

Fusion Sun Dome

Evaluation report

Prepared by

Laura Grant  **associates**

**2nd Floor
7-13 Cotton's Gardens
London E2 7BE**

June 2008

Contents

1	Introduction.....	3
1.1	Overview.....	3
1.2	Project aims.....	3
2	Evaluation methodology	4
2.1	Pre-research.....	4
2.2	Pilot	4
2.3	Rollout evaluation	4
3	Delivery metrics	5
4	Pilot feedback	6
4.1	Pre-research.....	6
4.2	Pilot findings	6
5	Evaluation findings.....	7
5.1	Opinions about the shows	7
5.1.1	<i>Rating the show.....</i>	7
5.1.2	<i>The dome venue</i>	9
5.1.3	<i>Opinions about the videos.....</i>	9
5.1.4	<i>Opinions about the interactive game</i>	10
5.2	Educational value	11
5.2.1	<i>Level of science content.....</i>	11
5.2.2	<i>Learning styles</i>	11
5.2.3	<i>Learning outcomes.....</i>	12
5.3	Attitude change.....	14
5.3.1	<i>Students' comparisons of science at school and in the Dome</i>	14
5.4	Other impacts	16
5.5	Further comments	17
5.5.1	<i>Suggestions for improvement</i>	17
5.5.2	<i>Further comments</i>	17
6	Conclusions	18
7	Recommendations.....	20
	Appendix.....	22

1 Introduction

1.1 Overview

The Sun Dome project was delivered by Culham Science Centre and funded by EPSRC's Partnerships for Public Engagement (PPE) Grants Scheme. It involved developing a dome show and related drama activity about the Sun and nuclear fusion. The project ran from January 2006 to March 2008.

This report summarises the findings of the pilot stage of the evaluation and provides detail on the evaluation findings from the rollout phase of the project. The full pilot report and evaluation materials are provided as appendices.

1.2 Project aims

The project had the following general aims:

- Improve the image and interest in science among students. The dome shows (visual and theatrical) will use, wherever possible, young and energetic fusion researchers.
- By employing the show at local schools' science fairs, within local schools and for local students visiting Culham, improve the image of Culham Science Centre amongst the local community. The Laboratory is sometimes perceived as secretive and dangerous. Local students and schools are well placed within the community to portray and spread a more realistic, positive image.
- By describing the fusion process and stressing the importance of this process as a future energy source, provide some relevance and depth to some aspects of the science national curriculum (e.g. atoms, states of matter, energy, climate change, sustainability). In a society where numbers in the further education science community and scientific literacy are at an all time low, sparking an early interest and involvement in science is very important.

The following specific objectives were also set at the start of the project:

- By attending major local and national science festivals (e.g. BA Science Festival, Edinburgh Science Festival, Cheltenham Science Festival, Oxford Festival of Science) and touring the Dome to local schools, aim to interact with an audience of 5000 10-14 year old children per year.
- After engaging in the Fusion Sun Dome, increase the numbers of students that understand what the fusion process involves and how, in simple terms, it releases energy.
- After attending the Fusion Sun Dome, increase or engender a positive attitude to fusion – and how this technology can contribute to a cleaner, more sustainable society in future.

2 Evaluation methodology

The proposed evaluation method had four elements:

- Pre-research with a focus group of teachers;
- Pilot evaluation using teacher questionnaires and student focus groups;
- Teacher questionnaires during the rollout phase;
- Student questionnaires during the rollout phase.

2.1 Pre-research

Following scoping of the show content, a focus group involving both primary and secondary science teachers was conducted. Eight teachers attended the twilight discussion which was held on 15th June 2006.

2.2 Pilot

Pilot performances were conducted in January 2007, and six focus groups with Year 5 and 6 students were conducted. Teachers were also asked to complete questionnaires. The pilot was an opportunity to gather the opinions of the show's target audiences to further refine its content.

In addition, the pilot phase allowed valuable testing of the mobile venue. Issues relating to set-up times and potential venue constraints were identified.

2.3 Rollout evaluation

Teachers were asked to complete questionnaires after the shows. The original idea was to conduct a questionnaire study of students in a sample of one in ten shows. However, following feedback at the pre-research stage, the age range of the target audience was lowered to include only KS2 students. This made the idea of the student questionnaire survey unrealistic, as it would take the students much longer to complete the feedback due to less developed literacy skills. An alternative exit poll method for collecting feedback was trialled, but the information collected did not provide sufficient depth. So questionnaire feedback was replaced with a further series of four focus groups conducted in February 2008, near the end of the project.

3 Delivery metrics

The pilot shows took place in January 2008. After the shows were adapted, they were rolled out at schools and science festivals between March 2007 and June 2008 inclusive. A summary of the audiences reached is given below:

Period	Number of shows	Number of students
Pilot: January 2007	11	200
March - December 2007	100	2200
January - June 2008	130	2752
Totals	241	5152

The ambitious target of reaching 5000 young people was exceeded by the end of June 2008, although the original project period ended in March 2008. More bookings for the Sun Dome have already been secured for July 2008 and beyond. It was difficult to keep track of audience numbers during the course of the project, so if anything these are probably an underestimate.

This is a great achievement by the project team and it required bringing a full-time science communicator on board to meet demand during 2008. The time and energy required to deliver the shows was somewhat underestimated at the start of the project. The plan is to train more researchers to deliver shows in future.

4 Pilot feedback

4.1 Pre-research

The feedback was incredibly useful and highlighted the fact that a similar show would probably not be suitable for both KS2 and KS3 students, as planned in the proposal. While the primary teachers felt their students would enjoy the interactive drama element of the performance, the secondary school teachers felt a discussion or debate activity would be more suitable for their students and would like to see a greater proportion of the show devoted to issues around sustainability.

The development of two distinct shows, one for KS2 and one for KS3, was beyond the scope of the original project proposal. So a decision was made to focus on KS2 audiences initially, with a view to seeking further funding in future to develop a KS3 show in line with teachers' suggestions.

4.2 Pilot findings

The pilot shows were delivered in January 2007 to Year 5 and Year 6 students in four schools over the course of the week. The evaluator visited two schools and conducted six focus groups with students.

The feedback indicated that students enjoyed the shows greatly and compared them favourably to other science enrichment activities, some of which they had found patronising.

However, a need to make some of the language more accessible was identified. Other changes made as a result of the pilot were clearer instructions during the interactive game, clear guidance when students enter the dome on how they should lie down and orient themselves, changes to the lengths of different sections within the videos and the introduction of a short reflection session at the end of the event.

The name of the activity also changed over this time. Prior to the pilot, the team decided to rename the Sun Dome the 'Solar Sphere' as they felt it sounded more exciting. However in the focus groups it became clear that none of the students could recall the name of the activity as it used unfamiliar words to them. So the team decided to go back to the original title of Sun Dome.

A copy of the full pilot report is given in the Appendix.

