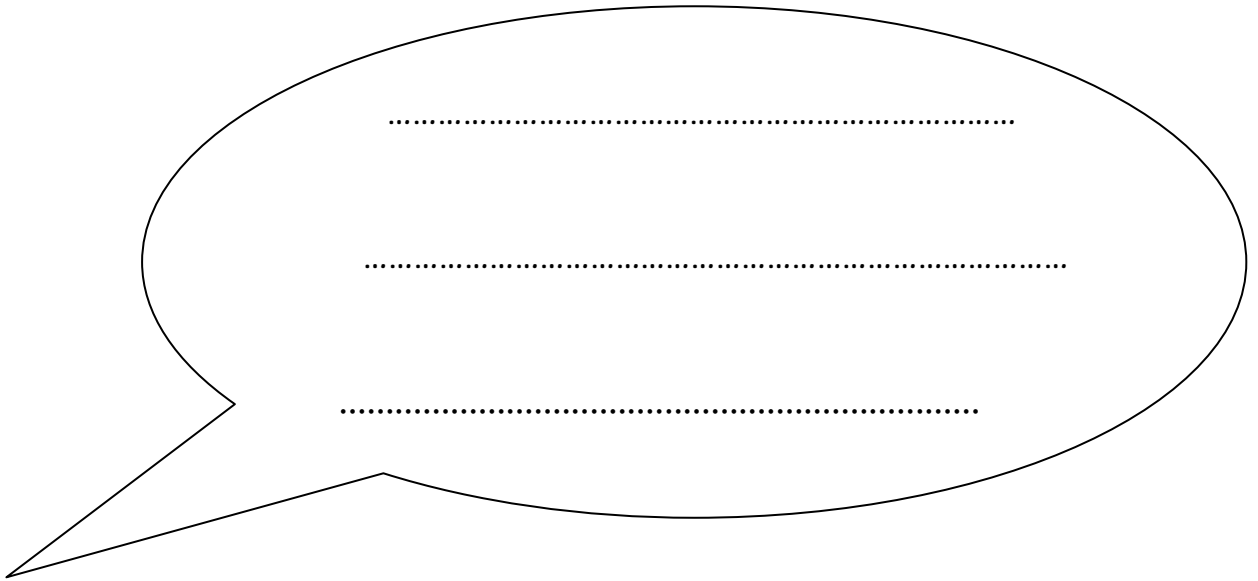
Write some more words if you like:

.....

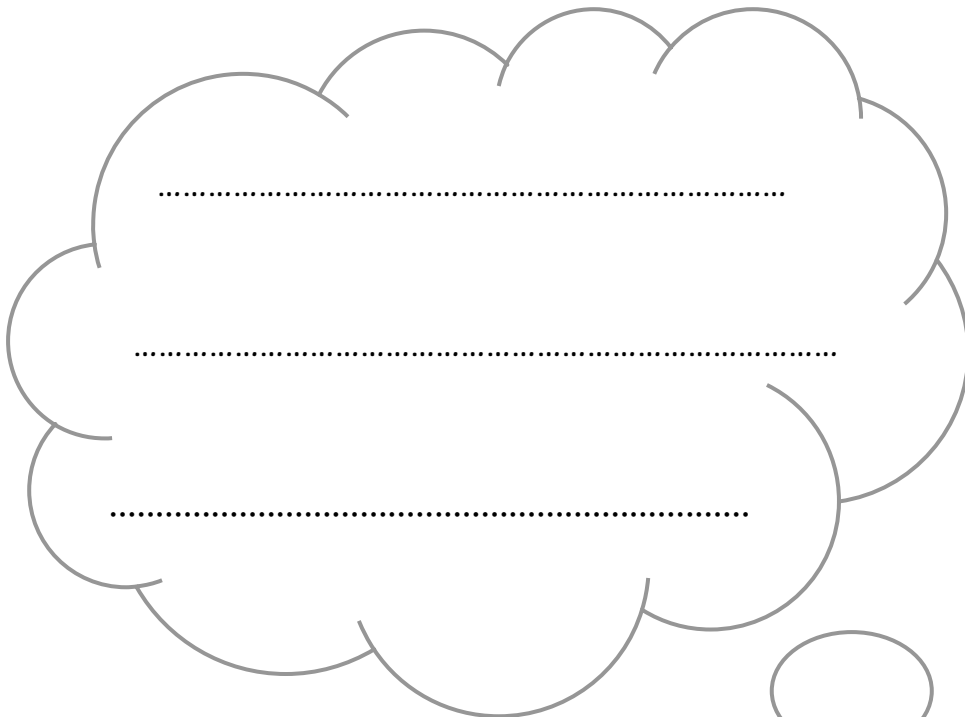
.....

