Project Faraday: GovEd Consortium

case-studies

Contents

Introduction 2

Principal Observations 5

- Connections – how schools connect science to the world beyond the lab 6
- Partnerships – opportunities and challenges 7
- Display – new roles for display in science in the digital age 8
- Teachers as innovators – the role of teachers and the process of change 10

Constitution High School, Philadelphia 11

School of the Future, Philadelphia 12

Science Leadership Academy and Franklin Institute 13

School of Environmental Studies, Minneapolis 15

Centre for Life, Newcastle 16

Bishops Park College, Essex 17

School of Medicine and Dentistry, Queen Mary College, U. of London 18

InQbate, Centre for Excellence in Teaching and Learning, U. of Sussex 19

Minnesota Museum of Science, St Paul 20

Introduction

This is a report of findings from research visits undertaken as part of the Faraday Project to institutions in the United States and United Kingdom. This section draws some key general observations from the separate visits together. Summaries of individual institutions follow.

The case-studies research has been informed by a literature review and workshops with Rednock School in Dursley, Gloucestershire and Estover Community College in Plymouth, Devon. Research in the US was conducted over seven days in March 2007.

Selection process

A number of particularly interesting sites emerged from the initial research (such as the 'Zoo School' in Minnesota). With these as a focus, we identified a set of 'criteria for interest', which helped us to identify other sites. The criteria emerged from the consortium's wider research including early design meetings.

Criteria for interest

- Innovative use of school grounds for science
- Designs that have the effect of de-ghettoising science
- Designs that create a connection between the school and its wider environment (motivated by science teaching or otherwise)
- Innovative use of ICT in science
- Ways of using the building itself as a teaching aid in science
- Connections between the school and research or industry
- Designs for sustainability

Schools and other locations that meet one or more criteria were considered as potential case-studies. We were also keen to see the relation between buildings and different approaches to teaching and learning, so we ensured that there was a wide range of approaches represented.

- **Constitution High School, Philadelphia**
- **Science Leadership Academy, Philadelphia**
- **Franklin Institute, Philadelphia**
- **School of the Future, Philadelphia**
- **School of Environmental Studies, Minneapolis (the 'Zoo School')**
- **Minnesota Science Museum, St Paul**
- **Centre for Life, Newcastle**
- **Bishops Park College, Essex**
- **School of Medicine and Dentistry, Queen Mary College, University of London**
- **Department of Computer Science, Queen Mary College, University of London**
- **InQbate (The Centre for Excellence in Teaching and Learning in Creativity, University of Sussex)**

Photo: Lorda

Principal Observations

Faraday Sculpture, Photo: Daniel Morris

Four recurring themes emerged from the research, which we have grouped under the headings: connections, partnerships, display and teachers as innovators.

Summary

- The schools invested considerable resources to maintain links with partners, the community and wider environment
- The schools valued their connections and partnerships highly, so the investment appeared to pay dividends
- There is a role for technology in maintaining the links created
- Simple design input can make a radical difference to the effectiveness of links
- The lack of ways to display and share digital student work was seen as a missed opportunity by both teachers and learners
- Display played an important role in organising space and facilitating personalised learning in the School of Environmental Studies
- Display plays an important role in maintaining links with the community and with partners
- Design and innovation in the schools was driven by teachers

Connections – how schools connect science to the world beyond the lab

One of the clearest messages to emerge from workshops at Rednock and Estover is that learners crave direct access to the world. They see science as a way of reaching out to the world and want to be doing real science, using real data, preferably in real-time. So we were interested to see new ways of making connections between:

- Science and other areas of the curriculum
- Science laboratories and the outside world

The value to students of direct connections with the world was brought into relief when workshop participants discussed an interest in marine biology. To support their interest, they wanted a 'fish-cam' – an underwater webcam that would link them to the sea. We suggested that they might be better-off with David Attenborough's BBC series *Blue Planet* on DVD as much of the time there would be absolutely nothing to see on the fish-cam. However, the students were not interested learning from the television. They insisted that a fish-cam would be much more engaging because it would be 'real' and it would 'belong to us'. Noel Jackson of the Centre for Life in Newcastle made a similar point. He is dismissive of the use of television but in his previous role as Head of Science at a Newcastle secondary school he got a great deal of mileage from having a goldfish in his laboratory. What other ways can equipment and buildings assist science teachers by inspiring curiosity?

