How can natural history museums support secondary science teaching and learning?

A consultative study  Sally Collins and Andy Lee
Foreword

The importance of science in our lives has never been more obvious, yet we continue to grapple with the challenge of enthusing students with science at school and its study post-16.

Teachers readily acknowledge the need to ‘bring science alive’ and to enable students to understand how science and scientists work. Teachers cannot do this on their own, which is where natural history museums can be so important. This report clearly reveals the positive and lasting benefits of visits to natural history museums and engagement with scientists working there. Museums are a rich resource of materials and people to enthuse students of all ages. The initiatives set out in the appendix show just what can be done.

By collaborating, the four natural history museums have ensured these events are available in a wide geographical spread, thus reducing the travel demands and potential disruption to school timetables.

I commend the museums involved in this programme and look forward to the findings of this report being used to develop more innovative ways of supporting science in our schools and colleges.

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Chair, The Learning Trust, Hackney

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How can natural history museums support secondary science teaching and learning?

Sally Collins and Andy Lee (Natural History Museum)

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King’s College London (KCL), [www.kcl.ac.uk/depsta/education/](http://www.kcl.ac.uk/depsta/education/)
Centre for Informal Learning and Schools (CILS), [www.exploratorium.edu/CILS/](http://www.exploratorium.edu/CILS/)
Abstract

This report presents the findings of a qualitative study that asked 38 secondary science teachers, ‘How can natural history museums effectively support science teaching and learning?’ A partnership of four natural history museums across England, teachers from their local areas and a university education department were involved. The museums work in partnership to support school science at 11–18. In-depth focus groups held at the museums and questionnaires were used.

The strongest themes to emerge were that natural history museums can effectively support science teachers by providing access to resources not available at school, offering opportunities for students to meet ‘real scientists’, and engendering a sense of awe and wonder about the natural world. Contact with lively and engaging scientists was seen as particularly valuable for informing career choices, and to support the new KS4 curriculum changes. Preferred museum activity formats were discussed and strategies were suggested to make best use of traditional museum displays and to facilitate student discussions with scientists. Practical information was obtained from teachers such as the preferred months to schedule events for each Key Stage.

Earth science, classification/taxonomy, evolution, Ideas and Evidence and ‘how science works’, were identified as curriculum areas that would particularly benefit from natural history museum resources and expertise.

A summary of the teacher recommendations and the partnership’s response in terms of its schools’ programming is described.

The origin and scope of the research

This teacher consultation arose from a partnership of four English museums needing to know how to channel their resources most effectively to support science teaching and learning in secondary schools. The motivation for the research was therefore practical. The museum partnership wished to gain an in-depth understanding of teachers’ views first-hand. Focus-group discussions were considered the best way to achieve this.

The partnership believes its institutions to be of a type that can offer unique support to secondary science. This is because each museum has access to the following:

- extensive natural history collections of international significance
- world-class curators and scientists involved in active research
- experienced museum education staff and provision for large numbers of school visits
- awe-inspiring exhibitions and galleries, with displays linked to the National Curriculum

The findings of the teacher consultation have directly informed the planning of the partnership’s secondary science events.

Applicability

The advice given by teachers within the consultation provides a valuable insight into secondary science support for other museums and science centres with natural history collections.

We hope the findings of this report will be helpful in providing pointers to curriculum links and effective learning strategies.
What research already tells us about the learning of school science in museums

Martin Braund provides a helpful overview of research into learning science at museums and hands-on centres and galleries (2004). Although the area is now receiving more attention, research providing evidence of improved knowledge and understanding in science following museum visits is limited.

The experiences of museum education staff interacting with school groups daily, suggest that museums and hands-on centres and galleries may be places where considerable conceptual development occurs. Explainers regularly provide anecdotal evidence of ‘eureka’ moments of understanding during an interaction. These seem to correspond to the intellectual leap to the ‘accommodation’ of a concept, as described within the constructivist view of learning, influential within science education for over 20 years (Driver, 1983). The ‘change of scene from school’, exhibits which are often purpose-built to communicate scientific concepts and talking with explainers, may be strong environmental triggers for the construction of new meanings. Stevenson (1991) found that family visitors to an interactive science gallery could recall the details of scientific ideas addressed by exhibits six months later. Falk and Dierking’s contextual model of learning in museums (2000) may be helpful in further understanding museum effectiveness in facilitating improved learning of school science.

The effect of repeat visits to a museum on a child’s understanding of school science has not been studied, although again, anecdotal evidence suggests a positive impact. One example is a visitor’s account of her daughter’s outstanding KS1 Standard Assessment Test (SATs) results. The child’s teacher attributed her success to years of repeat visits to the free-entry interactive galleries of the Science Museum in London. The child understood many of the exhibit’s challenging concepts, and perhaps most significantly, knew the names of all the explainers staffing five galleries, an indicator of time spent engaged in discussion.

Research on student views of learning activities

Braud explains that research does provide evidence that museums can have a major impact on pupils’ attitudes to learning science. That museums can affect attitudes to learning science is substantiated by a review of the science curriculum, conducted by students in 2002 (Murray and Reiss, 2005). Students designed a web-based survey for fellow 16–19 year olds, asking about their experience of learning school science. ‘Going on a science trip or excursion’ was rated the most enjoyable teaching and learning method out of 11 suggested options. Eighty-one per cent of 1,450 respondents included it in their top three. Second and third most enjoyable methods of teaching and learning were (2) ‘looking at videos’ and (3) ‘doing a science experiment in class’. This finding brings the potential of museums to impact positively on student attitudes to science into sharp focus. Arguably, the finding also brings with it a responsibility for museums to provide an enjoyable, inspiring experience for school scientists. Braund states that museums are rich and stimulating environments. They can and should be joyful places for learning... they are places where pupils can learn to place scientific phenomena and concepts within everyday contexts... where science is viewed and learned with a sense of awe and wonder (2004).

The preceding question in the student survey may be of even greater significance to museums. It asked ‘Which (of these same 11 methods of teaching and learning) are most useful and effective in helping you understand your school science?’ Students felt the top three were (1) ‘having a discussion/debate in class’, (2) ‘taking notes from the teacher’ and (3) ‘doing a science experiment in class’. Although there is little dispute that the main strength of a museum visit lies in its difference to the classroom experience, this finding is perhaps helpful. If we wish for meaningful learning to take place during a school visit, discussions and debate may be a useful focus for museum planning. That students find note-taking useful for learning is possibly a little surprising, but this may reflect...
the desire to record concepts, and to be given enough time to consider them. Both these factors can be supported through museum provision of pre- and post-visit information. ‘Doing a science experiment in class’ relates specifically to the school setting, however it may be useful for museums to note that this has been rated highly as both enjoyable and effective for learning. The benefits of specimen and artefact handling are well known to museums. The action of touching and observing closely, rather than just looking at objects in glass cases, stimulates questions about where the object is from, what it’s made of, how it ‘fits in’ the natural world (Hooper-Greenhill, 1991). However, the finding suggests that a greater focus in natural history museums on practical experimentation, perhaps reflecting the working methods of scientists and using materials not available in schools, might be appreciated by science students.

The survey revealed that the majority of respondents (69%) wished for controversial issues such as genetic engineering or cloning to be included in the curriculum. A majority of 57% also requested philosophical and ethical issues to be included. Natural history museums may be well placed to support these requests through their links with the scientific community.