.....

Please tell us something you think you learned from the show:



Did the show change how you feel about science? If so, how?



Thanks!

Teachers – what did you think about the Dome show?

We are interested in your thoughts about the Dome show your class recently participated in. We value your feedback and will use your comments to help tailor future activities more closely to your needs. Please tick the relevant box or write your comments in the spaces provided – thanks!

Student year group

School

Which activity did your class take part in?

- Cells
- Space
- Light and Colour

1. Overall, **what did you think** of the Dome show?

	Very good	Good	OK	Bad	Very bad	Don't know
Overall impression	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Science content	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Presenter/s	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Images	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Videos (if used)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Interactive element	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

2. Please describe your **overall impression** of the Dome show

3. Do you think that the **science** was pitched at an appropriate level for your students?

4. What did you think about the **graphics and videos**?

5. What, if anything, do you feel your students **learned** from the Dome show?

6. Do you think that events such as the Dome show make science **more exciting** for the students? Please tell us why you think this

7. Do you think that events such as the Dome show have **any other impacts** on students? Please tell us why you think this

8. What did you think of the **support materials**?

9. How could we **improve** the Dome show?

10. Do you have **any other comments** about the Dome show?

Thanks!

Projecting science focus group schedule

NB Plain bullet points are questions, bold italics are exercises.

A Introduction (~5 mins)

- Introduce group members
- Explain ground rules, recording and confidentiality

B Thinking about the show (~20 mins)

- ***The best and worst bits of the show.*** Use flashcards with the different elements of the show written on them and ask participants to rank them on a scale from a smiley face to a sad face. Ask each student to place a single card on the scale and give a reason for why they think it is good or bad. After all the cards have been laid down the group can discuss whether they would change the order of the cards. Include some blank cards so that students can add other elements if necessary. If this section is running over time an alternative is to go around the group and ask them to name one thing they liked and one thing they didn't. In both cases, follow up by asking how the show could have been improved.
- ***Write down one word that describes your experience of the show.*** Thoughts box activity: facilitator reads out all the answers then starts a discussion.
- ***What, if anything, did you learn from the show?*** Either write down and place in thoughts box (for older students) or go round the group one at a time. If the latter give them a few moments to think about it first.

C Thinking about science (~10 mins)

- How do you feel about science?
- Did you realise that science was being taught in the dome?
- Do you think the dome changed how you feel about science? In what way? Why do you think that is?

D Thinking about Science Centres (~10 mins)

- Does anyone know where the dome came from?
- Has anyone been to a science centre?
- Could you describe what a science centre is like to someone who hasn't visited one?
- Do you think something like the dome would encourage more people to visit science centres? Why or why not?

Appendix 2

- More detailed data

Attitude scale results

<i>Astronomy show</i>	<i>% before</i>					<i>% after</i>					<i>p</i>
	<i>SA</i>	<i>A</i>	<i>N</i>	<i>D</i>	<i>SD</i>	<i>SA</i>	<i>A</i>	<i>N</i>	<i>D</i>	<i>SD</i>	
1. I like coming to school	28	34	28	3	7	33	35	25	2	5	0.007**
2. We have to do too much work in science	11	17	43	16	12	5	9	41	22	22	0.0**
3. I should like to be a scientist	15	9	17	15	43	19	10	21	15	35	0.03*
4. Science is good for everybody	35	29	28	4	3	36	28	24	7	5	0.5
5. Science is just too difficult	7	7	36	21	29	7	7	32	21	33	0.6
6. Science makes me think	45	34	14	4	3	41	38	11	5	4	0.5
7. I like to watch science programmes on TV	24	15	21	15	25	22	17	23	18	19	0.3
8. We do too much science at school	8	11	31	26	24	3	10	37	29	21	0.4
9. I like science more than any other school work	10	11	20	16	43	13	6	22	21	39	0.5
10. We have to do too much writing in science	12	16	35	20	17	13	11	28	30	19	0.1