5 Evaluation findings

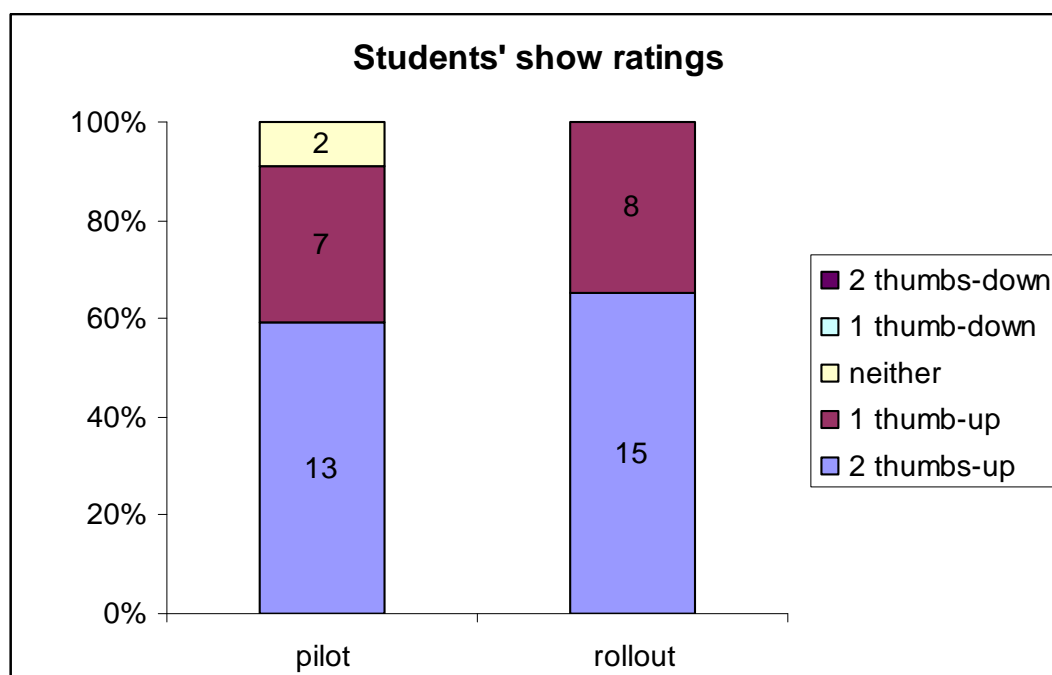
32 teacher questionnaires were collected over the course of the project; 8 during the pilot phase and a further 24 during the project rollout.

Ten student focus groups were conducted in total, six during the pilot (38 students) and four after the rollout phase (23 students). In addition, some students completed follow-up work that included an evaluative element.

5.1 Opinions about the shows

5.1.1 Rating the show

Students were asked to rate the show during the focus groups using a five-point thumbs-up / thumbs-down scale, where two thumbs-up was the highest rating and two thumbs-down the lowest. Results are presented in the graph below.



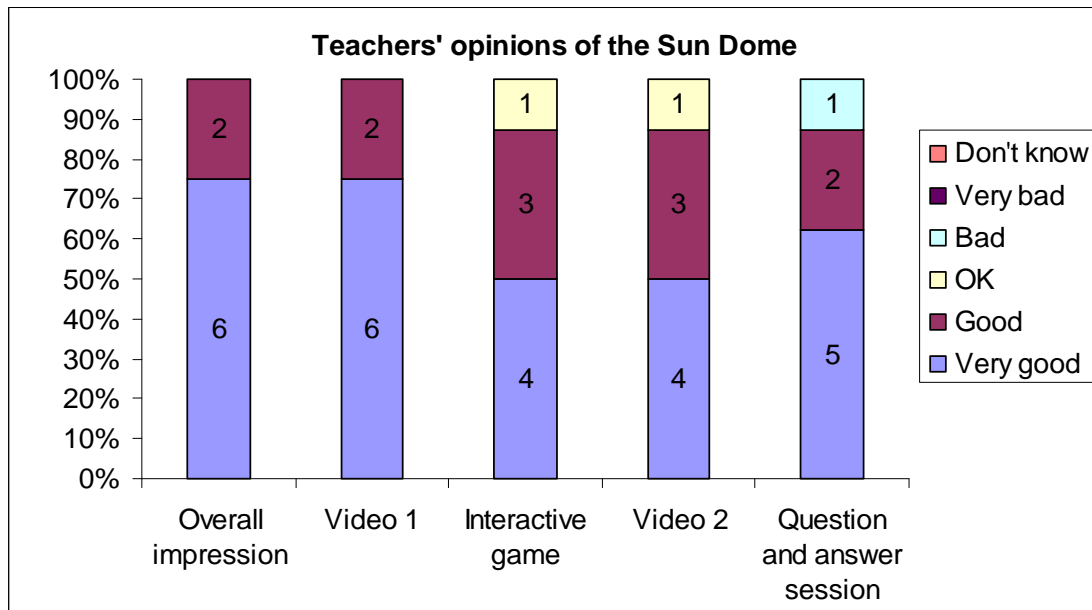
This was not used in all of the pilot focus groups, but it is clear from the results that the majority of students rated the show highly at both the pilot and rollout stages. At the rollout stage, all students rated the show as 'good' or 'very good'.

When asked what they thought about the shows during the focus groups, students were very positive. Comments included:

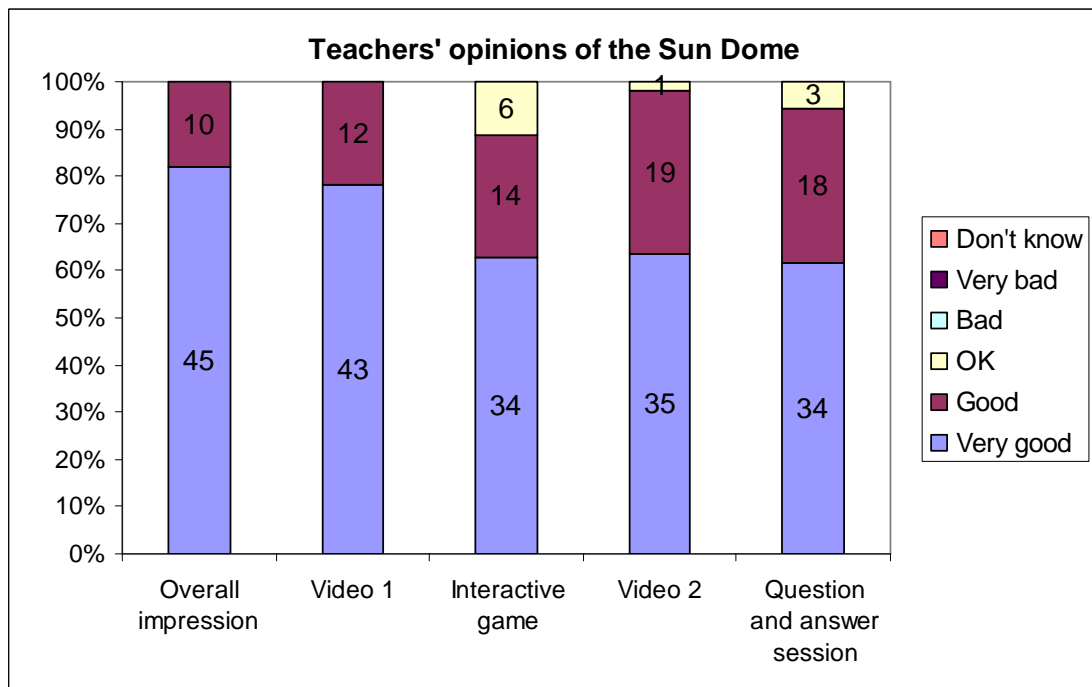
"It's fun to go into a big plastic thing and you get to lie down. It was awesome"

"I think it was quite amazing. It's not something that you do every day"

The graph below shows teachers' opinions of the *pilot* shows:



The graph below shows teachers' opinions of the *post-pilot* shows:



All of the teachers in the survey rated their overall impression of the Sun Dome and the videos as 'good' or 'very good'. The largest improvements appear to be in the interactive game and second video. Following the pilot focus groups, these sections of the show saw the most change so this is to be expected.

Teachers' overall impressions about the show were positive:

"Well organised and prepared. Well informed teacher who engaged the class throughout and was able to cope with the children's awkward questions!"

“Fantastic. It really captured the children’s’ imaginations”

“Superb - quite unlike anything else the children have experienced.

“An engaging educational experience. Especially the interactive session and the focus at the end on the environment and how we can find alternative energy sources”

“An excellent, interactive, exciting and visual way to teach yr 5 and 6 about how atoms fuse and how they create energy”

“Serves its purpose well, children impressed by it. It raised loads of questions (around whole school). Very memorable for children and will be a great reference point in future lessons”

Various themes emerged related to students’ and teachers’ experiences with the dome shows. These are explored in greater detail in the following sections.