The described student review of the curriculum helped to inform changes to the KS4 curriculum in 2006. To support science effectively at KS4, it is necessary for natural history museums to adapt to the increased focus on ‘how science works’. Teachers will require examples of working scientist research, particularly work involved with topical issues in science.

The consultation process

Recruitment

Secondary science teachers of all Key Stages were invited via email to attend focus groups at each of the partner museums. Recruitment proved difficult. Despite offering teaching cover costs, most teachers came during their lunch hour and free periods, an indicator of the difficulty of obtaining release from timetabled teaching. Recruitment was via existing contacts between the museums and schools. Most of the teachers had previously used the museum for a school visit.

Data collection

Education staff within the partnership led focus groups at their respective museums. A consistent discussion format was used at each focus group. Each session was recorded onto audiotape. NHM staff were present at focus groups at each partner museum except two: one at HM and one at OUMNH.

A questionnaire was used at the sessions to capture straightforward quantitative data, and explanations for these data. These questions mostly addressed the logistics of planning a visit.

A breakdown of numbers attending each focus group is given in Figure 1

<table>
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<tr>
<th>Focus group attendees</th>
<th>Questionnaire responses</th>
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<tr>
<td>Natural History Museum</td>
<td>15</td>
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<tr>
<td>Oxford Museum of Natural History</td>
<td>7</td>
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<tr>
<td>Manchester Museum</td>
<td>9</td>
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<tr>
<td>Hancock Museum, Newcastle</td>
<td>7</td>
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<td><strong>Total</strong></td>
<td><strong>38</strong></td>
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Figure 1. Numbers of focus group attendees and questionnaire respondents

The majority of teachers were biology specialists (Figure 2). The number of teachers who taught at the KS5 level was not captured.
Data analysis and reporting

NHM staff collated and analysed the data from the audiotapes, observation notes and the questionnaires. The majority of the analysis was qualitative in its approach. Emergent themes were identified from the teachers’ talk, which was within subject areas imposed by the focus group leader. The emergent themes are summarised in the following sections. The section headings are the imposed subject areas for discussion. Where general agreement across the museums occurred, this is stated as ‘Teachers generally...’ After a summary of views is described, quotes have been selected to illustrate meaning. The full range of emergent themes across the focus groups is reported here. Some discussions moved to subject areas that were only addressed at one or two museums, and sometimes only briefly. Some subject areas therefore only have one or a few quotes. Other frequently addressed subject areas, where many nuances of meaning were expressed, have many illustrative quotes. All the discussions concern the use of museums by secondary school science groups only. The quantitative data from the questionnaires is reviewed in Section 6, with a qualitative analysis of the written explanations teachers gave for their responses.

Summary of outcomes

Discussion subject 1: Formats for museum activities

Teachers were asked to rank nine museum activity formats in order of their effectiveness for learning secondary school science. Figure 3 shows the overall ranking from the NHM, HM and MM sessions combined (data was not collected at OUMNH).

Overall rank Activities
1 Fun science shows with practical demonstrations
2 Debate with scientists engaged in active research
3 Talks/lectures from scientists engaged in active research
4 Focussed tasks using museum collections and specimens not normally on display
5 Focussed tasks using museum galleries and displays
6 Practical experiments
7 Interactive tours
8 Activities involving group presentations from students
9 Free exploration

Figure 3. Outcomes of activity format ranking exercise, 1 = most effective use of museum resources, 9 = least effective use of museum resources
Teachers were then asked to tell the group which activity formats they thought were the most effective for learning and why.

**Fun science shows with practical demonstrations**

Teachers generally felt shows and demonstrations had the potential for communicating scientific concepts very well, in a fun and engaging way. They felt the format was particularly appropriate for KS3. Teachers had been impressed by the props and experiments used in school science shows they had experienced. The Royal Institution Christmas Lectures, shows at the Science Museum in London, and the Royal Society of Chemistry’s *Dr Bunhead* events were highly regarded, and so were used as points of reference for this format.

... you can do so many things we can't even begin to do in school. And practical demos are often memorable, they remember them long after. NHM 27.6.05

The need for good communicators and the requirement that fun shows should communicate curriculum concepts was emphasised by some:

If children say to me (about a lesson)... it’s boring, well there’s just not much else I can do with the nitrogen cycle... and when they get fun shows I feel it’s throwing my lessons in sharp relief: Things which demonstrate a principle are brilliant, and a good idea, and it’s wonderful that people have more imagination than I have, but a fun show with the emphasis, purely, on ‘coo, look at that isn’t it interesting’... it needs to embed itself more in the science. OUMNH 8.7.05

**Meet the scientist**

Although fun science shows came top in the ranking exercise across all the museums, it was meeting scientists, in various formats, that most often inspired enthusiasm. Section 4 summarises strategies offered to overcome social barriers to discussion and for students to get the most from a scientist’s interaction with a class. Teachers said students may rarely encounter scientists, and that doing so would not only provide examples of real scientific research, but could also be a powerful way to inspire students to consider scientific careers. It was seen as an opportunity to provide positive role models, counter media stereotypes, and show that becoming a scientist is an attainable goal.

What I really like is the opportunity to come and hear speakers who are active, intelligent, from my point of view, women biologists, who don’t look like your archetypal (scientists)... delivering biology with enthusiasm and commitment (students may think) ‘this is where I could go next with my A-level’. That’s what I like here. OUMNH 8.7.05

When students ask ‘how did you get into this field, what qualifications did you have?’ It’s good for them to hear somebody who’s really working in it. She’s a really nice, exciting person, talking with enthusiasm, that’s what they need... talking to scientists about the route that took them there, so they can imagine doing that. NHM 29.6.05

... they don’t really understand what a scientist is, most of them think a scientist is their science teacher. OUMNH 8.7.05

Scientists should give a brief biography – this helps the students put them in context and gives the science community a more human face. MM 19.7.05

There really is loads of scope here for getting students to think about careers in science and what scientists do... when you see how scientists are portrayed in the media, you know, sort of evil scientists, or boring boffins or whatever, you’ve got to work quite hard to put a more positive spin on it. NHM 27.6.05

I don’t think the (current) KS4 Investigation gets across how science is really done... meeting a scientist and hearing them explain their work would be great for getting across what a scientist actually does. HM 22.6.05

Teachers generally thought the new KS4 curriculum, and its emphasis on ‘how science works’, meeting scientists and engaging with their work, would be a valuable support (see Section 2).

At each museum, the personality of the scientist was deemed vitally important.
I think something like this depends on the personality of the scientist. We've had people in to talk to kids and in the first five minutes they've switched off and they don't want to be there. **NHM 15.7.05**

You've got access to scientists who can talk to children. That's one of the strengths here. **OUMNH 8.7.05**

We had Robert Winston in four weeks ago. It was Years 6–10... because of the type of character he is and the topics he covered, he fascinated them, he really did... If you can get someone who can really engage the kids it can be very effective. **NHM 15.7.05**

I arranged for a scientist to speak to two classes who would probably behave and be focussed... I reluctantly got the whole year group in, much against my will, and she held them spellbound for an hour... it was fantastic... and it wasn't all practical things. She had an interactive data projector and, personality. **NHM 15.7.05**

At MM, services where scientists visit schools were discussed, such as Jodrell Bank's school outreach and the Researchers in Residence programme where PhD students formed an on-going relationship with schools. Teachers at MM agreed that if possible the ideal situation is for students to see the scientist in their place of work.