Percentages may not total 100% due to rounding
**denotes significance at the 95% confidence interval*
***denotes significance at the 99% confidence interval*

<i>Light and colour show</i>	<i>% before</i>					<i>% after</i>					<i>p</i>
	<i>SA</i>	<i>A</i>	<i>N</i>	<i>D</i>	<i>SD</i>	<i>SA</i>	<i>A</i>	<i>N</i>	<i>D</i>	<i>SD</i>	
1. I like coming to school	16	47	24	6	8	22	37	30	4	7	0.2
2. We have to do too much work in science	10	15	31	26	18	4	10	33	23	30	0.002**
3. I should like to be a scientist	6	9	22	23	41	6	9	22	22	41	0.9
4. Science is good for	30	33	27	8	2	33	29	24	8	7	0.4

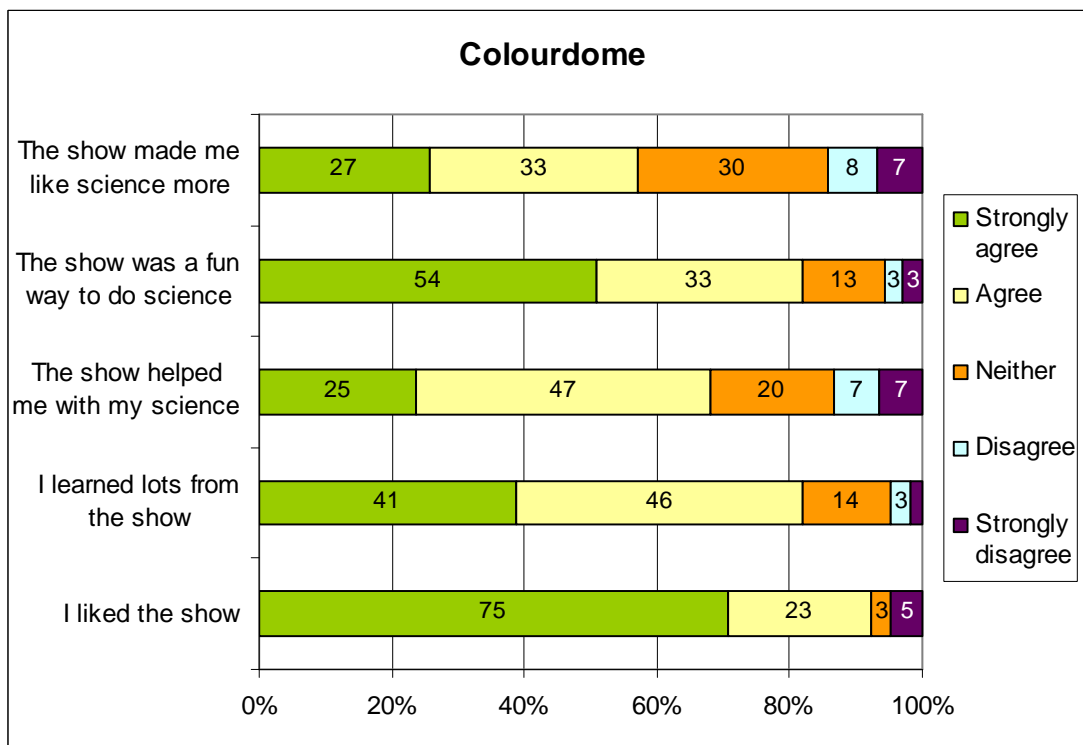
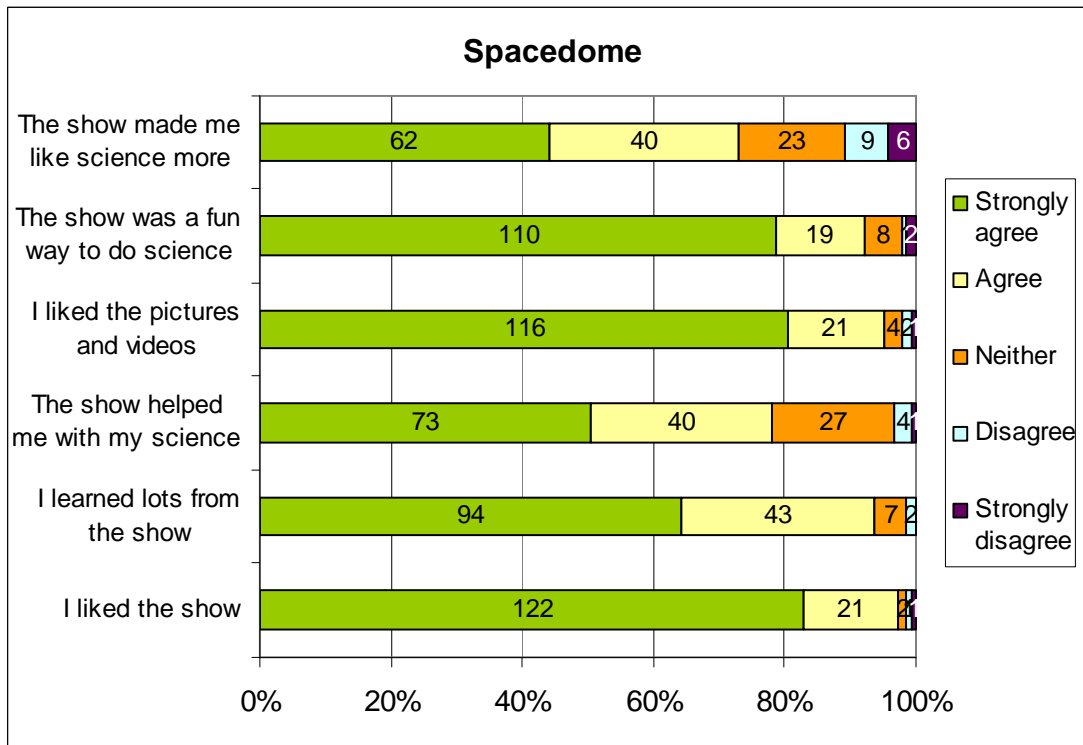
everybody												
5. Science is just too difficult	9	9	31	24	27	7	7	32	27	28	0.5	
6. Science makes me think	44	35	9	6	7	42	34	18	4	3	0.9	
7. I like to watch science programmes on TV	19	17	23	16	25	17	18	29	12	24	0.3	
8. We do too much science at school	6	9	25	18	42	7	4	30	24	36	0.9	
9. I like science more than any other school work	11	8	24	18	39	8	11	17	27	38	0.5	
10. We have to do too much writing in science	10	11	26	27	25	7	9	30	31	23	0.6	

