



Talk Science Seminars

Engaging secondary students and their teachers in
science using museum collections

Seminar 1: Exploring the Potential of Museums

27 June 2012

Science Museum

Executive summary

The first Talk Science seminar, on Wednesday 27 June 2012, brought 55 people together at the Science Museum to explore the potential of museum objects to support science teaching. The seminar focused on:

- What academics are saying about informal learning, schools and museums.
- The creative techniques museum practitioners are using to help schools engage in object-rich galleries.
- Barriers to learning and how to help teachers overcome them.

The day was positive, practical and participatory, encouraging discussion and the sharing of best practice.

A full report follows, but here are some of the key challenges and opportunities that emerged.

1. Gallery interpretation often presents a big challenge for teachers trying to use objects to promote discussion or facilitate science learning. Science teachers do not always have the same skills as art and history teachers to promote discussion around the objects on display. With dry content, a lack of curriculum links or simply exhibits targeted at a different audience, the interpretation does not often seem to hit the mark. On the flip side, all museums contain incredible stories and science links (even if these are sometimes hidden), and museums have a clear opportunity to facilitate science learning. We need to find a way to tell these stories and allow deep learning to take place.

2. Hi-tech learning resources often mean overcoming great technical and practical challenges and fears – Wi-Fi, access, whether they work, cost. But the evidence suggests that the opportunity offered by digital technologies (targeted interactive content,





for example) now more often outweighs these fears in teachers' minds. Digital technology can also very usefully disrupt the usual power balance – putting learning in the hands of the pupil.

3. There is a big challenge in giving people confidence to ask questions. The portrayal of science and scientists tends to favour cleverness and knowledge, rather than enquiry, and science teachers often feel they are expected to have all the right answers. But emerging from the seminar was the idea that enquiry-based learning is an opportunity to put learning back in students' control. The museums community has experience of how to direct questioning to help it lead to discovery, 'wow' moments and truly memorable learning.

4. Museums have the content, but staff face a big challenge in finding the time and money to create the resources that people want. The good news was that both big-budget and quick-and-dirty resources can work, as demonstrated by the seminar speakers. So the opportunity is there for any kind of museum collection to develop exciting and meaningful ways of encouraging scientific enquiry.

5. Do schools know how good museums would be at helping them do what they want to do? There is a big challenge in letting teachers know the potential of a museum visit or resource, because they are under such pressure. But the opportunity is that museums really can offer robust learning, delivering ways for teachers to join the dots of curriculum knowledge, reflecting on science, its impact and meaning.

Introduction

Background

These seminars are a series of participatory workshops exploring the potential of museum collections to support the teaching of science. Our aim for these seminars is to provide a practical forum to explore a range of creative techniques which help teachers and their students to engage in object-rich galleries.

Museums are great places for teachers to bring their students to enhance classroom learning. Ofsted's 'Learning outside the classroom' study found that the most effectively managed schools and colleges include visits 'as an integral part of a well planned curriculum which ensures the coherent and progressive development of knowledge, skills and understanding'.

These seminars are a forum for bringing together research, experience and expertise from the museum community to explore how schools can benefit from museums, and to support learning – gathering and sharing ideas and tools that schools and teachers can use.

Reference

'Learning outside the classroom', Publication 070219 (London: Ofsted, 2008)

Outline of the day

The first seminar explored the barriers to learning science using objects for teachers and their students as well as a range of solutions to these problems. It was also an opportunity for delegates to share their interests in future topics and support needs.

The day was split into halves. The morning session focused on why we should use museums to engage students in science. Why are our collections an ideal way to support science learning? What are the opportunities, and how can we grab them? The presentations surveyed what academics are saying about informal science and what support teachers need to engage their students with museum collections.

The afternoon session looked at how we can engage students in science learning using museums. What are the barriers that students and teachers might face, and how can we try to overcome them? A panel of professionals from different museums outlined five different approaches. These included both hi-tech solutions using mobile and digital technology as well as more traditional object-handling techniques. The delegates then split into groups to find out more about and critically evaluate each approach for engaging school students in science in museums.