**Meet museum education staff, make students feel special**

Museum staff were also seen as highly effective in engaging students with science. Many teachers felt that students responded well to learning in museums when they had a friendly welcome, and they felt the museum was interested in communicating its science to them. Teachers requested students go 'behind the scenes', and be provided with a special experience that cannot be offered at school. When asked for the reasons teachers might bring students to the OUMNH, one teacher highlighted the opportunities students had to meet museum staff as well as scientists:

They meet real people here, they have taught sessions, they came in and actually handled specimens... I think this is important as well as actually meeting the real scientist, like when they met (the scientist) Darren Mann, they are still talking about that. **OUMNH 8.7.05**

The time 15 years ago when it was... worksheets, off you go kids, fill these in and come back, it's just completely lost on them now... it has to be something they can't have access to themselves... they have to be able to go into a room, behind the scenes, speak to people, it needs to be something different to what the public would get. **OUMNH 8.7.05**

I think going behind the scenes is very important, they've stepped beyond where the public go... that has an impact, that has a bit of awe about it... I was very impressed by it. **NHM 15.7.05**

The museum must have input. Offer something you can't get from the telly or the internet... like talking to Darwin himself (gallery character)... that's what people will come for... the experience we can't give them at school. **NHM 27.6.05**

**Archived meet the scientist sessions on the web**

Archived recordings of meet the scientist sessions on the NHM's website was mentioned as a useful resource.

There's a long list of titles... there's nearly always something to do with the topic you're teaching at the time... I came for a forensic entomology talk, but I'd also shown one (of the archived talks) to some other students that couldn't come which was brilliant. **NHM 29.6.05**

**Video-conference with scientists and museum staff**

Although not many teachers present at the NHM and HM sessions had access to video-conferencing equipment, it emerged from the discussions that it was something they would like to be able to do, particularly for pre- and post-visit meet the scientist link-ups in school.

I think with video-conferencing, rather than... reducing (our) interest in getting kids in for a visit, if we'd had the opportunity to do a pre-(visit) consultation or conference, and then a post-visit one... that would actually encourage a visit and get more of the kids along... to have had a bit of a taster. **NHM 15.5.05**

There could be a marketing slant on it on your behalf. We're sent flyers from publishers left, right and
centre... but if you've got someone speaking to you from the Natural History Museum and they've got the personality required, they're basically selling this place. Come to the Natural History Museum, this is fun and you will learn... NHM 15.7.05

At HM and MM it was noted that some City Learning Centres are offering video-conferencing sessions, and these were highly recommended.

**Challenge students to form opinions**

Activities where the students are challenged to form their own opinions were considered useful.

*I think the most important thing is to challenge students to form opinions... that's where Science GCSE is heading and that's what kids just can't do. That's where the idea of the Great Debate workshop is interesting (OUMNH and NHM KS4 workshop). You could get kids to actually engage and be involved and participate in that process, equip them with skills to evaluate data, evaluate evidence, so if they read in the newspaper that if they get less than eight hours sleep a day they won't live as long or whatever, what do they do with that? How do they cope with that information? Do they ignore it or can they actually think, 'no I can make sense of that, I can apply that to me'.* NHM 15.7.05

**Use of Information and Communication Technology (ICT) in the galleries**

The use of ICT was frequently suggested. At an NHM session, most teachers agreed they would like teacher-led gallery activities to be structured using ICT, rather than worksheets.

A lively discussion culminated in the suggestion that information could be recorded electronically in the galleries, perhaps linked to a pre-visit activity, and emailed back to school. A request was also made for the loan of digital cameras and the ability to email pictures back to school.

*... (NHM's) worksheets look good. They look like they fit the topics nicely. But I've got textbooks that fit the topics nicely that I bore the kids out of their minds with!* NHM 15.7.05

*There is a death by worksheet. I've brought kids here (NHM) for many years, they're great worksheets, but I'd like to now see use of the interactive whiteboards that are in many schools. We've got all the IT equipment needed to be able to take anything away in the way of facts and figures. It would be nice to be loaded into a computer here, and collect it back at school, so the day is not just one of coming for the visit, going, carrying on with what we do at school, but actually then being able to make that link by accessing information they put in here...* NHM 15.7.05

**Facilitate learning through games**

Teachers at an NHM session discussed why computer games are so popular, and whether a game devised by the NHM with an educational purpose could be as enjoyable for students as those played recreationally. It was agreed that the competition element in the games was the hook that engaged students.

*... I have been surprised by what I've been able to make students do, just by putting a competition element into it... you see them rise to the challenge, (it) gets them up, gets them lively...* NHM 15.7.05

Whichever activity formats are used, many teachers emphasised that natural history museums should not lose sight of how they can engender a sense of wonder in the students about the natural world.

*Here you've got the potential for awe and wonder. That Diplodocus in the hall... it's amazing. Another picture of a horse's leg evolving down the side of the page, it just doesn't compete... Make the most of that.* NHM 15.7.05

**Discussion subject 2: Curriculum links**

Following tours around each of the museums, and explanations about their current school provision, teachers were asked which subject areas would most benefit from a visit to a natural history museum, as well as from a visit to that particular museum.
Ideas and Evidence

Ideas and Evidence was frequently highlighted as a curriculum area difficult to deliver in school, and which museums could support with both historic and contemporary examples.

I know from my own students and from marking exam papers, students can't cope with that type of (Ideas and Evidence) question, where to them it's very, very abstract. I was looking at a question we set about evolution and Darwin, Wallace and Lamarck, and they were abysmal. And nationally they seem to struggle with it... But if they'd had the chance to come in and visualise something so it was no longer abstract to them (at a museum)... you can do it to a certain extent in a classroom, but to see it on such a grand scale, in any museum, I think would help. NHM 15.7.05

Bringing 6th formers upstairs to the Great Debate room, the sheer wow factor of that, when you read about it after and you think, gosh we were there... that's a major thing as well. OUMNH 8.7.05

4C in 21st Century Science (a unit in a new GCSE exam syllabus for September 2006) is about how certainties in science and technologies and scientific ideas change over time, and about the roles in the scientific community in validating these changes... you could use Darwin to illustrate this just as well as modern-day scientists. OUMNH 8.7.05

I think (museums) are important. What you can address here in this place, and I don't think it's something we address well in schools, is the philosophy of science, and how science has developed over so many years. HM 23.6.05

The nature of science and the way real scientists work is difficult to portray in the classroom, because of a lack of access to real case studies and the scientists involved. This is the most useful way a natural history museum can support secondary science teaching. OUMNH 8.7.05

The new KS4 curriculum

Teachers generally felt that for museum provision to be most useful at KS4, it should be linked to individual exam syllabuses, rather than the National Curriculum's programme of study. Teachers agreed that marketing and teacher information should clearly state which exam board and course component a particular event supported. Although there was much speculation about the trends in syllabus uptake, there was a general agreement that to cater for all, the range of syllabuses should be supported. However, subsequent discussions then tended towards the support of particular pieces of coursework.