If the goal is to inspire students to take an interest in science, it is not always important how efficiently or inefficiently they learn about a topic. More important is their sense of personal engagement with it, so helping students to see the connections for themselves is vital. The visits moved our thinking about connections forward in a number of ways. How a school creates connections between classroom science and the outside world is a combination of design on the one hand and the school's approach to teaching and learning on the other. In many cases, the design and curriculum decisions with the most dramatic impact on students were very simple. Examples include space to work outside, good sight-lines from laboratory windows, and ways for teachers to see each others' lesson plans.

Every school has material assets on or adjacent to their grounds with latent potential to inspire science students. Urban environments have as much potential as rural ones – though the opportunities will be different. Schools that manage to inspire science students tend to be those that can act on the particular opportunities afforded by their situation. Flexibility in the timetable of some of the case-study schools helped them take advantage of the opportunities. In the School of Environmental Sciences an important factor was the freedom teachers had to innovate and the expectation that they would. Specific measures to increase flexibility such as Constitution High School's policy of seeking blanket permission from parents for school trips over the course of the year were also important. As Principal Thomas R. Davidson explained, this simple measure gives gave teachers the freedom to "use the city as a campus" and responsively extract all the value they can from their location.

Technology in the classroom is sometimes used to replace direct interaction with the real world with film or simulations. DVDs such as *Blue Planet* and simulation software such as Crocodile Clips certainly has its place but our case-studies reveal that technology has most impact on students when it helps mediate interaction with the real world rather than replace it. For instance, in the School of Environmental Sciences simulation software is generally only used in conjunction with fieldwork. The interaction does not always need to be 'hands-on' (e.g. the fish-cam is not hands-on) but it appears to make a difference to students if they can see a link between work in class and authentic, real-world, real-time phenomena.

Partnerships – opportunities and challenges

The case-study schools' partnerships with outside organisations were valued extremely highly by both teachers and students – but they came at a cost. The schools explained that partnerships had to be robust to work and required considerable investment from both sides. When the links are strong, they are flexible and afford a variety of ways of interacting. Students' interactions with partner institutions varied with age and stage of learner as well as individual interest. For instance, the relationships between the Franklin Institute and the Science Leadership Academy in Philadelphia and the School of Environmental Studies and the adjacent Zoo led to:

- Students designing museum exhibits
- Work experience and job shadowing opportunities
- Zoo used for first day introduction programme
- Students able to visit zoo during free periods
- The zoo and museum both used for other subjects (notably art)
- Team teaching with zoo staff for some projects
- Guest speakers

We heard about a wide range of different partnerships. Microsoft's involvement with the School of the Future in Philadelphia and The Constitution High School's involvement with the Constitution Center and other partners offer different models for partnership. In addition to close ties with their adjacent zoo, the School of Environmental Sciences also maintains strong links with field-centres around the world. Teachers and students make frequent visits to these field-centres but back in Minneapolis the school maintains the links in the minds of the students with displays on the wall.

Display – new roles for display in science in the digital age

As well as maintaining connections between the schools we visited and their partners, display has a number of other important roles. All the case-study schools display student work as a way of signifying its value. In the Science Leadership Academy displaying work also has the effect of communicating the school's ethos. Posters and other displays are valued as means of supporting 'passive learning' but limited wall-space means that passive-learning is low on the agenda of most schools.

The most significant observation from the case-study school though was the absence of digital display. We saw digital projectors in use in lessons but, even in the School of the Future, which had state of the art facilities, digital display was generally limited to students' own laptops. There was not much scope for students to share the digital work they were doing.