Morning session

Why should we use museums to engage students in science?

Jenn deWitt and Justin Dillon, King's College London
Opportunities for museums to broaden students' understanding of science

Jenny Blay, The Langley Academy
Embedding a museum learning approach into the science curriculum

Hannah Clipson, Science Museum
Teacher and student engagement with collections at the Science Museum



Museums can make science
hands-on, collaborative,
interactive and fun.



Jenn deWitt and Justin Dillon,
King's College London

Opportunities for museums to broaden
students' understanding of science

Museums fill a valuable niche and have resources that schools do not have themselves. Whatever happens to the curriculum, there are opportunities for museums to broaden students' understanding of science.

The Aspires project is a five-year study of science in schools involving 5000 students in Years 6–9. We found no drop-off in interest in science at Year 8; many students enjoy it more than science at primary level. They also have a positive view of scientists, enjoy lessons and are positive about science teachers. Despite this they do not want to be scientists.

So what is the problem? It is not about being seen as geeky, they just cannot imagine themselves in a science-related career. There is an association between science and needing to be really, really clever. Girls need to see female role models in science. Girls and boys are not sure what being a scientist really involves.

Museums have an opportunity to promote a broader image of science and what is out there in terms of science and related jobs. Museums and science centres can promote the idea that for any science content, there is a job that goes with it.

Museums should consider the image of science and scientists that they portray, developing kids' awareness of what science careers might involve. Museums can pose the question: is science a special activity done by a minority? Or is it a normal thing that lots of people do?' Museums can make science hands-on, collaborative, interactive and fun.

References

kcl.ac.uk/aspires

informalscience.org

Jenny Blay, The Langley Academy

Embedding a museum learning approach into the science curriculum



Science teachers at secondary level have the subject knowledge but they are looking for links and inspiration. ‘Curiosity, exploration, discovery’, Langley Academy’s motto, mirrors enquiry-based learning that begins with a spark of curiosity. The school is a science specialist school with a museum learning focus. It seeks to embed museum learning across all age groups and subjects including science.

What is museum learning? We have given ourselves the freedom to say it is about objects and how we use them. It is also about how we use museums, how we use the people who work in museums and their skills. We have built sustainable partnerships with both local and national museums. The Langley method is based on a New York museum school model. Elements include looking, researching, asking questions, presenting ideas, making displays, finding connections, evaluation, handling objects, listening.

Why are we focusing on museum learning? Museum learning is a tool that helps to meet students’ needs. It is particularly useful in developing students’ cross-curricular thinking. We want students to link ideas together and encounter real-world applications.

What are the opportunities for embedding museum learning across the curriculum and age range?

At Key Stage 3 we want to maintain students’ interest and enthusiasm by giving the ‘wow’ factor. Year 9 has

most opportunities and gives more freedom to do things with discrete groups of kids. For example, Year 9s have been involved in a project with the Science Museum, working with designers on an exhibition about pain and consciousness. The students involved are influencing their peers to see science as exciting.

GCSE is more challenging as it is hard to break into exam years. However, once there is an opportunity which is linked to a course module, this will be used year on year for multiple cohorts.

At A-level, despite these being exam years, teachers have the most freedom with students to organise museum-focused projects. They must relate to the exam, but soft skills including how to tackle exam questions and write balanced answers are a challenge that museum projects can help solve. The museum learning approach helps with the skills of summarising, explaining, exploring, which in turn helps in exams when students are given a lot of new information.

Social media opportunities are currently limited. You may be excited about social media, but it is so hard to explore their possibilities in school. For example, it is not possible to access Facebook pages. Schools are not ready for using these platforms.

References
langleyacademy.org

Hannah Clipson, Science Museum

Teacher and student engagement with collections at the Science Museum



Museums allow students to develop curiosity and inspiration by bringing material from textbooks to life, but there are also barriers and challenges posed by our collections.