*Percentages may not total 100% due to rounding
 *denotes significance at the 95% confidence interval
 **denotes significance at the 99% confidence interval*

Cell biology show	% before					% after					p
	SA	A	N	D	SD	SA	A	N	D	SD	
1. I like coming to school	7	53	32	3	5	10	48	36	3	3	0.6
2. We have to do too much work in science	3	22	35	33	7	3	20	39	29	9	0.9
3. I should like to be a scientist	3	12	25	30	31	3	5	24	48	20	0.8
4. Science is good for everybody	17	41	36	5	0	14	49	29	7	2	0.9
5. Science is just too difficult	2	2	39	42	15	0	3	31	54	12	0.4
6. Science makes me think	32	63	3	2	0	22	68	9	2	0	0.06
7. I like to watch science programmes on TV	12	27	20	22	19	7	37	29	20	14	0.7
8. We do too much science at school	0	5	33	45	17	2	10	34	44	10	0.05*
9. I like science more than any other school work	9	9	25	48	10	10	9	27	48	7	0.2
10. We have to do too much writing in science	17	24	31	25	3	12	31	29	19	10	0.5

*Percentages may not total 100% due to rounding
 *denotes significance at the 95% confidence interval
 **denotes significance at the 99% confidence interval*

Further questionnaire data – closed responses



Celldome