For 21st Century Science, students have to produce a case study, which is 20 per cent of their coursework. They've got to come up with topical issues, and if we knew that there were scientists here to discuss that with, we could channel them in that direction. OUMNH 8.7.05

At OUMNH, specific case studies were requested, for example one relating to biological control and interdependence. Discussion then occurred as to how to broaden the appeal to teachers not wishing to use the event for coursework. It was proposed that museum marketing could suggest other ways in which the 'coursework event' could be used, e.g. for a related project, to support other parts of the specification, or as a springboard for a debating activity. If the event could be used for coursework, on-line information about the scientist's research could support student reports, and provide case-studies for schools unable to attend.

It was clear from the discussions that museum staff will have to research the syllabuses thoroughly if they wish to effectively support KS4 science students.

Earth sciences

Teachers were asked to write down topics within the life and earth sciences that would particularly benefit from support. One very strong theme to emerge was the need for help with the delivery of earth science. This was generally attributed to a lack of resources and expertise in schools.

Geology is generally quite difficult due to the wide range of materials needed and cost involved in purchasing them... as a general rule, the museum provides a wider range of resources than those available in school. The wide range of samples in the Earth Lab (at NHM) really helped pupils realise the range and scope of geology. NHM 15.7.05
The rock cycle at KS3. It’s popular with the children, but schools are lacking resources. MM 19.7.05

Geology was a difficult area, although now (OUMNH’s) loan box and activities have been well received in school. OUMNH 8.7.05

Plate tectonics, due to a lack of 3D models. We have to rely on computer animations... 3D models (at the museum) would certainly give the pupils a better appreciation of plate tectonics. NHM 15.7.05

KS3 rocks and weathering and the rock cycle, there’s a lack of expertise and resources. NHM 15.7.05

Fossils and how they are formed, the rock cycle, plate tectonics and volcanoes... earth sciences are not popular to teach. MM 19.7.05

Specific topics within the life sciences

At MM and NHM, evolution was identified as a difficult topic to teach, due to student difficulty in grasping the timeframes involved, and a lack of fossils to show.

Evolution relies on textbooks and video, as there’s usually a lack of fossils... NHM could help ‘bring to life’ evolution, which is often seen as boring and dry. It has the historical context of Darwin’s ideas, as well as fossil evidence, so pupils can see for themselves what the textbooks say. NHM 27.6.05

The fossil record. Students struggle to perceive such large time frames and the concept of evolution. NHM 15.7.05

Classification, variation, adaptation, genetics and inheritance, microbes and disease and interdependence were frequently identified as difficult to teach due to a lack of resources and/or practical activity.

Certainly classification. We don’t have specimens. (Students can learn about classification by seeing) how (the specimens) are all put together here, classified, how it’s all stored... why we classify them and why they are there. NHM 15.7.05

Students want to know what animals are and what they look like. We need to open their eyes to the diversity of life. There was a KS3 SATs question, which asked about antlers – and many pupils didn’t know what they were! The number and variety of animals can be presented by the museum using their collections. MM 19.7.05

Adaptation to the environment. You could use the vivarium to explain how and why specific environments have been created and also talk about lifestyle. MM 19.7.05

3D models were often requested, particularly to support the teaching of human physiology.

... the digestive... and nervous systems, inheritance and survival, selection, survival and evolution, health and exercise, the lungs, the circulation, all the above suffer from a lack of resources... (do you have) any models, simulations? NHM 15.7.05

Various aspects of human and plant physiology – they’re difficult to explain without 3D moving images... large, preferably moving, interactive 3D models are a really useful feature of museums. Students won’t have these at home or school (unlike Internet resources). NHM 27.6.05

Practical genetics workshops were frequently requested, particularly for KS5. The Polymerase Chain Reaction (PCR) and electrophoresis workshops offered by the MM and Wellcome Trust were recommended. These also provide a valuable opportunity for 6th formers to interact informally with the university students who deliver the workshops.

For KS5 support, many of the topics already highlighted were suggested, as well as forensic science, the psychology of learning (which both feature in the new Salter’s Nuffield Advanced Biology syllabus), plant reproduction and evolution, farming, mono-cultures and sustainability.

Environmental issues

Teachers at an NHM session discussed how scientists could make environmental issues seem more ‘real’ and urgent.

Students say coal and oil aren’t really going to run out... and no matter what you tell them they still don’t believe it. Hearing it here from a scientist (would help). NHM 15.7.05
Students tend to think of (human impact on the environment) as a bit of a wishy-washy topic... I'm constantly finding teachers setting it as self-study research projects and (students) are left to get on with it... they're totally uninspired by it. But actually seeing someone who’s on the job... would hopefully reinforce it a bit better than 'there you are, go to the library' NHM 15.7.05

Teachers discussed how scientists could be very helpful in clarifying the differences between key environmental problems.

Global warming, greenhouse effect, CFCs, ozone layer, acid rain as far as the students are concerned it’s all the same thing. If scientists explain it to them they might listen. NHM 15.7.05

... (CFCs, CO₂) They'll include all of those in an answer in an exam question, every one of those. They'll all be piled in... as one big problem. NHM 15.7.05

Even on News at 10 they get them confused. A headline BBC programme at 10 o'clock – they'll move seamlessly from global warming into the ozone layer. NHM 15.7.05

It was again agreed that when discussing serious scientific issues with all Key Stages, it was vital to choose an engaging scientist.

Support for teacher’s Continuing Professional Development (CPD)

Some teachers suggested that museum scientist expertise could be used to help improve subject knowledge in earth science and taxonomy.

I really liked the fact you can teach taxonomy here, as it can be such a dry subject. The taxonomy workshop we did here with the Year 12s, I'd like to do that with my colleagues in the science department. I think earth science CPD would also help people. NHM 27.6.05

Discussion subject 3: How to make effective use of traditional museum displays

When teachers were asked how they would use the traditional, Victorian-style galleries, this generated lively discussion at each of the museums. The general view was that the displays could engender a sense of awe and wonder about the diversity of life, and so could provide an inspiring introduction or consolidation activity for a topic (e.g. variation, classification, evolution). Particular specimens could illustrate certain learning points, e.g. the stories and science associated with the coelacanth, dodo, and Archaeopteryx. It was generally agreed that use of these galleries would have to be structured to some extent. Some teachers thought a staff-led walk-through, with certain specimens highlighted was sufficient, others envisaged more structured tasks.

What can students learn?

I think... those conventional displays... when we walked down those corridors, and even the Darwin Centre, just seeing all those specimens... I just wanted to go back and have a look. The main function for me is just to inspire them (the students)... I think that’s a good use for them... so that you’re overwhelmed by the sheer numbers and the variety. NHM 29.6.05

They do see a lot of nature programmes, but a lot of it is very small snapshots (of nature), and I think seeing some of that (the specimens in the display cases of the conventional galleries) is a big brushstroke of (life)... it's just 'bang' there it is. It is quite awe-inspiring, seeing the massive variety of life. NHM 29.6.05

You also have the stunning amount of biodiversity here (at OUMNH)... That (insect) display upstairs... you could almost not have any writing on it, the complexity of the display almost speaks for itself... I think there's a sheer wow factor of coming here and seeing that. OUMNH 8.7.05

... you know the skeletons of the horse, man and dog?... just to go past something like that and see it, will be very memorable for them. NHM 29.6.05
I love the Hancock... I like the idea you can look round and find things for yourself, and you don’t have to press a button to find what the answer is... Although the students are used to instant information, I think we should offer them both... if they’re particularly interested in something... they can just look at all the different shapes of the insects, and how big some of them are... Because I like that (type of display) myself, I might be able to transmit that to the students. HM 22.6.05

We’ve visited with 6th form before... they like seeing things they’ve not seen before. They might not necessarily do what they’re supposed to have done when they got there, but then they will have noticed something that interested them, or something that was funny or memorable. HM 22.6.05

After I brought my group last time, some of them wanted to go and see some other bits... and this was our lower ability group... I thought they couldn’t wait to get out, but they wanted to go and see something else for themselves. Just being there, looking round was great. NHM 29.6.05

I’m always amazed by how little natural history experience my students have. They wouldn’t be able to recognise any kind of wild flower, let alone insects or spiders, so to see all this variety, which probably passes them by to a certain extent, I think is very important. NHM 29.6.05

An atmosphere conducive to learning?