At the Science Museum we are aiming to make collections physically, intellectually and culturally accessible, giving life-enhancing experiences that are engaging, inspiring and memorable. We know that objects can elicit strong feelings and reactions such as shock, awe, amazement and personal recollections. The benefits of objects for students are that they can observe and appreciate real things, researching and contextualising subjects and ideas introduced in the classroom. Appealing objects can be authentic, familiar but perhaps shocking, linked to prior knowledge, have a 'wow' factor, be personally relevant, large, working models or big things with intrinsic appeal.

However there are also barriers which need to be overcome. Students often find the language used in interpretation quite dry and formal, which is problematic and disengaging. The interpretation often does not reflect the diversity of science. As one teacher noted, 'All the "famous people" stories from my museum are about dead white men – not portraying science in the way we really want!' The sheer volume of objects in some galleries can be overwhelming. Teachers do not have time to create a bespoke visit or select particular objects to focus on which will engage a full class. Curriculum links are not always obvious or easy to discern. Sometimes objects were originally meant to be working or moving, but on display they are static. Objects can be

remote, bland, silent, incomprehensible, perceived as educational, and students are not able to see the relevance to their own lives.

Our research with teachers shows that they are asking for themed content and context around curriculum topics which build on prior knowledge, particularly interpretation which focuses on personal stories and human connections. They are looking for creative ways to encourage pupils to engage independently of teachers and opportunities for interaction with expert facilitators – for example museum staff in character or lively demonstrations and explanations. Teachers have limited time and feel more encouraged to make visits when provided with resources and ideas for pre- and post-visit activities. In response the Science Museum has developed a prototype for an iPad app to support Key Stage 3 science teachers in engaging their students in science curriculum topics behind our objects. The response from teachers was positive and has helped us plan future resources to support teachers. Ultimately we have to continue to ask teachers what they want to ensure that we are offering them resources and ideas that are useful and encourage them to visit the Museum with their students.

References

Morris, Hargreaves and McIntyre, 'Revolutionising the classroom – engaging teachers and pupils with object-rich galleries', unpublished report (London: Science Museum, 2011)

K McSweeney, 'Model of object engagement with objects – students and teachers', unpublished report (London: Science Museum, 2011)

Barriers to learning and teaching science in museums

At the end of the morning session, participants were asked to consider their own museum and reflect on the barriers teachers and school students face when using the collections to support science teaching and learning. The common ideas are identified below.

Major themes

- **National curriculum constraints:** It can be tough to link collections with what schools need to teach, referred to as 'NC blinders'.
- **Teachers' time:** In planning and preparing for visits, accessing resources beforehand and once inside the museum.
- **Seeing relevance:** Both teachers and students struggle with this. Collections are historical, they disconnect from the now. 'What does this mean for me?' We need better stories as a way into objects.
- **Object/physical issues:** Vast collections, poor or inadequate interpretation, outdated gallery design, physical barriers.

Secondary themes

- **Confidence/attitude/awareness:** Teachers can be intimidated or afraid to say they do not know about the topic. They do not think of using objects to teach.
- **Availability of support resources.**
- **Narrow perception of the potential of collections:** For example, teachers know natural history collections can be used to study evolution, but do not realise collections can support learning chemistry, physics, maths. Not all museums are seen as a science destination.
- Museums have a **limited budget** to pay for live interpretation on galleries.
- Museum professionals **lack a shared language** with each other and with schools.





Sharing ideas and tips for using handling objects.



Afternoon session

How can we engage students in science using museums?

Lucinda Blaser, Royal Museums Greenwich
Technology as the facilitator

Emily Dutton and Louise Palmer, Horniman Museum
Handling objects

Tanya Dean, Science Museum
Extension objects

Alison Taubman, National Museums Scotland, and **Chris Speed**, Edinburgh College of Art
QR codes and ghost objects

Alyson Webb, Frankly, Green + Webb
Potential and challenges of mobile technology

Lucinda Blaser, Royal Museums Greenwich

Technology as the facilitator



The National Maritime Museum has created a mobile app to help school students engage with the objects on display. The software is open source and therefore adaptable both within the museum as well as for the wider museum community.