5.1.2 The dome venue

The outside of the dome was printed to look like the Sun. This provoked a mixed response from students. They all found it interesting, although for some it was a little scary:

“It was very good because there was like pictures of the sun and it wasn’t blank”

“From the outside it looked a little, a tiny bit scary but when we were inside it was good”

A few teachers also identified the outer cover of the dome as an effective way of stimulating interest and enthusiasm for the activity:

“It certainly created a lot of interest in the school. A lot of the younger children were interested in the exterior of the model”

“It looked great from the outside and like the tardis inside - it seemed more spacious. The colour and pattern of outer shell is very impressive and sun-like”

“If the children had a presentation like this without the dome they would not be interested or switched on”

5.1.3 Opinions about the videos

Students greatly enjoyed the videos, especially because the environment was so immersive:

“It felt like you were lying in front of the sun and looking at all these things. I liked that.”

“I thought it was a really good idea that we got the video and we could lie down and stuff because it made it really 3D”

Teachers’ comments highlighted the visual nature of the videos and the dome environment as success factors:

“The videos were excellent. The children really enjoyed them and they made it real for the children”

“Children enjoyed feeling part of the sun and solar system. Being on a dome, lying down with music made it all the more interesting”

“Music and the 'surround' vision was good”

“V good what a fantastic view of the sun in much more detail than we could explain”

“Children said they felt they were actually at the sun as it was so close! V informative”

“The videos were interesting and informative. The children were fascinated by the images which provoked further discussion in the classroom”

“Overall very impressed - although felt a bit sick! Positioning of children to view - is there a correct way?”

“Once I'd adjusted to the shape of the screen I thought they were excellent. The first one drew more an the awe+ wonder of our solar system and was more suited to a dome shaped screen than a second one”

The most appropriate way to position the children within the dome evolved throughout the programme; initially, when asked to sit within the dome, children complained that it was uncomfortable looking up at the dome. So children were usually asked to lie down inside.

5.1.4 Opinions about the interactive game

Although responses were mixed at the pilot stage, taking the time to get the interactive game right was worthwhile. Students described how the game helped them understand the process of fusion:

“We watched the video and if we hadn't played the game we might not get how it happens”

“I sort of learnt, it sounds weird, but what it would be like to be an atom”

“We had to sort of bang into each other, you had to spin round and show energy”

“It made a lot more sense than if you had read it out of a book”

Teachers highlighted the way the drama game appealed to students with kinaesthetic learning styles and helped reinforce the learning about fusion in a memorable way:

“Good way to explain atoms and energy - Kinaesthetic learning!”

“We couldn't believe that nuclear fusion could be so simple! Hopefully the children will always remember it”

“Good fun - but not sure the children took in the point of sticking together and then producing energy however many were playing this game at playtime”

“The children enjoyed the drama activity. It enabled them to learn through experience and was also timed well so they got to move around in between the 2 dome sessions”

“The children learnt a lot beyond the ks2 curriculum which has hopefully given them a better scientific understanding”

“The game was fun and helped the children to understand better how the atoms work. It also let them run around after still being in the dome. The few simple rules meant that the children felt they could move freely but still provided a structure”

In addition, two teachers described the idea as one to be taken back into the classroom:

“It really helped the children understand the concept and has reminded me of the value of drama in science for my own use”

“I’ll use it again with my class”

5.2 Educational value

5.2.1 Level of science content

Although originally targeted at Years 5 and 6, some students in Years 3 and 4 also saw the show. Teachers generally felt that the show was pitched appropriately for Key Stage 2, which is impressive since fusion is not covered in the curriculum until Key Stage 5 (A level). When asked if they felt the science was appropriately pitched, responses included:

“Yes - perfect for a mixed Y5/6 class. It recapped prior knowledge and introduced new concepts”

“Yes they could tell me what they had learned once we got back to class, even the less able ones”

“Yes, with such a wide range of ability in my class it still managed to engage them all and I think they all learned something”

“The information was pitched very well which enabled all the children to access at least some of the details. The children’s questions were answered fully - regardless of how trivial or serious they seemed”

“Yes and no... it was pitched as well as it could be but the understanding of fusion in a difficult process for a 10yr old to take on”

“It was explained in a child friendly way despite the concepts being advanced”

“You kindly let my yr 4s in and they enjoyed it. I think they understood some of it. For yr 5 and 6 I think the pitch was spot on.”

5.2.2 Learning styles

The show appealed to students with a range of learning styles. Apparently some of the Year 6 students interviewed had recently identified their own learning styles via a questionnaire, so they were well able to comment on this:

Girl: It's for kinaesthetic people.

Facilitator: So what's that all about? Tell me a bit about that then.

Boy: People that like to do things instead of just looking.

The show also appealed to visual learners:

"I like seeing things as well as hearing them, it's easier to understand them"

A teacher commented:

"Visual aural & kinaesthetic learning covers all students"

5.2.3 Learning outcomes

Students were asked to describe what they had learned during the show. One student gave a very articulate description of the process he learned about during the drama game:

"Well, they keep on moving around and then they sort of hit each other and they bounce back and while they are bouncing back they sort of let off some of their speed and energy"

This quote identified the necessity of a collision for fusion to take place, and the link between speed and energy. The fact that the process releases energy was also learned. An inaccuracy in this description is the way that the atoms 'bounce back': this is where the analogy of the drama game begins to break down, as the products of the fusion reaction are different from the original atoms.

Many students gave accurate learning points:

"That it's hotter in the centre of the sun than on the outside"

"I learnt about the little atoms, like how small they are and what they are equivalent to and how many there are. It's quite amazing to find out that there's loads and loads in a tiny little pin needle"

"The hotter an atom gets, the faster it moves"

However this question also highlighted some misconceptions the students had picked up:

"If you split an atom in half it explodes"

"When atoms are on the surface of the sun they repel"

One interesting discussion related to an animation of the fusion reaction in the first video. The project team felt the animation wasn't ideal, as energy was represented as a blue 'squiggle' emanating from the reaction, which looked like a strangely shaped particle. In one of the focus groups, students discussed this:

Girl1: Um, well, the thing that I didn't really get when we were in the Sun Dome was as soon as they got together something else came out and I didn't know what it was.

Facilitator: OK, does anyone know what that was? Who could explain that to Girl1?

Boy: Do you mean the blue squiggles?

Girl1: Yes, the blue squiggles that came out when they crashed.

Boy: That was atoms, just an example of atoms, the old atoms coming out.

Facilitator: Girl2, did you know what that was?

Girl2: No.

Some teachers also identified the fact that students may not have fully understood all of the science (especially within the videos):

"The children really enjoyed the experience but I'm not sure how much they learned"

"Children couldn't really relate to it - a bit out of their sphere and understanding"

"Very interesting for me, some of the children didn't understand all of the content"

This is perhaps not surprising given that fusion is not normally covered in science until GCSE or A level, however developing an alternative animation for this key area would be helpful. From talking to students, it appears the concepts built through the interactive game were more accurate than those developed through the animation.

In terms of other learning points, one student described how the Sun Dome had given him an insight into the work at Culham:

Boy: Because I live in Culham I go past Culham quite a lot and I see the science lab and I thought it was quite interesting to see what's inside because it looks really complicated.

Facilitator: So did you know what was inside the Culham lab before?

Boy: No

Facilitator: OK, what did you think was in there?

Boy: I didn't think it was like, you know, packed with stuff.

This indicates the impact of the show in explaining the work that goes on at Culham Science Centre. Teachers also raised this, as described below.

Teachers were also asked to reflect on what they felt their students had learned from participating in the Sun Dome. Key learning points related to atoms, fusion, the Sun and the work at Culham.

"Afterwards, children told me they learnt about: atoms and 2 million on a pinhead; what fusion is; what JET is; that making a mini-sun can create electricity"

"As a literacy summary task, the children did this in class the next week. 1. The heat / energy from the sun is made by atoms fusing (fusion); 2. Scientists in England are creating a sun"

"I feel the children learned more about the nature of atoms and how they move and fuse. Some had a basic knowledge which was consolidated by the sun dome. Also I think some children were very surprised to find out that a sun can be made in a lab"

"Loads - fusion for one. A lot of the children saw that science is even more interesting than they thought and opened up job futures so to speak"

Some teachers also identified the sustainability link within the show as an important learning point:

"Cleverly linked to global warming and environment issues today"

"How atoms create energy; how we are working towards sustainable energy through the use of the sun"

"A greater understanding of the sun, its different parts and how we know. Cleverly linked to global warming and environment issues today"

5.3 Attitude change

5.3.1 Students' comparisons of science at school and in the Dome

A significant section of each focus group explored whether the Sun Dome had an impact on students' attitudes towards science. Firstly, participants were asked what they thought about science before they saw the Sun Dome show. They were then asked whether the show changed how they felt about science and to compare the dome to their lessons.