Although the traditional displays were valued by teachers at HM, they suggested that the galleries may be too quiet, and the atmosphere not necessarily conducive to encouraging discussion among students.

I think it’s a bit too quiet sometimes, even when you’re just looking. You could have some background noise, some rainforest music or something... because I think (when it’s quiet) it makes you whisper to each other and not talk about things, or you think you might be staying too long, or somebody might be watching you. I think kids might feel like that. HM 22.6.05

Further opportunities to support Ideas and Evidence and ‘how science works’

At the NHM and HM, it was suggested that the traditional displays be used to address how the Victorian collectors ‘did’ science, compared to how the modern-day museum scientists carry out cutting-edge, collection-based research.

At HM, one teacher proposed that in addressing how Victorian scientists worked, the ethics of taxidermy and collecting could be discussed. This could possibly lead to a comparison of Victorian and modern-day practices in the field, and the current need to catalogue biodiversity by ethical means.

I think (students) will ask why (the specimens) are stuffed, and you could bring ethics into it, look at ethics and knowledge... but also, the history of science... this is what people used to do, this is how we found out about it. HM 23.7.05

Strategies for using the traditional galleries

Teachers generally agreed that the use of the traditional displays to inspire students would need to be structured in some way.

... otherwise they’d just wander... as it is so vast. NHM 27.6.05

However, some of the suggestions became noticeably more structured than ‘walks through the brushstroke of life’.

The variety of interactive exhibits and the traditional ones, I quite like that. I like the fact you have the choice... I think the students could cope with the (traditional) Birds gallery, if you showed them that first and then the interactive bit... but in order to hold their interest it would need to be very structured ‘go to this cabinet and find this... then go to this cabinet and find that’. I think they could manage quite happily... but you couldn’t give them free rein. HM 23.7.05

... (Question sheets and quiz sheets) are good because it’s not always the teacher that takes them round... if you split them into smaller groups it could be a learning assistant that takes them round, if they’ve got what the students are supposed to do in their hand, it helps them. HM 23.6.05
... (To try and move away from worksheets and closed questions) you could have a group of students in the Birds gallery, a group of students in another gallery, and then come back to the lecture theatre at the end of it and give a presentation.  

HM 23.6.05

You could look at it in terms of... you're going to do a project, spend a lesson in school preparing yourself for when you go to the Hancock, perhaps direct the students to a website to get information, they come here and they've got something specific to look for, they've got a big build up, and back in school they can finish it off, it might be to build a model... do a presentation...  

HM 23.6.05

I think it's good if you give students, not a worksheet, but like that quiz we did here with Year 8. They did the talk in here so had some background knowledge, and then it was... let's see who can go and get the most points now out of the museum, go off and look at something for 15 minutes. I think that kind of thing works very well.  

OUMNH 8.7.05

Through discussion, teachers moved towards agreement on strategies that allowed students to freely search the displays in a selected gallery, but that the search should be motivated by a set task.

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**Discussion subject 4: Discussions with scientists – how?**

Teachers were asked their opinion on formats for class encounters with scientists, which would break down social barriers and most effectively facilitate discussion.

*Have more than one scientist, if they can afford the time. Then have smaller groups.*  

NHM 27.6.05

*It depends on the age of the children. I think the KS3 children would be better off with the Christmas Lecture-style demonstrations... to keep them entertained as well as focussed, whereas the older ones might benefit more from a chat show style (led by a facilitator).*  

HM 22.6.05

*A Christmas Lecture format with a few volunteers coming out to help with demonstrations is good, but it's got to be all bangs and whistles... it's got to be a show.*  

HM 22.6.05

One teacher at HM had brought a class to one of the partnership events, a KS4 Evolution Day which included a meet the scientist session with two NHM scientists.

*(The level) was probably a bit high, but I don't necessarily think that's a bad idea because it might tell what they can aspire to... it was the length rather than the content that was the problem... just a bit too long. It was good there was stuff to handle... but... afterwards they said it was a bit long.*  

HM 22.6.05

**Classroom strategies**

Classroom strategies for facilitating discussion were offered at NHM and HM, providing opportunities for thinking time and anonymous questioning.

*What about using strategies like we use in class, like using the whiteboards, and they can talk to their neighbour, and give them thinking time?*  

HM 22.6.05

*Give them a few minutes to write down a question, which the chat show person reads out. They could do that in twos or threes... the direct questions are good, you wouldn't want that to go... but you have to give them time to ask a question, and often if there is an embarrassing silence then they'll get going. You need to make sure you don't jump in because you think there aren't going to be any questions... in any (A-level) group there's usually a few who are always going to ask a question, you can guarantee it... as long as you give them a few seconds to get their thoughts together... the chat show person can read them out if necessary.*  

NHM 29.6.05

Sending a message to an interactive whiteboard was discussed, where the interviewer or scientist could select a question to read out. However this did not seem to have great advantages over writing on paper. Sending text messages from mobile phones was suggested, but no solution found for the possibility of students sending messages to friends instead.
Voting systems

It was proposed that students could vote on which questions to ask, using an interactive voting system. They love using Activate, a voting system we use in school. You can use it for answering questions too, they select a, b, c or d. NHM 15.7.05

Preparing questions before the session

It’s quite difficult to think of questions when we don’t know what he or she (the scientist) is going to say yet, but sometimes if we’ve got a scientist coming in we’ll say we want at least six questions from each of you (students), so everybody think of a question beforehand. HM 22.6.05

Why don’t you give the kids a sheet with, say, 40 questions, and ask them in groups to choose a question beforehand, that they agree as a group is a question they want answering. Then you can say, can I have that group’s question now? NHM 15.7.05

Have the basic questions you need to ask, and... before the question time they could be given out to the teacher, who could choose a few pupils they know would be happy to read out a laminated card. So have a few planted questions, just to break the ice. NHM 15.7.05

Teachers need to prime students before any sessions – a topic needs to be discussed with parents and students and questions prepared in advance. Teachers should then act as facilitators. MM 19.7.05

Debates with scientists

Holding a debate between the students and scientists was suggested as a good way to stimulate a response from pupils.

Children can be very opinionated and will answer back! MM 19.7.05

At MM it was noted that debate would support the citizenship curriculum as it includes role-play and discussion. The use of interactive voting systems was also suggested. It was felt these helped students feel connected to a debate, even if they were reluctant to speak. It was seen as important to choose topics relevant to all, and not just for those planning to study science post-16. A website relating to the discussion topic was seen as useful, tied into the museum’s programme or research.

Game format

At an NHM session, a teacher proposed a game format, which challenges students to thoroughly understand a scientist’s research and identify the ‘real scientist’ in a group. The response to this suggestion was positive, nearly every teacher present suggested ideas for it.