We asked some students, 'What kind of activity would you invent for the museum if there were no limits?' They said, 'A quiz.' We said, 'Really?'

What we have developed is a mobile application which uses optical recognition technology. The students set their own statement to prove or disprove and are let loose on gallery. They take pictures of objects that show both sides to the topic. We have also given them extra links to other objects in our collections that might not be on display. They can follow routes. We give animations, characters who offer face-to-face interaction, audio clips.

The students are inspired by what they find interesting, and they create a spider's web. They collect five pictures that either support or contradict their statement. They have to think about what is important to them – like creating an essay but in digital format. The students get so passionate they want to go further. We give them their material in a PowerPoint document, which teachers love, to create their own things at home so that they maintain their learning and inspiration. We have noticed that the students are really enjoying our mobile app, so we are going to provide one as part of a new gallery we are producing.

Participant thoughts

- Technology-supported experience benefits from human mediation – it is a tool to scaffold a process that has been effective for years.
- Technology helps make an educational resource more relevant and engaging.
- This is a way of associating objects on display with other information and objects.
- It could help extend pre- and post-museum interaction.
- It is very positive that this is an open-source project available to others.
- How do museums hope to keep up with changing technology for involving students? How can this be future-proof?
- One of the challenges is that students get locked into the screen when we want them to take a look at the object on display. They tend to say, '**I like to see objects in 3D on a screen**' – despite the fact that the object is there in front of them.

Emily Dutton and Louise Palmer, Horniman Museum

Handling objects



Handling objects provides a unique opportunity to 'touch' the collection and ask questions, and so learn by self-interpretation. Our approach using our handling collection is about enquiry-based science education – how can objects themselves show how science is a process of enquiry? We use critical thinking skills to do individual science thinking.

The Horniman Museum is an amazing, eclectic collection of objects. We have musical instruments, anthropology, live animals and natural history. Therefore, the relationships we can make between objects are infinite.

We also have 4000 authentic objects in a handling gallery called Hands On Base. It is a gift because we can make links between science ideas and other ideas, teach pure science, look at the environment, evolution, go behind the scenes with garden staff, or look at the biology behind the conservation department.

A quick demonstration:

One volunteer takes the object and the rest of the group ask questions about it. The only rules are that you cannot give the object a name. But we can ask questions about it... What noise does it make? Does it smell? What is it made of? What is on the other side? What is inside? Can you open it? The group also make suggestions... Could it be for making music? Could it be for a magic trick?

Ultimately our goal is to find out the function of an object or the reason it was made. Naming objects can be really unhelpful because to interpret the name requires specific prior knowledge.

The demonstration showed the power of questions to open up discussion, in the opposite way to labels which can sometimes close it down. It also allowed the group of non-expert 'students' to be both asking and answering the questions.

Participant thoughts

- There is no need for specialist knowledge to engage with objects.
- Less is more – quality versus quantity.
- Give students space to ask their own questions.
- Inspire pupils to be courageous and inquisitive.
- Labelling can be counterproductive.
- Objects are inherently engaging – there is no need for unreliable technology.
- Balance content/knowledge sharing with a questioning process.
- Handling historical collections versus conservation issues.

We are looking for ways to get visitors asking the right questions.

Tanya Dean, Science Museum

Extension objects

Extensions are objects or props which explainers use to help them explain scientific concepts behind the interactive exhibits in hands-on galleries. They can help prolong engagement with interactive exhibits, but can they increase student engagement in object-rich galleries too?

In our hands-on galleries we look for ways to get visitors asking the right questions to enable them to work out what the interactive is trying to show them. For example, the hydrogen rocket is really exciting, but as soon as it explodes the students want to leave and not talk about the science. How can we adapt this approach to engage students in the object-rich galleries?