The Year 6 students' opinions about science in school were mixed. For a few, science was their favourite subject, but it was considerably less popular with others.

"In year 4 and 5 I thought science was rubbish but now I think it's more exciting because now that we're a bit older they can trust us with more things"

"I love science, it's probably my favourite lesson"

"I don't particularly like science which is rare for me... I find it boring that you just get loaded with information and it's always the same every week."

"Science is just sitting on a chair, it's boring"

The Sun Dome was seen by students to make science more interesting:

"Because you done like the Sun Dome and it's more exciting you think science can be a little more exciting cos you won't forget that you went in the Sun Dome."

"Normal science, I found it quite hard to pick up because it wasn't that well explained but when I went into the Sun Dome it was easy to pick up. It was a lot better"

"I think it makes it more interesting, it gets you more involved"

"I used to think that science was boring but now I know it can actually be more interesting. Now I've been inside the dome, I like science now"

However, some students felt that while the Sun Dome was an interesting experience, their attitude to science hadn't changed that much because they would have to go back to their normal lessons:

"I'm kind of mixed because science was boring then I got into the Sun Dome which was fun and then I go back to normal science and it's going to be boring again"

"Bits seem really boring but then we've gone to the Sun Dome and we've had fun and then we'd want more fun in the lessons but we know we won't do"

"It hasn't changed it as much. I'd quite like to have lessons like we had in the Sun Dome every week. That would completely change my view"

It is interesting that while the students undoubtedly enjoyed the Sun Dome experience, for some their dissatisfaction with science at school still remained. It is especially interesting because these students were in Year 6, when many lessons are necessarily devoted to revision for SATS.

All of the teachers agreed that the Sun Dome made science more exciting for their students. Reasons included the 'wow factor' from the presentation, the fact it was so different to science lessons, the inclusion of real scientists (including female scientists) in the videos and as presenters, the mix of learning styles the show appealed to and the dome venue itself:

"Anything out of the ordinary gives a WOW factor and enriches the curriculum"

"A different way of seeing/experimenting new information. Games and fun. Not all teacher speaking/telling"

"Important for children to meet individuals who are scientists and can act as role models"

"Events like this bring science to life for students. Visual learners in particular benefit from the videos and the kinaesthetic learners benefit from the games. I believe children need to know how science is applied in real life to gain a greater understanding and appreciation"

"Because concepts like the earth and beyond are hard to get out heads around without this kind of thing. You taught things I wouldn't be able to do"

"Anything from a different angle and showing women as scientists is good"

5.4 Other impacts

The impact of the Sun Dome on interest in science careers was explored in two of the focus groups. One girl felt that, although working in a lab like Culham might not be for her, it had given her a greater appreciation for the work of scientists:

“The second movie, I think I learnt more about the science stuff because you knew what they actually did as your job, cos I thought it was you just found out facts and stuff but you actually try and make it better for the environment and things. And I wouldn’t personally work there but it looks very interesting, what you do.”

However several other students felt that Culham could be somewhere they would like to work in future. The idea of working with robots especially appealed to some of the participants:

“I’d like to work at Culham because it would be a good experience to see all that equipment and making the sun and stuff like that”

“When we were watching the robotic arms... it looked really fun”

One teacher also commented on this aspect:

“The children really enjoyed the experience. Lots of them now want to work at Culham when they grow up.”

Teachers also identified a range of additional impacts on students. These included the promotion of science beyond school and as a career, inspiring students to ask more questions and promoting awareness of environmental issues including those with a local context.

“Yes may inspire children to take up science later in life”

“Encourages them to ask more probing questions because of the way the information is delivered”

“In school we have spent a good deal of time discussing the environment - and how eventually fossil fuels will run out. The sun dome reinforced and built on previous knowledge.”

“Inspires to motivate their learning and raises their awareness of issues”

“These are lessons they particularly remember. Make them aware of other jobs and what people locally are doing - the importance of which has a global effect”

“Yes especially with newly erected wind turbines nearby - the importance of finding new energy is very near to them”

“Memorable - can hang other learning on it, they see science in the real world and scientists explaining what they do and enthusing about their work (and no white coats and crazy hair in sight)”

5.5 Further comments

5.5.1 Suggestions for improvement

Teachers were asked to suggest ways in which the Sun Dome could be improved. Many respondents felt unable to suggest improvements.

"I don't think you could - it was brilliant"

Some of the suggestions are given below. The main ideas related to follow-up work, closer links with the KS2 curriculum and including a mechanism to check students' learning.

"Some information which could be left with the class would be good. This would provide a follow-up science session in school"

"Maybe include more of the KS2 curriculum to support as well as extend learning e.g. earth, sun + moon - seasons night + day shadows"

"I personally loved it but to hit the primary sector id advise an extra 10 minutes just hitting the earth and beyond objective that teachers have to teach"

"More q's during the talks to check children's understanding"

"Possibly another, different game at the end or a mini quiz to let the children check what they have learned"

Information more closely linked to the curriculum should only be included if it can be done in a way that does not limit the amount of material related to fusion, or make the presentation too long. However the suggestion for follow-up materials is a good one, and a quiz or similar activity that checks learning could be included in follow-up materials or incorporated into the Q&A session at the end of the session.

5.5.2 Further comments

The final item on the questionnaire provided space for teachers to leave additional comments. They included:

"We all enjoyed it thoroughly - children and adults"

"The children loved it and we had really positive feedback from parents too"

"Our headteacher chose this activity. Beforehand, this would not have been my choice, due to no links with QCA science coverage! However this turned out to be the most popular activity for the children!"

"It was presented with confidence and interest. It was pitched at just the right level"

6 Conclusions

The evaluation of the Sun Dome shows it was well received by students and teachers alike. This high level of success was due to effective pre-research and piloting, where a number of changes to the show were made in response to feedback from the target audiences. The show is now established and four members of staff at Culham Science Centre are trained to deliver it. A large number of bookings have been made beyond the lifetime of the project.

The remainder of this section reflects on the original aims and objectives of the project and the extent to which they have been achieved.

Aim 1

- *Improve the image and interest in science among students. The dome shows (visual and theatrical) will use, wherever possible, young and energetic fusion researchers.*

The show certainly improved the image of and interest in science among the young people it reached. One surprise was the negative attitudes towards science that many Key Stage 2 students had already developed, and the realisation for some that while activities like the Sun Dome are exciting and educational, 'normal science' is much less so.

Success factors for the dome included the innovative and immersive nature of the venue itself (including the striking cover that looks like the sun), the balance between 'watching' and 'doing' activities within the show, enthusiasm of the presenters, good images and the fact that the science and language included was pitched at an appropriate level.

Most of the shows in the project period were delivered by presenters that are not or are no longer active fusion researchers. Although there is the potential to train more researchers to deliver the shows in future, the solution of employing a full-time science communicator to meet the high demand for the activity was a logical one which allowed the ambitious audience targets to be met.

Aim 2

- *By employing the show at local schools' science fairs, within local schools and for local students visiting Culham, improve the image of Culham Science Centre amongst the local community. The Laboratory is sometimes perceived as secretive and dangerous. Local students and schools are well placed within the community to portray and spread a more realistic, positive image.*

Several students and teachers in the sample commented on the way in which the show demystified the work at Culham. However, because many shows were delivered at different venues nationally, ongoing rollout of the show will continue to communicate this message locally.

Aim 3

- *By describing the fusion process and stressing the importance of this process as a future energy source, provide some relevance and depth to some aspects of the science national curriculum (e.g. atoms, states of matter, energy, climate change, sustainability). In a society where numbers in the further education science community and scientific literacy are at an all time low, sparking an early interest and involvement in science is very important.*

Students and teachers identified a wide range of relevant learning outcomes from the shows. Although some of these were not yet covered in the national curriculum at Key Stage 2, the show provided a valuable insight into one way that scientists and engineers are hoping to provide a clean, sustainable energy source.