The class is divided into teams, and asked to devise questions... they could do pre-visit work, know the topic, so they could have some pretty tough questions so as to dig out the real scientist. NHM 15.7.05

Visual and practical elements to discussions with scientists

A visual and/or practical element to the discussion, whether it was specimen handling or a demonstration, was generally welcomed.

I think you should have something strongly visual at the start... objects, specimens from the museum... Make it visual, audio and kinaesthetic, make sure you're covering all three. NHM 15.7.05

People coming from the audience, helping with this (practical demonstration), even if it's just holding something, that style is very appealing. NHM 27.6.05

(Re. including a practical element to the session) some students want to do some of the A-Level sciences because of the activities and practicals, rather than any other reason. They’d rather do it than say history because of the practicals. NHM 27.6.05
Working on a task with a scientist

When we took the students to a university setting, the workshops that worked the best with the scientists were where they showed what they were doing... one of them was doing forensics research and he let them test all the different chemicals. He taught them what to do and how to do it, and they did it. They got more out of that because they could see it was relevant. HM 23.6.05

They were really proud, when (the scientist) said they had done well (with their presentations) at the end. They talked about that quite a lot next lesson, that he'd said they'd done well... they thought what he said was very important and that he thought they'd done well. HM 22.6.05

A task before meeting the scientist

Some teachers felt that a task related to their encounter with a scientist beforehand, using the museum's collections, would be beneficial.

To get them going... have a focussed task with the museum's collections and then meet the scientist... it can engage them more in the discussion... It would focus them on something, get their minds tuned in. NHM 27.6.05

Discussion subject 5: Benefits of and barriers to a natural history museum visit

Benefits

Although many benefits to learning had been raised by teachers when discussing particular museum activities, teachers were asked for general benefits to bringing students to a natural history museum.

Primarily it's to get out of school isn't it? Otherwise it gets boring. HM 23.6.05

It's different. By Year 11 they've had years of sitting in a classroom, if they come here it's different, it's huge, it's an exciting day out they will remember. NHM 15.7.05

A visit is seen as enrichment. MM 19.7.05

For student interest, it hopefully educates, presents science in a positive light. NHM 15.7.05

I've been awed, in the Darwin Centre earlier. I saw a jar of platypuses and thought that was a really amazing thing. NHM 15.7.05

The sheer scale of it, seeing that number of specimens. NHM 15.7.05

Certainly living where I am, there's quite a lot of low self-esteem and a lot of people who wouldn't dream of coming to visit a gallery... you can give them a taster, that you can just walk in off the street into a museum. It's even better now without the charges. HM 23.7.05

Would teenagers be made welcome if they came into the museum on their own at the weekend? MM 19.7.05

If we don't take them to somewhere like here, they generally don't have the get up and go to do it themselves. They might find they like it and come more often themselves. NHM 15.7.05

Children wouldn't come into the museum unless they were brought in – there is a need to 'sow the seed' in order to pass down the desire to visit to future generations. MM 19.7.05

It's a nationally and internationally significant place... coming somewhere like this would be a memorable life experience. NHM 15.7.05

It partly answers that question they always ask you... why is science important, who cares about it? When you come here you see obviously lots of people care about it. NHM 15.7.05

Barriers

At each museum, teachers stated that the paperwork associated with organising a museum visit was a barrier, although this varied between schools. Anything that museums could do to reduce the paperwork was considered very helpful.
11 hours of paperwork was required to bring 80 students to the Manchester Museum! MM 19.7.05

For teachers, contact numbers and consent forms all take a long time to organise. MM 19.7.05

Teachers at OUMNH and MM suggested having downloadable Risk Assessment guidelines on the museums’ websites. Teachers at MM suggested the museum should be included on the Local Authority list as having been pre-registered for school visits. Manchester LEA will handle Risk Assessments and actively encourages educational visits.

Information that strongly supports the case for taking students out of school was requested, to help obtain permission from senior managers. Teachers asked for clearly stated curriculum links and positive quotes from satisfied teachers on the museum’s website.

Cross-curricular sessions were also suggested, to help get permission for students to leave school.

If you could (offer) trips that are cross-curricular, you might tick more boxes. HM 23.6.05

If I’m going to take Year 10 off timetable for a day, I might have to make it (the trip) cross-curricular to justify that... I can sell that better if I can involve maths, English, geography, history or whatever. NHM 15.7.05

However, the general feeling was that to be useful, museum-learning experiences should be targeted to particular areas of the curriculum. The most successful cross-curricular visits were seen as those supporting topics which happen to be closely linked to different school subjects e.g. earth science within the science and geography curricula.

I think there may well be some cross-curricular things... certainly with geography and chemistry, and evolution even. There might well be things you could do that cover aspects of all of them (different subjects), so it is still linked, but I would stick to the discrete topics, because that way you’re more likely to hit the target. HM 23.6.05

Disrupting students’ learning in other lessons, especially during GCSE years, and taking staff away from lessons to maintain staff/pupil ratios required by museums, were seen as key barriers to museum visits.

Visits can be disruptive to the work of schools. Small group visits can leave classes short of numbers and staff have to go to maintain ratios. MM 19.7.05

Outreach was consistently suggested across the museums as a way of avoiding difficulties getting students out of school.

It would be really handy if you had some sort of roadshow, which could run concurrently with a particular unit of work that could end in a visit here. HM 23.6.05

Are loan boxes available? Could museum staff come to schools with specimens? MM 19.7.05

At MM it was suggested that an outreach programme could be linked to current events in the museum, which would help build its informal audiences. The possibility of local schools linking together to provide a large potential audience for outreach sessions was suggested. Teachers were familiar with the services of ZooLab, which takes live animals out to schools. MM is also considering the possibility of taking live animals out to schools. Teachers at all the museums were keen for students and museums to build a two-way relationship, and to encourage students to visit the museums in their own time.

Transport difficulties were mentioned at each museum as a possible barrier to a visit, as was lack of confidence in student behaviour. At MM, it was suggested that behaviour guidelines were made clearer to students.

Children are unsure of how they should behave in a museum environment. There is a need to build ‘museum literacy’. MM 19.7.05

Discussion subject 6: Visit logistics

Teachers were asked questions to help the museums plan the practical aspects of their school provision. Teachers were asked about the age and size of the groups they would bring, when in the
day and year they would visit and why, which museum facilities they thought were most important to make their visit run smoothly, pre- or post-visit activities they thought would be beneficial and whether they would be interested in any follow-up communications with the museum via the web, email or video-conferencing.

The results below and their explanations have been useful in planning our museum events across the partnership.

1) Timing of the visits in the year.

Teachers were asked, ‘When in the year would you be most likely to visit?’ then asked to circle as many months as appropriate, for Key Stages 3, 4 and 5. They were then asked ‘When in the year would you be least likely to visit?’ and asked to circle as many months as appropriate. The results from the 38 teachers were as follows:

![Fig. 4 Timings of visits, KS3](image)

For Key Stage 3, March and April were generally seen as too near the May SATs exams, but June and July were seen as good times for post-SATs enrichment. Some teachers also said they were released from teaching Year 11 and Year 13 exam classes, so they were more available. September and January were often seen as too early in the term. Most teachers mentioned SATs in their explanations, which leaves the reasoning for timing of Year 7 and 8 trips a little unclear. Year 7 and 8 visits could possibly follow a similar trend due to internal end-of-year assessments.