The absence of digital display was perceived as a problem by all schools. There was a recognition that as increasing amounts of students' time was spent on digital tasks there was a need for them to display their work digitally (for all the various reasons it can be useful to display work on paper, and more). From the School of Environmental Studies there was a sense that once you have gone out and collected data in the field, it should not then disappear completely into an electronic black-hole. The connection between the lab and fieldwork should be kept open by technology, not disguised by the process of digitisation.

Project based work was very important in the schools we visited but because the outputs have to be paper-based this limits how the learners can engage with their subjects. The students themselves all appeared to like working digitally. Those with personal laptop computers appreciated them greatly and those without were envious. They were also keen on the digital tools that were made available to them.

Amongst both teachers and learners there was a sense of opportunities are being missed. The students expressed frustration at being cut-off from tools that they use outside school and mentioned several Web 2.0 applications such as YouTube and MySpace. The significance of these tools in particular is that they provide students with a way to work collaboratively and get feedback on their work.

There is a tension between the real and the virtual worlds – especially in science. Resolving the tension is something the schools we visited are actively working towards. The solutions being sought focus on display and on design that, as we saw in the Minnesota Science









Museum, creates connections between the real and the virtual.

The School of Environmental Studies provided a glimpse at a potentially very powerful role for display in the design of spaces for science. In each 'house' space in the school, what looks at first-glance like an amorphous and incoherent space is actually a very effective working space. It works because it enables interaction on a number of different scales simultaneously. It is easy to switch from individual activities to activities involving 100 students. One of the components of the design that enable it to work is the way display is used.

Addressing modern priorities for personalised learning requires thinking at a range of different scales. Learners themselves come together in a range of ways – sometimes they are pursuing individual interests and at other times involved in whole class or whole school activities. The spaces have to accommodate all these scales of learning.

In summary then, as work becomes increasingly digital, the absence of digital displays is seen as a missed opportunity by both teachers and learners. The World Wide Web (when accessed individually) is inadequate by itself. There is a need to bring digital content out into the real spaces learners and teachers occupy as well as creating virtual spaces. Display played an important role in organising space and facilitating personalised learning in the School of Environmental Studies. It also played an important role in maintaining links with the outside.

Teachers as innovators – the role of teachers and the process of change

We found through the research process that it is impossible to separate school architecture from the approach to teaching and learning pursued at an individual school. No school building is a 'blank canvas' and when you ask questions about spaces and technologies and you get answers about teachers and the curriculum! It seems that questions about innovation will always be entwined with questions about who will drive it forward and why. A recent workshop at Estover Community College culminated in participants designing their ideal science labs. One group at Key-Stage 4 placed their favourite teacher in the centre of the room and worked from there by asking themselves what Mr Westhead would need to do his job.

Design and innovation in the schools we visited was driven by teachers. The education authorities worked hard to create the conditions under which this could happen. In the case of the School of the Future, Rosalind Chivis of the School District of Philadelphia described this in an insightfully negative way. She explained that they were trying to 'grow' teachers who would end up unable to teach in traditional environments. In the School of Environmental Sciences, there is a policy of encouraging teachers to pursue their own interests and to innovate – even if this results in changes to the timetable. In general, the school prefers to employ teachers with a wide range of interests because they are more likely than specialists to develop innovative cross-curricular approaches.