Objective 1

- *By attending major local and national science festivals (e.g. BA Science Festival, Edinburgh Science Festival, Cheltenham Science Festival, Oxford Festival of Science) and touring the Dome to local schools, aim to interact with an audience of 5000 10-14 year old children per year.*

This objective was partially met; over 5000 young people participated in the shows up to June 2008 and further bookings have already been made. However, following early feedback from teachers that a quite different show would need to be developed to meet the needs of the Key Stage 3 curriculum, a decision was made early on to focus on Key Stage 2. So the target audience changed from 10-14 year-olds to 7-11 year olds.

Objective 2

- *After engaging in the Fusion Sun Dome, increase the numbers of students that understand what the fusion process involves and how, in simple terms, it releases energy.*

The evaluation clearly demonstrated the educational value of the shows. The combination of the videos and the interactive game gave students with a range of learning styles the tools necessary to understand the concept of fusion. Students grasped the links between speed and energy, and the fact that fusion occurs when atoms collide. However their mental models broke down slightly when queried further, which was not helped by the animation that led some students to believe that additional atoms were released. However considering the presentation was aimed at such a young age group, their grasp of the topic following a relatively short presentation was impressive.

Objective 3

- *After attending the Fusion Sun Dome, increase or engender a positive attitude to fusion – and how this technology can contribute to a cleaner, more sustainable society in future.*

Students that participated in the shows were very positive about science and fusion afterwards. The second video in particular helped students put the research into the context of a very real problem facing humanity. Teachers felt that an even stronger focus on this aspect would be highly successful at Key Stage 3.

7 Recommendations

As the external evaluator for this project, I feel it has been delivered to the highest possible standard. The critical and reflective approach of the project team has led to the development of an activity that has been very well received by both teachers and students, as evidenced by the feedback detailed in this report.

1. I recommend that this **project be rated 'outstanding'** in the final report to EPSRC for its *Impact in terms of Public Engagement Objectives, Quality of the Communication, Project Management and Partnerships, and Resources and Cost Effectiveness.*

While the existing Sun Dome show was clearly effective in achieving its objectives, the evaluation has identified several ways in which its impact could be enhanced and extended in future.

2. Develop **further shows** for use within the dome. Secondary teachers involved in the pre-research were very interested in an interactive KS3 show that combined videos and a role-play or debating element around sustainability and/or nuclear power.
3. When developing shows for future audiences, the **process** of pre-research followed by pilot shows was effective in developing a high quality show. This process should be repeated for any further shows that are developed.
4. Creating **wraparound materials** to support teachers and students that have participated in the shows would add significant value. They would allow extension of the show's impact through follow-up work in class and could also help iron out any misconceptions students had picked up. Including a quiz or game that tested students' knowledge at the end of the show or as a follow-up resource would also address this. While some teachers conducted follow-up work anyway, it may be that teachers that are less confident in science would not. Providing materials would help give such teachers the confidence to deliver further fusion activities as part of their lessons.
5. Some teachers felt the show should be **tailored more closely to the KS2 curriculum**. Any changes to address this should be made with caution; enrichment activities such as the Sun Dome aim to enhance rather than replace classroom teaching. However if curriculum material can be included in the existing presentation without detracting from the messages about fusion and without making the presentation overly

long, this could be considered as a way to more effectively market the activity to teachers.

6. One of the **animations** about fusion was found to be confusing for some students. Further funding could be sought to commission a new animation to use within the first video that more accurately represents the fusion process.
7. **Training more researchers** at Culham to deliver the shows would allow the Sun Dome to visit more schools and science festivals.

Appendix

- Pilot evaluation report
- Evaluation materials

Sum Dome pilot report

13 March 2007

Introduction

The Sun Dome pilot took place during the week of 22 January 2007. Four schools were visited and 10 shows delivered to a total of approximately 200 students.

The pilot evaluation considered the opinions of students and teachers. Focus groups with students were convened on the first two days. Four focus groups were conducted on the first day, two with Year 5 students (total of 12) and two with Year 6 students (total of 16). Two focus groups were conducted with Year 6 students on the second day (10 students altogether). The notes from the focus groups are provided in Appendix 1.

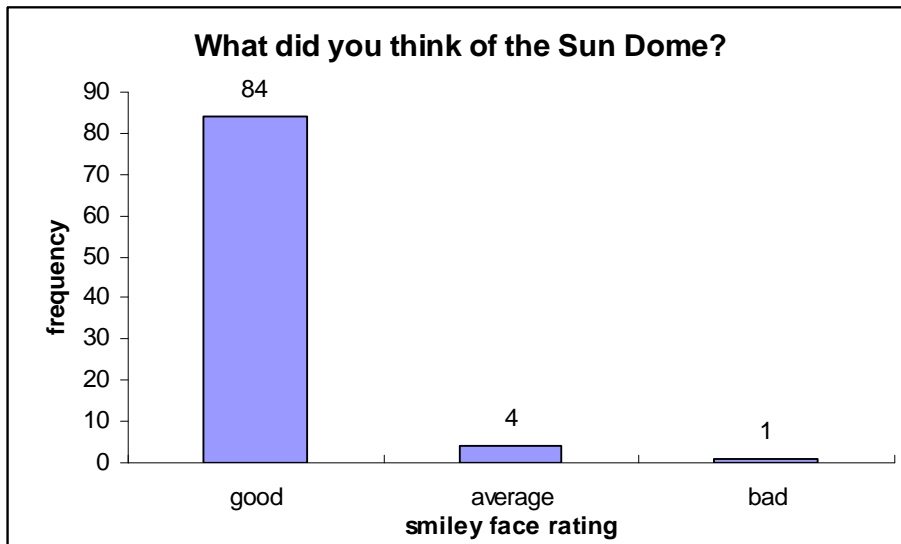
At four of the shows, students were asked to give their opinions about the Sun Dome by placing stickers on a large smiley face scale drawn on a flipchart page. Four charts were completed in total.

Teachers were interviewed in an informal focus group on the first day of shows, and were subsequently asked to leave written feedback on a questionnaire. Eight questionnaires were returned.

Feedback on the Sun Dome was very positive, and the experience was useful for the project team who changed several aspects during the course of the week. Some recommendations for further development are made at the end of this report.

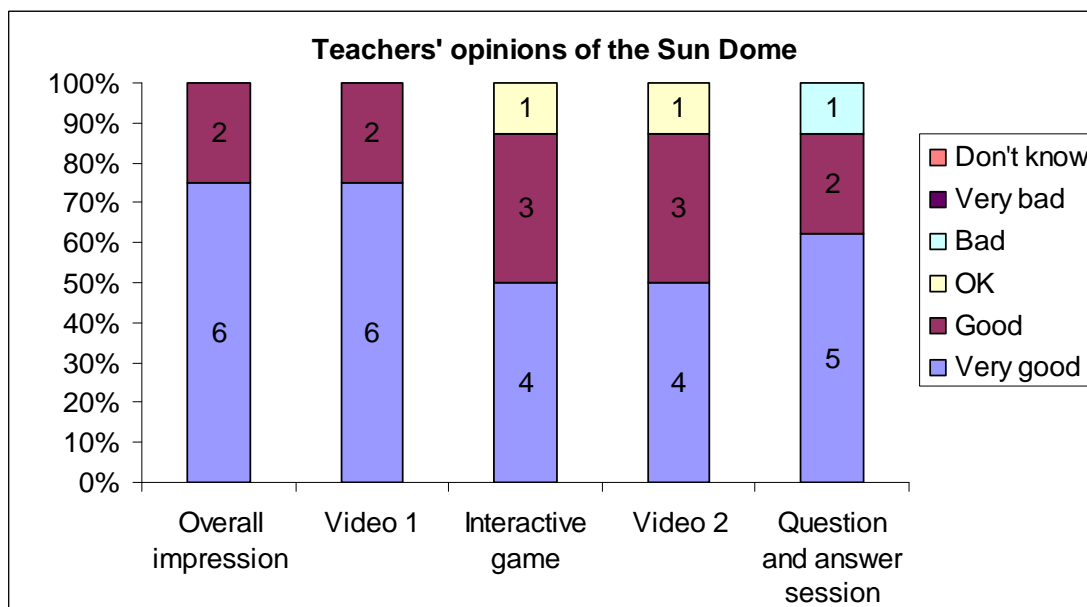
Overall opinions

The graphs below present the findings from the teacher questionnaires and students' smiley face charts.