Object extensions are great for lots of reasons. They can prolong engagement with the interactive. You can use extensions to change the pitch of an interactive by giving a simpler way to explain it or a more complex example. Or it might be that you want another example of the same concept so you can show it in different contexts and make links to students'

own lives. Sometimes you can show something the students can do at home so they do not forget it. For example, 'ear gongs' show how sound travels through objects.

Extensions in object-rich galleries could be used to make visible something that is not visible, or show how something moves when the object on display is static. For example, pistons on Stephenson's *Rocket* could be described using a bicycle pump.

Participant thoughts

- Prolong engagement on gallery.
- Make an object interactive.
- Encourage questions.
- Help tell a story.
- Reinforce a principle.
- Be brought along by students.
- Be used by volunteers.



Alison Taubman, National Museums Scotland, and Chris Speed, Edinburgh College of Art

QR codes and ghost objects



This is about relevance, personal stories and visitors creating content.

A new gallery, Scotland: A Changing Nation, had objects tagged with QR codes. This tied in with the idea of 'the internet of things', in which everything will be tagged, helping make links between things. But the internet of things has new stories on new things. The idea of the museum project was to use social web platforms to add stories to old things.

This project used QR codes to tag things in the museum within living memory, encouraging people to leave their own memories and stories connected with the objects in the gallery.

What most people do not realise is that QR codes are a two-way form of communicating and are able to accept 'writing back'. So to help people understand the idea, the curators introduced six 'ghosts' of the real things – for example a shoe that is the 'ghost' of a shoe that is really on display in the case.

Visitors could take a sticker, record a story and stick it on the ghost object. Other visitors could then scan the QR code with a phone and hear the stories which had been recorded – perhaps hearing about dance halls and courting culture in Scotland.

The shoe is now ubiquitous. It is on a book cover with its QR code, which can still be scanned. It lives on.

Participant thoughts

- Knowledge can be transferred in a relaxed way.
- Collect stories and memories.
- Plenty of visitor interaction.
- Expand information available, translate into foreign languages.
- Use this technology to change how people use museums – 'Let them do some work.'
- We need to be fearless using modern technology and linking to visitor-generated content.
- Are QR codes inclusive enough (for all ages/access to smartphones)?
- Do schools' social media policies (i.e. safety/privacy concerns) hinder this?
- Wi-Fi in the gallery did not always work.

References

nms.ac.uk/our_museums/national_museum/explore_the_galleries/scotland_a_changing_nation/tales_of_a_changing_nation.aspx
talesofthings.com



Demonstrating the use of QR codes to capture and communicate visitor stories inspired by objects on display.

Alyson Webb, Frankly, Green + Webb

Potential and challenges of mobile technology



We want to get students talking about science in museums. In a conversation you have a shared framework. There is a common experience or knowledge which provokes sharing and contrasting opinions. How can mobile learning support this kind of experience?

We encounter mobile learning through guides in museums, delivering data. But the mobile in your pocket is a communication device. It is not just for receiving calls but also texts, Facebook, Twitter and Instagram. The conversation should be two-way and encourage social interaction with peers. We tend to believe that guides close down conversation. But evidence suggests that if bites of content are short, then they can support conversation. They should encourage active looking, interrogation and asking you to look at things in a particular way. If you structure this well, it can be provocative and stimulating. Students can also do this for themselves and take more ownership over their experience.

A lot of mobile projects are quite complex and large, and cost a lot of money. So why not hijack what people are already doing? For example, people are already taking photos, so why not build an activity around that? The Tate Smart Guide allowed students to access interpretation, but they could also draw, write and record their own content to be shared, used and shaped back in the classroom.

Digital is new, sexy and exciting, but it will require you to go back to all the skills you already have and reapply them in a new way. Teachers need to feel super-confident before they will attempt mobile activities.