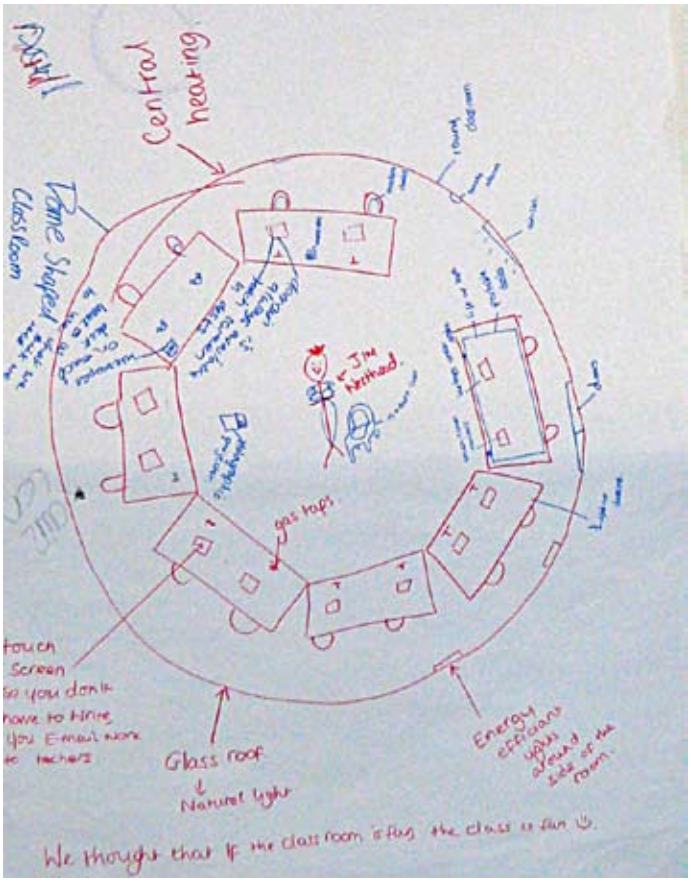
The question of inspiration is relevant to teachers as much as students. Paul Curzon is a Reader in Computer Science at Queen Mary College, University of London. Amongst other roles, he is responsible for increasing student recruitment in mathematical sciences and has developed a series of successful outreach strategies with schools. Curzon explained to us that, from a recruitment point of view, it is not so important to enthuse students as it is to enthuse teachers.

Teachers have to take ownership of the technologies they use and the spaces they occupy. One of the most inspiring aspects of our visits to the four schools in the US was seeing this in action.

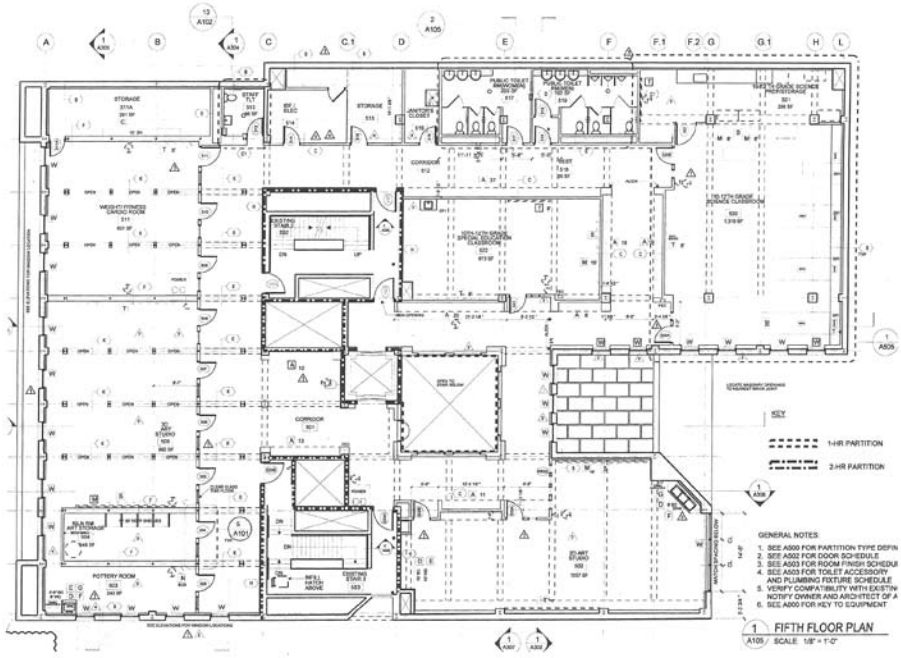
The impact of assessment

A significant difference between schools in the US and the UK is flexibility not just with respect to curriculum content but also with assessment. Teachers in the UK report that, even though the new science curriculum offers much more flexibility, their ability to move to more student-led approaches is severely constrained by the assessment regime. Exam board specifications (particularly at Key Stage 4) continue to inhibit teachers' own creativity and the ability of schools to develop novel approaches.