Overall, students responded positively to the Sun Dome. These results are particularly encouraging for a pilot show.

Students in the focus groups were asked to rate the show using a thumbs-up/thumbs-down scale. Some groups used a five point scale so the results aren't directly comparable. 21 students rated it as 'good' or 'very good', and three rated it as 'average'. The slightly less positive ratings may be due to the fact that four focus groups were conducted on the first day, and the sticker chart evaluation was used later in the week when efforts had been made to improve elements of the show.



All of the teachers rated the Sun Dome as 'good' or 'very good' overall. The first video was the most popular element. Feedback on each element of the activity will be described in more depth later in this report.

The dome

Students responded positively to the dome – so much so that it was difficult to calm them down so they could watch the first video! The visual appearance of the dome engaged the students before they stepped inside. As one teacher commented:

“This is a very good experience to children that do not usually or cannot go to a planetarium”

The name of the activity was discussed after the first pilot show. The name had been changed from the working title ‘Sun Dome’ to ‘Solar Sphere’, which the project team felt sounded more exciting. However, in the four focus groups the students found it difficult to refer to the dome, looking to the facilitator to remind them what it was called. No students referred to it as the Solar Sphere.

It was therefore decided to revert to the original and simpler name ‘Sun Dome’.

Videos

Students enjoyed the first immersive video:

“It felt like you were in the sun”

“Much better than a picture in a book which is rubbish”

Students liked the level of detail of the explanations, but felt that some parts of the video (the sun’s surface and the particles fusing) went on a bit too long for the accompanying explanations.

The first groups were concerned about the fact that the Sun will eventually grow into a Red Giant and swallow some of the planets, possibly including Earth. Lots of the questions at the end of the show focused on this and some students were quite scared. It was decided to omit this section from subsequent shows as it detracted from the activity’s core messages about atoms and fusion, and caused unnecessary anxiety amongst students.

The second video was also well received, but less popular than the first. They liked this because they *‘got to see what is inside the place’*, which was *‘hard to imagine before’*

Some students felt that parts of the second video (e.g. the ITER animation) didn’t fit with the explanation – they couldn’t really see the doughnut shape and there were some sections where they didn’t understand what was going on. They suggested using a pointer to point out the relevant parts – the screen was so big they weren’t sure what they were meant to be looking at. In this video students liked the robots but disliked watching the scientists sitting at their computers (*‘boring’*).

A major issue with the videos was the way in which students sat in the dome. It is not obvious on entering the dome which way they should face: some sat in a circle and some lay on the floor. This then meant that some of the images were upside down or difficult to see – especially for the second video. Lots of the students said that watching the videos hurt their necks. Teachers also commented that it was difficult for them to direct the class if they were unclear as to where the students should be sitting.

As shown in the graph, teachers were impressed by the videos. Comments from the questionnaires included:

“The 1st video really brought a 'planetarium' type experience to the school. The 2nd video really answered a lot of questions about Culham that we see daily”

“Good videos, dome a real stimulus, could be slower to see what each aspect was”

“Very informative. Engaged the children as we had a mixed ability group”

“Very good - easy for the children (and staff) to understand”

Visualisation and interactive game

On the first day, students in the focus groups said they found the visualisation difficult because it was hard to imagine what the atoms looked like. More description was given in later shows, which successfully addressed this.

Generally there was a more mixed response to the game than the videos, and it was clear from observing that some students hadn't quite grasped the purpose. However, for some students (likely to be kinaesthetic learners) the game provided an opportunity to further explore the concept of fusion. In the focus groups, these students said that the game was the best bit:

“It was fun and you got to be the atoms”

Students and teachers felt that the game added a fun dimension to the activity and that the balance between watching and doing was good.

“Thank you for inviting us! Parents who accompanied [children] were very impressed and liked the mix of seeing, talking and doing”

Teachers' responses to the game were positive overall. The only suggestions for improvement were in the delivery rather than the concept: one teacher said there was *'too much talking at the beginning'* and two were concerned that students may not have been clear what they were supposed to do, especially those of lower ability. The narrative for the game can be improved for future shows. Other teacher comments included:

“The drama game is a strategy that reinforced the idea for lots of children”

“Excellent - encourages the children to act out the fusion, therefore clarified what was happening on video 1”

“The explanation of fusion was fully understood by some but we had 2 [children] of lower ability that did not understand what to do”

“Excellent - it brings the science to life and helps the children to understand and remember”

The game was the part of the show that evolved the most over the course of the pilot shows as it couldn't be rehearsed beforehand. So it is unsurprising that it received some mixed reviews early on.

Question and answer session

Students liked the opportunity to ask questions at the end of the show and there were a wide range of interesting questions from students (some are given in Appendix 2). In all shows observed there were more questions than the time permitted.

Teachers' comments included:

“Seeing 'real' scientists gives an authority”

“It's interactive and great for children to speak to real scientists and be able to ask questions”

The science

Some of the most interesting findings came from this line of questioning in the focus groups. The language used during the videos and interactive game aimed to be accessible yet scientifically correct. The students felt that the level of the science was appropriate to them, although the language used was not always clear and they would have liked more explanation of some of the terms. Interestingly, the students often felt patronised by other science activities (including planetaria) aimed at their age group. Several gave specific examples of well-known attractions that won't be named in this report! Their comments included:

“I knew some of it but most was new”

“It's better to hear new things although it can be good to be reminded”

“Once I got used to the words it was fine”

“It wasn't babyish”

The students certainly appreciated learning about real science and the work of real scientists; where the language was inaccessible it did not appear to be

greatly detrimental to the experience. They suggested slowing the pace, explaining some of the technical terms and having the key words flash up on the screen during the videos to help with some of the difficult language.

Teachers gave mixed opinions about the level at which the science was pitched. Their comments included:

“Too much technical language for Y5”

“Overall it was child friendly. Presentation was appropriately pitched to the children (and we enjoyed it too!)”

“It was challenging for them”

From speaking to the students, it appears that this aspect can be improved by simplifying the language of the presentations, rather than removing some of the more difficult science.

Learning

In the focus groups, students were asked to name one thing they had learned from the Sun Dome. There were a wide range of responses – those from Year 6 students were considerably more articulate than those from Year 5.

Many of the learning points were related to the sun:

“The sun is made out of gas”

“It takes years to get to the Sun”

“The Sun was just a strange subject before – now there is a lot to know”

“How the Sun is born and all the different parts”

Many were about atoms and fusion:

“Atoms are tiny”

“There are lots of atoms in the Sun”

“About the little things – atoms”

“About atoms – I didn’t know they make energy to power the sun”

“Particles fusing”

“Fusion and energy”

“About robots and the doughnut”

Some students learned about the nature of science and scientists:

“Scientists aren’t all in white coats”

“I didn’t know science was so powerful we could make our own sun”

“I didn’t know they could make a sun – that’s amazing”

“People are making buildings for the mini sun”

“The world could find out how to live on Mars”

And one student said she had learned:

“When we’re older what we have to do to save the world”

Teachers also felt that the students had learned a lot from the activity. When asked in the questionnaire, teachers picked up on the main learning objectives which were about the Sun, atoms, fusion and alternative energy.

Attitude change

In the focus groups, students were asked whether the Sun Dome had changed the way they feel about science. All of the students said that the Sun Dome had made science ‘*more fun*’ or ‘*more interesting*’. Worryingly, many students appeared to already have negative constructions of science at school. The interesting science content and novel approach were important in changing students’ attitudes towards science.