![Fig. 5 Timings of visits, KS4](image)

March and April were generally seen as too near GCSE exams in May and June for Year 11. June and July were seen by some teachers as good months to take Year 10 out. Three teachers timed their visits between January and March to coincide with teaching evolution. Some schools had mock exams in December.
May and June are exam times, as is January, for many modular courses. July was seen by some as a good time to take Year 12 out of school.

2) Time required for advanced planning

Teachers were asked, ‘How far in advance do you have to book your trip on the school calendar?’

Answers varied from one week to ‘requests must be submitted by the end of May for the following academic year’. Generally, the larger the group size, the more time required.

3) Year groups

Teachers were asked ‘Which year group would you most likely bring?’ and then to circle as many years as appropriate.
Teachers generally felt natural history museum visits were important for all years. Years 8 and 10 are not exam years and so were sometimes highlighted as good times for motivational visits. Some of the teachers taught in schools with no 6th form. Sixth form visits were generally encouraged, and these were viewed as easier trips to organise as students can travel independently.

4) Group size

Teachers were asked ‘What size group would you bring?’

Fig. 9 What size of group would you bring?

Coach capacity of 50 places was mentioned as a reason for bringing more than one class. Bringing a whole year group was thought by some to be too disruptive to other subject lessons, and more difficult to obtain permission for. However, some teachers felt it was best to take a whole year group as it did not exclude any students from the experience.

5) Arrival and departure times

Teachers were asked ‘What would be your earliest and preferred arrival times, and your latest and preferred departure times?’

Fig. 10 Arrival and departure times

The preference of many to leave after 14.30 was interesting. The assumption often made by museums that teachers will want to return students to the school gate by the end of the school day may not always be the case at the secondary level.

6) The most important facilities for a visit to run smoothly

Teachers were asked ‘What facilities and provisions do you think are the most important to make your visit run as smoothly as possible?’ and asked to circle all options that applied.
Fig. 11 What facilities are important?

Lunch space, good teacher information and easy access to toilets seemed very important as they featured in the top four. ‘Efficient welcome/registration’ was also valued highly, coming second. Suggestions made under ‘other, please specify’ were flexibility for sessions, opportunity for students to buy food and drink, opportunity to provide evaluation comments for the museum staff, half an hour rather than one hour for lunch to avoid behavioural issues, and good teaching resources for the students to use during the day that are challenging enough for all abilities.

7) Teachers were asked which pre- and post-visit activities they thought would be beneficial.

Pre-visit suggestions:

Teachers suggested various forms of electronic visual presentation that they could show before the trip. These included a video-conference link to school, possibly with a scientist discussing their work or a member of museum staff setting a task, or a virtual tour of the museum as a video or PowerPoint slide-show. Teacher information sessions were requested, on Saturdays or after school. Outreach was again requested, where scientists or museum education staff visit the school before the visit. Pre-visit information was seen to be especially important for meet the scientist sessions, where the topic to be discussed could be prepared. The ability to email questions before a visit was proposed by one teacher as being very useful.

Post-visit suggestions:

Email communication with the scientist was welcomed, especially if students had formulated any questions, or were using the session for coursework. Post-visit video-conferencing with the scientist or museum staff was requested, and as with the pre-visit requests, outreach visits from scientists or museum education staff was a popular suggestion. There was a wish to make museum visits regular rather than one-off occasions, possibly planned to fit with a specific unit of work.

Video-conferencing was also suggested as a stand-alone activity, not necessarily linked to a visit. It was seen as a use of ICT which would enhance science learning in general. Three teachers wrote:

Were under pressure to increase ICT. MM 19.7.05

Students may sometimes want to ask an expert about a particular organism, (plant, freshwater invertebrate) to help with fieldwork reports. NHM 27.6.05

‘Ask the scientist’ video-conferencing could also support the teaching of various current issues, such as global warming. Students enjoy asking an expert. HM 23.6.05
Conclusion

The depth and quality of the responses has provided valuable insight into the most useful support natural history museums can offer to teaching and learning in secondary science. It is hoped these findings will provide pointers for other museums with natural history collections towards curriculum areas most in need of support, and towards effective learning strategies. The KS4 science curriculum changes, the current review of the KS3 curriculum, and the comparatively greater focus on primary school provision across the UK museum sector, may indicate a need for an ongoing consultation with science teachers.

To offer optimum support to science teachers, further research is required into the extent to which museums and hands-on centres and galleries can affect knowledge and understanding of school science. This may give institutions a steer on how to channel their resources, for example to support understanding of particularly challenging concepts, such as the time-frames involved in evolution.

In conclusion, the science teachers in this qualitative study made many recommendations to natural history museums. The following summary outlines the strongest themes to emerge.

Summary of recommendations

• Offer fun science shows involving practical demonstrations.
• Make the most of the resources not available in school.
• Allow students to meet engaging scientists who can positively influence attitudes to learning science, career choices and can support the KS4 curriculum changes, especially the emphasis on ‘how science works’.
• Allow students to go ‘behind the scenes’ and have an experience that differs to that of the public.
• Provide video-conferencing to support the understanding of science in the classroom, and to enable pre-visit preparation and post-visit consolidation.
• Use debate formats, challenge students to form opinions on scientific issues.
• Move away from worksheets towards the use of ICT in the galleries, and e-communication with schools.
• Use games that include an element of competition.
• Support the delivery of Ideas and Evidence and ‘how science works’. Make historical case studies less abstract and current issues relevant through exhibitions and links with the scientific community.
• Plan events and resources to support each new GCSE science syllabus, rather than the National Curriculum’s more general Programme of Study.
• Provide case studies of scientists’ work and topical science issues for new GCSE syllabuses.
• Support teaching in the earth sciences, a subject in need of particular support within science departments due to a lack of expertise and resources.
• Support subjects in the life sciences which are challenging conceptually and/or lack resources and practical activity, particularly evolution, classification, variation, adaptation, genetics and inheritance and interdependence.
• Use 3D models, particularly to demonstrate aspects of plate tectonics and human physiology.
• Support teachers in conveying the reality of environmental issues, and in clarifying the differences between environmental problems.
• Use traditional museum displays to convey the diversity of life on Earth. Combine structured tasks with the freedom to search displays.
• Capitalise on the differences between the school and the museum. Use the welcome change of scene, the potential to engender a sense of awe and wonder about the natural world, to provide a memorable life experience, and to answer the question ‘who cares about science?’.
• Help overcome practical barriers to using museums by providing risk assessment guidelines, clearly advertised curriculum links and good on-site facilities. Be aware of transport difficulties, preferred arrival and departure times, and SATS and exam scheduling.

Areas for further research/comment
The consultation has highlighted further areas of research, which may help in planning secondary science provision in natural history museums. Suggestions are:

• To what extent can museum visits assist with conceptual development in learning school science? Areas to consider may be the impact of dialogue with museum staff, repeat visits and 3D models.

• Widespread research on the logistics of schools visits to museums, possibly an online database that museums can access to inform programming.

• How can museums help to build ‘museum literacy’ in students to support teachers with behavioural expectations during a visit?

• To what extent do pre- and post-visit resources support learning of school science in museums? To what extent can ICT help?

• Should training be offered to scientists in effective communication with school groups?