The success of the School of Environmental Science, and the Philadelphia schools is due in no small part to the ability to work with the school district to develop ways of assessing students that are appropriate to the learning style adopted.



Constitution High School, Philadelphia



The Constitution High School is a new school in downtown Philadelphia. It places emphasis on cross-curricular project work. The school aims to create a 'home from home' and stability and safety are important qualities the building has to project. Nevertheless, the school's location and its partnerships are very important to the school also, which makes it outward-looking. The School uses "the city as a campus".

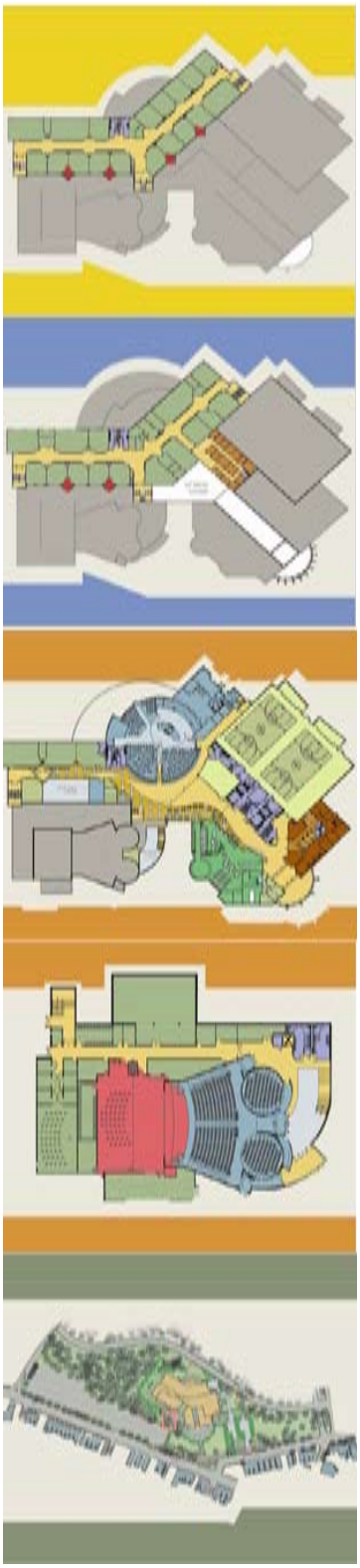
Constitution High School is a specialist school with emphasis on history and politics. It has city-wide admission and applicants must demonstrate high academic and behaviour standards. The initial intake is 120 ninth graders. The school is a refurbished building in downtown Philadelphia that is adjacent to some of the oldest districts in the city.

The school takes full advantage of its location. Barriers to taking students out of school into the city are minimised (e.g. by blanket permission from parents for educational visits). The city views from the windows are used to good effect. Students reported that that sightlines between classrooms and corridors had a positive effect on behaviour.

The science labs are large and have distinct areas for practical and theoretical work. This was planned from the start to make switching from lecture/discussion based teaching to collaborative practical work as easy as possible.

The students and staff value partnerships with the National Constitution Center; Gilder Leherman Institute of American History; Legal Firm of Ballard Spahr, Andrews and Ingersoll; and the History Channel very highly.

School of the Future, Philadelphia



The School of the Future is a new school with a ninth-grade intake. The school has received support from Microsoft, though the support was managerial rather than technical or financial. It is a model for neighbourhood (non-selective) schools of the future. The school differs from most neighbourhood schools in that 50% of the places are allocated by lottery from the rest of the city. It also has a maximum capacity of just 700-800 students (rather than 2000-2500).

Though the school aims to explore the potential for new technologies in education, the teaching and learning agenda comes first and the technology follows only if it is appropriate; the school is not a 'response' to new technology. Each student has a laptop and uses it extensively. A dedicated team supports these technically. Nevertheless, with the exception of the laptops and the smart-card identification system, the school does not feel particularly high-tech.

Science Leadership Academy and Franklin Institute

Science Leadership Academy, Philadelphia is a science specialist school with a strong partnership with a science centre: the Franklin Institute. Although it is a selective school, it does not select according to grades. The school's approach to teaching and learning places emphasis on investigation, which requires a level of maturity and independence that (the school finds) is not always present in 'straight-A students'.