“I thought science was about boring stuff like air resistance”

“I learnt about the world and what’s happening”

“At school it is dull writing in books”

“We do solids liquids and gases every year”

“This is more exciting”

“At school all we do is fill in sheets or books”

“It makes science more fun”

“In primary it’s all boring we don’t get anything to do”

To the students, scientists have bushy grey hair, glasses and white coats. They agreed that Chris (the presenter) definitely doesn’t look like a scientist, so the show challenged these misconceptions.

“I didn’t realise that scientists were trying to help the world”

When asked to comment on whether shows like the Sun Dome make science more exciting for students, all of the teachers responded positively. Some of their reasons are given below:

“Yes. It’s a tool that makes learning interesting”

“Much more exciting - children learn from the interaction”

“Yes because it’s visual. Hands on is always more interesting for children”

“Yes. Science in school can be difficult to teach and come across as boring”

Recommendations

1. Help students orient themselves within the dome: clearer instructions on entering the dome (to teachers as well!), a holding screen on the video with text would make sure students faced the right way and more time to settle at the start would also help keep students' excitement at a manageable level.
2. Make the language of the show more accessible: explain technical terms such as 'vessel' and use the text of key words on the screen to help students understand them.
3. A clearer start and end to the videos would help direct students, especially for the first video where showing the laptop desktop looks somewhat unpolished (a holding slide would also help this).
4. Using a laser pointer during the videos would help students focus on the appropriate part of the very large screen.
5. Continue to refine the visualisation element so it doesn't take too long but gives students enough information to complete the task.
6. Make the movements more exciting during the drama game perhaps by giving students some examples to help them come up with their own movements.
7. A brief reflection at the end of the session (before questions) would help reinforce the messages and learning points.

Appendix 1

Notes from focus groups

Focus group findings – group 1 (Y5, 3m, 3f)	
Video 1	Students loved the immersive video: “I liked the spinning it felt like you were really moving”
Game	Most of the girls liked the visualisation, the boys didn't. when asked why they didn't really know, they just said it was 'boring' because you 'didn't do anything'. They said it could have been shorter, or you could have been moving around while it was explained. When they heard they would be doing fusion they pictured the 'balls with the little squiggly blue line' rather than a movement they could do. They said it was difficult because the groups at the end didn't want to mix.
Video 2	Good – but not quite as good as first – it was hard for them to see what was happening without hurting their necks.
The science	Pitched at a good level: “I knew some of it but most was new”; “its better to hear new things although it can be good to be reminded” However some of the language was a bit inaccessible: ‘once I got used to the words it was fine’. They felt some of the words needed to be defined.
Learning points	‘there are loads of parts in the sun’ ‘the sun is made out of gas’ ‘about robots and the doughnut’ ‘it takes years to get to the sun’
Overall opinion	Good – weird – cool – fun They all wanted to see it again
Attitude change	They said it made science more interesting because they had never been in a dome before, and because ‘other science is boring’
Other points	Commented on the acoustics in the dome: “When someone spoke it was all around you” They acknowledged that it would have been better to allow the class time to settle inside the dome before starting the explanations – more of an intro for the first video. One idea for improvement was to have two domes, and one student suggested setting up a charity for fusion so they could build more power plants! She said everyone who went in the dome could donate 50p!

Focus group findings – group 2 (Y5, 3m, 3f)	
Video 1	The videos were well received: ‘much better than a picture in a book which is rubbish’ ‘it felt

	<p>like you were in the sun'</p> <p>They liked the level of detail the explanation went into, and said 'chris explained it really well' they said it could have been a bit longer, although they felt that it 'told us everything' and agreed it was better to be a bit shorter than going on too long and getting boring. One student said Chris should have said the names of the planets, then they realised he probably did but they weren't paying attention! They agreed that the pace of the first video was good, it was 'fast enough'</p>
Game	Mixed response – some said 'immense', most agreed 'confusing'. They had observed the boy/girl split. They felt that running around was ok but it was a bit boring – they didn't really get what they were meant to be doing.
Video 2	
The science	The group felt that the language was a little technical, but that this was good because it was 'not babyish'. Two members of the group described other planetaria they had visited where the explanations were very slow and basic. Thee students found this patronising.
Learning points	<p>'the sun will swallow the earth'</p> <p>'I learnt how the sun was made'</p> <p>'particles fusing'</p> <p>'Fusion and energy'</p> <p>'we will all die in a few thousand years'</p> <p>'whats in the middle of the sun'</p>
Overall opinion	We did a 3-point thumbs up /down rating. The solarsphere got 4 thumbs up and one average rating.
Attitude change	
Other points	<p>The group's very first point was that it should be made clear that it will be billions of years before the earth gets eaten by the sun. They were somewhat disturbed by this fact!</p> <p>One person thought the music sounded 'like an evil person's lair' – the others liked it.</p> <p>They felt the pictures should be on the side not the ceiling – they were all lying down facing different directions so some of the images were upside down which was confusing.</p>

Focus group findings – group 3 (Y6 3m, 3f)	
Video 1	They really liked the 3D videos: 'it looked as if you were there', 'it showed us things we didn't know before'. They felt the particles section was a bit repetitive. Some felt a voiceover may have been clearer. They thought it was weird that the sun would eat the planets
Game	They felt the visualisation was a bit confusing, it was hard to imagine what the different things were when they weren't told, and they found it a lot to imagine. One suggested showing

	<p>some images or a video of what the journey looked like to make it easier to imagine.</p> <p>They weren't really sure what they were meant to do with the game, and would have liked clearer instructions, and the chance to ask Jane questions about the instructions of how the game would work.. They said it was fun at the end when they all went together. Some said it got a bit boring. They would have liked some props like hats or rockets (!) Some suggested including movements other than running (one suggested inventing 'atom hopscotch') – they found it hard to think of their own movement which meant it wasn't enjoyable.</p>
Video 2	<p>They liked the robots. They felt that some of the second video (esp ITER animation) didn't fit with the explanation – they couldn't really see the doughnut shape and there were some parts where they really didn't understand what was going on. They suggested using a pointer to point out the relevant parts – the screen was so big they weren't sure what they were meant to be looking at.</p>
The science	<p>They didn't fully understand the language and the science – 2 of the students who were clearly very interested in science (one said he had learned about atoms from reading his science encyclopaedia) did understand it, they said it was difficult at the start but OK by the end. They felt this could be easily improved with a little more explanation at the start. They would have liked a slower pace with more explanation. Some of the words like vessels made them feel 'a bit muddled'. They liked the idea of seeing what scientists do, although they didn't like seeing all of the people sitting at their computers.</p>
Learning points	<p>'what the scientists do there'</p> <p>'the sun will grow and evaporate – I thought it would explode'</p> <p>'the sun will grow'</p> <p>'When we're older what we have to do to save the world'</p> <p>'atoms'</p> <p>'The world could find out how to live on mars'</p> <p>'scientists aren't all in white coats'</p> <p>'The birth of the sun'</p> <p>'the sun is 15 million °C'</p> <p>'atoms'</p> <p>'I didn't know science was so powerful we could make our own sun'</p>
Overall opinion	<p>They liked the dome itself. On a five-point scale from very good to very bad, four students rated the solarsphere as good, and two as average. When asked why they gave the lower ratings, the two students said the show could have been 'more joyful' or 'more upbeat', with more humour.</p>
Attitude change	<p>All of the students said they were more interested in science</p>

	<p>as a result of taking part in the solarsphere activity: 'I thought science was about boring stuff like air resistance' 'I didn't realise that scientists were trying to help the world' 'it made me think about space' 'I learnt about the world and what's happening'</p>
Other points	<p>The floor was uncomfortable It was sometimes hard to see the bottom and the top of the screen – esp on second video They thought that Chris looked like a builder in his polo shirt! Some of the students weren't clear about Jane's role</p>