Participant thoughts

- Can facilitate science journalism.
- Can create open-ended challenges or tasks.
- Potential for co-curation.
- Allows information-sharing.
- Swap roles of student and teacher.
- Good for all ages – adults want engaging experiences too.
- We want to get to the point where technology, audience and mission intersect. Then they are all beneficial to each other.
- Keep it simple – do not go too resource intensive.
- Concerns over misuse of data or unreliable internet sources.

References

L Novey and T Hall, 'The effect of audio tours on learning and social interaction: an evaluation at Carlsbad Caverns National Park', *Science Education*, 91/2 (2007), pp260–77



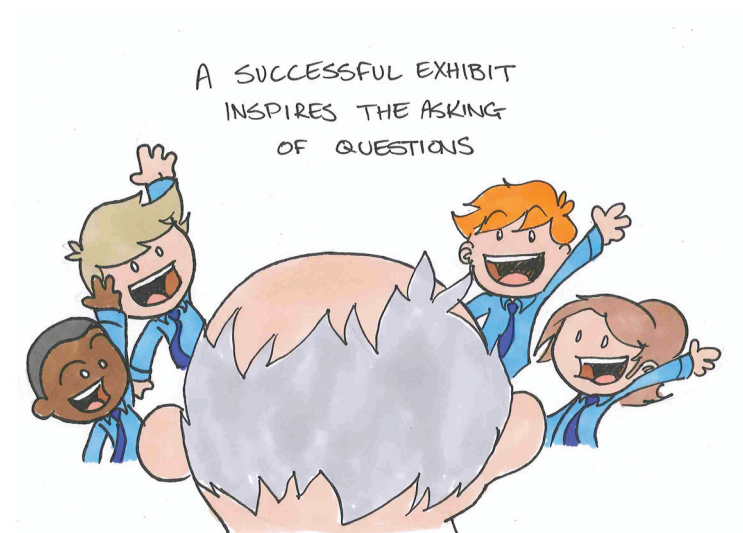
Organisations represented at the seminar

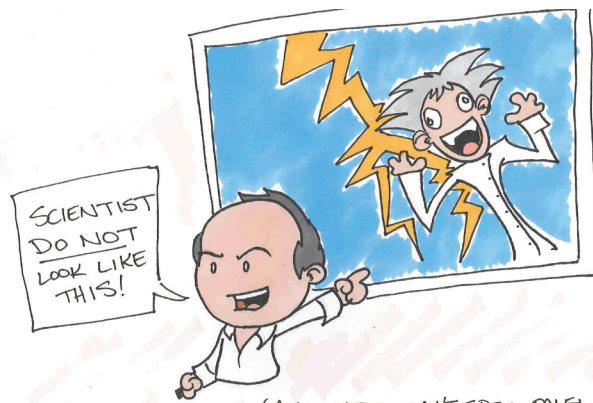
Coventry Transport Museum
Edinburgh College of Art
Firepower – The Royal Artillery Museum
Frankly, Green + Webb
George Marshall Medical Museum
Hampshire & Wight Trust for Maritime Archaeology
Horniman Museum
Imperial College London
The Infirmary, Worcester
Islington Museum
King's College London
The Langley Academy
Museum of Science & Industry, Manchester
National Maritime Museum
National Media Museum
National Museums Scotland
National Museums Wales
National Railway Museum
Natural History Museum
Quex Museum
The Royal Institution
Science Museum
St Paul's Cathedral
TextWorkshop
University of Glasgow

Illustrations

Three artists – Helen Broadbridge, Matthew Loffhagen and Srividya Sridharen – were invited to create illustrations that captured the ideas discussed by the speakers and delegates throughout the day.

All the illustrations can be found online at [flickr.com/photos/scmlearningresources](https://www.flickr.com/photos/scmlearningresources/).





(ALSO KIDS CAN'T SPELL ~~PALEA~~
~~PALAEON~~
~~PALAEONTOLOGY~~
DINOSAUR GUYS)



SCIENCE NOW EVEN LEARNING



The Talk Science project has five years' experience of working with 2500 secondary science teachers. Talk Science is about facilitating young people in discussing the science that shapes their lives.

Supported by BP