Bibliography


Appendix

How is the partnership of natural history museums responding to the consultation?
Teachers’ requests and advice directly informed a two-day planning conference of partnership staff at the Manchester Museum in September 2005. The result is a programme of events being delivered and piloted at each partner museum, which attempts to answer as many of the consultation outcomes as possible.

At the Hancock Museum:

KS4 Evolution days (termly)

• Students meet Victorian Darwinist and creationist characters (gallery actors) and witness their heated debate. Students are challenged to find evidence for evolution in the galleries, and present the evidence to the class and historic characters for a debate at the end of the day.

• Structured tasks using handling specimens and the fossil exhibits provide evidence to prepare presentations in groups.

• Students hunt for fossils in a mound of shale from a local quarry, splitting open rocks to find their own 300-million-year-old carboniferous fossils.

• Museum scientists deliver a fun, interactive talk about Darwin and his contemporaries, and give students a tour through geological time.
• Students meet contemporary scientists, who join the students to present evidence for evolution in the final debate. The class is transported back in time as the gallery characters draw the students into the clashes and frustrations of the 1860 debate.

**KS3 Rock cycle half-day sessions (in pilot)**
• Groups of students move around workstations, arranged in a large-scale diagram of the rock cycle. Students carry out experiments at the workstations which demonstrate the processes of the cycle.
• Students’ small-scale experiments are linked to the real-life processes via video footage, with pointers for further investigation in the galleries.

**At the Manchester Museum:**

**KS4 Earth science split visits:**
**Manchester Museum/University of Manchester (every two to three weeks)**
• Students participate in earth science activities using museum galleries.
• Students carry out practicals with scientists in the laboratories of the University of Manchester’s School of Earth Atmospheric and Environmental Sciences.

**KS3/4 Forensic science workshops (on demand)**
• Students process DNA before using gel electrophoresis to separate it into fragments. Students gain an understanding of how DNA can be used as forensic data for solving crimes.
• Students learn how to take fingerprints and find out how they are used for forensic data collection.

**Genetics AS- and A-level study day (in pilot)**
Students discover how biology at A-level translates into real research projects.
Students have three 30-minute lectures by scientists:
• An Introduction to Genetics to recap the topic as covered in A-level syllabuses by a postgraduate researcher.
• Clinical Genetics, its Uses and Future, by a clinical researcher.
• Ethics and the Law by a research fellow at the Centre for Social Ethics and Policy, University of Manchester.

Students visit the North West Genetics Knowledge Park and meet researchers co-ordinating the first clinical trial of a pharmacogenetic test, and meet a genetic counsellor to find out how embryos can be screened for serious genetic conditions.

**KS3/4 Great Debate workshops (in pilot)**
• Students meet Victorian Darwinist and creationist characters (gallery actors) and witness their heated debate.
• Students are challenged to find evidence for evolution in the galleries, and present their evidence to the class and to the characters.

**At the Natural History Museum:**

**AS- and A-level biology days (weekly)**
• Behind-the-scenes discussions with scientists and curators about their work, showing students the collections and their working environment.
• A hands-on taxonomy workshop.
• Tour plus facilitated meet the scientist session in the Darwin Centre, the museum’s newest research and collections storage facility.
• The day supports the Visit Report coursework component of the new Slaters-Nuffield Advanced Biology course, but is suitable for all AS- and A-level biology courses where encounters with working scientists are useful.

**KS4 Great Debate workshop (two workshops, weekly):**
• Exhibits and statues are used to introduce the key historic characters of the Great Evolution Debate of 1860, and tell its story.
• Students recreate the lively historic debate in the inspirational gallery setting. Groups use evidence from gallery displays to prepare and present support for a historic character’s argument. Students finish by evaluating opponent groups’ interpretation of evidence, discuss the selection and interpretation of evidence to suit a theory, and how contemporary scientists evaluate each other’s work via peer review.

**KS3 Earth science lecture theatre show:**
**Rocks the House (in pilot)**
• A fun, explainer-led show about plate tectonics, earthquakes, volcanoes and the rock cycle. With large props, messy experiments and a great deal of audience participation.

**AS- and A-level chemistry days (in pilot)**
• Behind-the-scenes talks and practical demonstrations in the Mineralogy Department with Museum chemists and geochemists.
• A curator’s tour of the Minerals gallery.
• A gallery trail of syllabus-linked displays.
KS4 How Science Works at the Natural History Museum workshop (in pilot)
• Practical activity developed with Museum micropalaeontologists, reflecting their working methods.
• Students process clay to reveal an array of microfossil species under the microscope. The class is asked to identify species and reach a consensus on the age of the deposit.
This workshop aims to support the September 2006 KS4 curriculum changes.

Teacher’s Continuing Professional Development in Earth Science (in pilot)
• To be developed in conjunction with the Earth Science Teachers Association.
• Discussion and ‘question-time’ with museum geologist.
• Use of Earth Galleries displays.

KS3 Biodiversity gallery trail (future pilot)
• Students identify distinguishing features and record examples of adaptations in each vertebrate class.
• Students take digital photographs of specimens and form an ‘adaptations database’ at school.

At the Oxford University Museum of Natural History
KS4 Great Debate workshop (on demand)
This workshop originated at OUMNH and has been adapted throughout the partnership.
• Students are shown the venue of the Great Evolution Debate of 1860 and introduced to the debate’s key historic characters and social setting, in a story-tour of the museum.
• Groups prepare to debate as supporters of the characters, and are directed towards a piece of evidence from the museum that was used to support that person’s view.
• Students recreate the debate in its authentic setting, and the session concludes by considering the evolution vs. creation debate of today.

KS5 Study days (termly)
• Students have three 45-minute lectures given by Oxford University scientists.
• The students break up into groups for a programme of practical sessions and interactive tours at various university science departments.
The themes are molecules, cells and systems, genetics and ecology.

KS4 Science of Life: Biological Science Fair (summer and autumn terms)
Teachers choose from an all-day programme of lectures, demonstrations and workshops, including a lecture about the ‘science of Saturday night’, explaining our TV watching or socialising ways, demonstrations with insectivorous plants and birds of prey, and workshops where students can either use plants for forensic science or interpret fossils to get a glimpse on a prehistoric world.

KS4 Science Behind the Headlines workshop (pilot)
A scientist gives a brief description of their work and career path, before leading a session with students where together they discuss the portrayal of science in media. Headlines and newspaper articles are analysed. Discussion includes whether scientists are portrayed as accountable, as individuals with high status, working independently of political, business or media pressure, and whether science is portrayed as exciting, challenging or collaborative.
Students also write a scientific article using a scientific journal paper as a source.

KS3 Elements, Mixtures, Rocks and Fossils workshops (on demand)
Comprises three 20–30 minute activities:
• Rocks and Minerals trail
  Students are challenged to use museum exhibits to identify rocks and search for information about them.
• Giant Rock Cycle puzzle
  Students are given a giant floor puzzle to solve as a group, requiring the identification of rock types and the processes leading to their formation.
• Looking at Fossil Evidence
  A short museum tour during which students are introduced to some of the early dinosaur hunters and their amazing discoveries, as well as more recent discoveries of prehistoric animals.
A partnership of natural history museums and organisations concerned with informal science education carried out a consultative study of the views of secondary science teachers.

Meet the scientist session at the Hancock Museum, Newcastle

Forensic science workshop at the Manchester Museum

Front cover: the Great Debate workshop at the Natural History Museum, London.

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