Focus group findings – group 4 (Y6, 1m, 9f, self-selected)	
Video 1	<p>Generally good. Commented that it hurt their necks to look up, and got a bit boring if the same picture was on for too long (e.g. some parts with the surface of the sun). some felt the images of the atoms joining together went on too long, but acknowledged that there needs to be enough time for explanation. Some felt that the planets all looked the same colour so were difficult to distinguish. Overall the groups felt that the videos were about the right length.</p>
Game	<p>They found it hard to do the visualisation, some said because they had other images in their heads. They needed more description because they didn't know what atoms look like or how big they are (as big as planets?) – they also would have liked some mats to lie on! They said that everyone just clumped together with their friends, and it might have been better to all form a circle.</p>
Video 2	<p>Interesting, but would have benefited from more explanation</p>
The science	<p>Some were familiar with the science, some weren't. they agreed it was good to learn new stuff. The said the science was interesting, but it would have been helpful to explain what some of the words meant, maybe the word could come up on the screen.</p>
Learning points	<p>'atoms' 'the sun gives off loads of energy' 'we could create a sun' 'I learnt about the stars and the sun' 'what the sun is made of' 'atoms are tiny' 'people are making buildings for the mini sun' 'how the sun is made' 'atoms' 'there are lots of atoms in the sun'</p>
Overall opinion	<p>Best bits – moving in the dome, showing the power station, the second video, the game – it was fun describing particles, the dome – it felt like you were there, the cartoon – it made you dizzy. On a five-point rating scale there were 8 very good</p>

	responses, and two good responses.
Attitude change	The group were unanimous that the solarsphere had improved their perceptions of science – it made science ‘more fun’. The activity was more fun than they had anticipated.
Other points	They suggested improving the solarsphere by having two domes so they were less squashed inside.

Focus group findings – group 5 (Y6, 5m, 1f)	
Video 1	Good – great – quality ‘it was interesting because it had facts what I didn’t know’ The video was very effective and the students liked the sensation of movement. One said it was ‘like a simulator’. One said she liked it because she liked studying science. They said sometimes it was hard to see the images because they were upside down if you were lying on the floor
Game	Most of the students liked the visualisation: ‘it was cool – you could imagine yourself in the sun’ two students didn’t like shutting their eyes, and suggested doing the visualisation in the dome where it was dark so you could imagine without shutting your eyes. Four of the six students said that the game was the best bit – ‘it was fun and you got to be the atoms’ ‘you got to run around everywhere’ two explicitly described what happened when someone they had chosen as a friend had chosen them as a foe (or vice versa). The other students enjoyed the game, but preferred the videos.
Video 2	One student thought it was a bit boring, but the others enjoyed it, especially the bit where you go inside the building.
The science	All said it was good, although there were some words they didn’t understand, like atoms, which they felt they had grasped by the end of the show, and fusion, which they felt they had not fully understood. ‘what actually is it? ‘what does it look like?’ Some students felt there should be more facts and explanation. All said there was a good mixture of easy and hard science. They suggested asking questions at the start so they could be covered during the session.
Learning points	‘about the little things – atoms’ ‘about atoms – I didn’t know they make energy to power the sun’ ‘the sun is not really burning’ ‘I thought the sun was fire’ ‘I had never seen what it looks like or what was going on in the sun’ ‘I didn’t realise that the sun was that much bigger than the earth’ ‘I didn’t know they could make a sun – that’s amazing’

	They said it was interesting to hear about the sun because they hadn't thought much about it before 'the sun was just a strange subject before – now there is a lot to know'
Overall opinion	5x 2 thumbs up, 1 x 1 thumbs up ('I learnt stuff which was good but some of the videos were the same')
Attitude change	All the students said that the sun dome had made science more interesting. 'at school it is dull writing in books' 'we do solids liquids and gases every year' 'this is more exciting'. They agreed that Chris definitely doesn't look like a scientist. To them, scientists have bushy grey hair, glasses and white coats.
Other points	The students were probed as to whether the mix of activities was the right one. They were unanimous in their agreement. They really liked having the opportunity to ask questions at the end. One student said that the jumper that said 'fusion' was good, and suggested that everyone on the team wear one.

Focus group findings – group 6 (Y6, 2m, 2f)	
Video 1	Good – but hard to look at the top without hurting neck But if you lie down it can hurt the back of your head. Some students said it was difficult to know what to look at, and when asked if a pointer might help they said yes.
Game	They thought the game was 'not that good' or 'it would be better to just let us run around'. One student suggested having a game where everyone you touched had to fuse and join the group. Overall they said that the game was a good idea, but it could have been better. They felt it could have been improved with more interesting acting and movements, or if it had been played in the dark inside the dome.
Video 2	They liked this because they 'got to see what is inside the place', which was 'hard to imagine before', and also because they could lie down. One said that the way the video was put together was clever, especially the ITER simulation.
The science	'its good to make sure that we can have electricity a different way with no pollution'
Learning points	'what the sun was made of and how it started' 'I learnt from all of it, it was all interesting' 'how the sun is born and all the different parts' 'I learnt about the smallest particle thing' (had to be reminded they were called atoms) The students were prompted to talk about fusion. They said 'I learnt the fusion chamber is safe' One student had picked up on the different fusion reactions shown in the first video, and would have liked some more explanation of these. 'it's a good idea to have a plan B in case it went wrong'

Overall opinion	All the students liked the sun dome, except one who said it was boring. Although when asked he said he finds everything boring.
Attitude change	All the students said that the Sun Dome makes science more interesting (even the one who said it was boring) 'at school all we do is fill in sheets or books' 'it makes science more fun' 'in primary its all boring we don't get anything to do' 'its not in the classroom'
Other points	One student said 'it was a bit confusing when Chris was moving the cursor around'

Appendix 2

Students' questions

Group A

- One day will we have electric cars?
- How much energy would you get from 600 fusion particles?
- How hot do you need the sun to make electricity?
- Is there any chance of a leakage from the big doughnut?
- How do you get the gas into the chamber?
- How long will it take you to make electricity?
- How big is the Sun?
- How big is the earth?
- Do satellites get affected by the sun?
- What kind of metal do you make the sun with?
- What will happen when the sun eats up the other planets?
- How do you get satellites into space?
- How wide is the sun?
- Is the sun like a giant planet that's covered in explosions?
- Is there any chance of life in the sun?

Group B

- How long will it take to build [a fusion power plant]?
- How long does the eclipse last?
- What could go wrong with making the sun?
- Why France?
- If the mini sun is in the chamber doesn't it get hot?
- Is it magnets that hold the planets in their orbits?
- Are there any other fusion stations?
- Is there any air on mars?
- Will the sun be a white dwarf?
- Could the sun grow bigger than the whole solar system?
- When the sun grows big will it be in the newspapers?
- Why is the sun not expanding now?
- How much energy will your sun generate?

Group C

- How will you put the sun up in the air?
- My dad works at Culham.
- How long have people been doing it [fusion research]?
- Will we still need pylons?
- Why will it be in France?
- How do you make the robots?
- Do you let people go in and see the machine?
- What is the doughnut actually made out of?
- Will it work?
- Will we be able to stop pollution?
- When the sun explodes will people still live on earth?

- Is Mars that different to earth?
- Can't we just suck up the pollution?

Group D

- How big is the sun?
- How big is the earth?
- How big are we making the sun?
- How hot is it?
- How far away is the sun?
- How near can you get?
- What is the container with the sun in made of?
- How do you know all this?
- How come the dome keeps flapping?

Teachers – what did you think of the Sun Dome?

Please tell us what you thought about the Sun Dome. 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

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

	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"/>
Video 1 (Sun and solar system)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Interactive game	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Video 2 (Fusion on Earth)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Question and answer session	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

2. What did you think about the **videos**? Please tell us why you think this

3. What did you think about the **interactive game**? Please tell us why you think this

4. Please describe your **overall impression** of the Sun Dome

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

PLEASE TURN OVER...

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

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

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

9. How could we **improve** the Sun Dome activity?

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

Thanks!

Sun Dome focus group schedule

1. Purpose of the focus group, ground rules and anonymity

2. Elements of the show
 - a. The dome
 - b. Video 1
 - c. Interactive game
 - d. Video 2
 - e. Question time
 - f. Thumbs up rating

3. Learning
 - a. What did you learn?
 - b. How did learning in the dome activity compare with learning in lessons?

4. Attitude change
 - a. Pre-existing attitudes to science
 - b. Did the Sun Dome change how you feel about science? In what way? Why?

5. Thank and close