Science permeates the curriculum and students wear lab-coats throughout the day rather than traditional school uniform. The partnership with the Franklin Institute is valued very highly by staff and students, and also by the Institute itself, but it requires a lot of resources to make it work. Each institution has a member of staff whose main role involves coordinating the relationship. The school considers the students' journey to school to be part of the school day and available for science teaching. The relationship with the Institute involves weekly visits by students and involvement in the development of exhibits and work experience.

The students have personal laptops (Macintosh) and these are used in most lessons. The Science laboratories are large and divided into theory and practical zones. Displays of student work around the building play an important role in communicating the school's ethos.


IN HONOR OF BENJAMIN FRANKLIN
KING TUT
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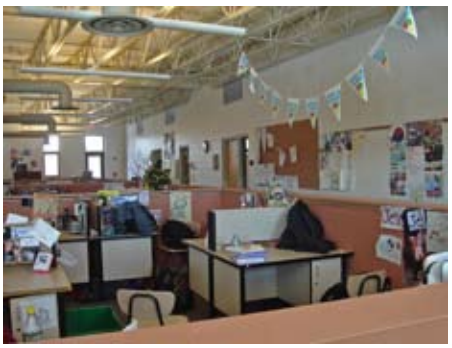
School of Environmental Studies, Minneapolis



The School of Environmental Sciences is a selective school built into the grounds of Minneapolis Zoo. It is a small senior school (400 students, years 10-13) with a strong emphasis on fieldwork. The school also has a uniquely flexible system for organising students, which is part architectural and part administrative.

The 'house' system is a way of organising students into year-groups. Each of the four year groups has approximately 100 students and occupies an open-plan 'house' space. This is organised into 10 'pods' that each contain personal desks for 10 students. In the middle of the house space are tables and chairs that can be re-arranged as necessary. The personalised, open-plan space works on a range of levels and allows teaching and learning to switch easily from individual study to collaborative team-work to whole-class lectures and discussions. The system has a dramatic effect on students' sense of ownership of the space and sense of community, which in turn supports their engagement with learning.

The design of the building avoids corridors and provides long sight-lines both within and outside the building. In contrast to other schools where open-plan teaching has been attempted, there is no attempt to demarcate the space or create ersatz walls. Personalisation obviates the need for demarcation.

Centre for Life, Newcastle

The Centre for Life, Newcastle is a science park complex that contains research institutes as well as a science centre and laboratories for schools. There are three large laboratories and a separate ICT suite. Schools book day-long or half-day courses for a class of students, which are facilitated by Life Centre staff. As well as the specialist staff, one of the most important ways the Centre adds value to school science is its use of professional equipment. For instance, the use of professional electrophoresis equipment allows a class to conduct an investigation, obtain results and discuss them within in a single session, and the use of professional microscopes improves students' engagement with the subject. Using professional equipment is also inspiring for some students and helps to give them a sense of what it might be like to be a scientist. Collaboration with the research institutes that share the Centre for Life is also helps students to identify with science.

The laboratories are double height, which has a surprisingly large impact on users. The extra height is used for a few activities such as rocket launches but these by themselves do not explain why the extra space is valued to the degree it is. It appears to be the generosity of the volume itself that is important and possibly the sense it gives of inhabiting a range of different scales of space at once (especially when doing microscopic work). There are problems with the design of the labs – aspects that the Centre would specify differently next time: the acoustics are poor (partly as a result of the double height); there is no way to create black-out and the automatic ventilation system causes irritation. Nevertheless, in the staff's estimation, the benefit from the extra height outweighs these problems, which is an indication of its value.

Collaboration with the local researchers is on-going and has proved so valuable to the Centre that it has inspired collaboration with partners further away. It appears that the concentration of potential partners within the Life Centre, which has facilitated collaboration, has also had the effect of demonstrating the value of collaboration generally. In the words of the Noel Jackson, Head of Education, "it shows it's worth getting on your bike".

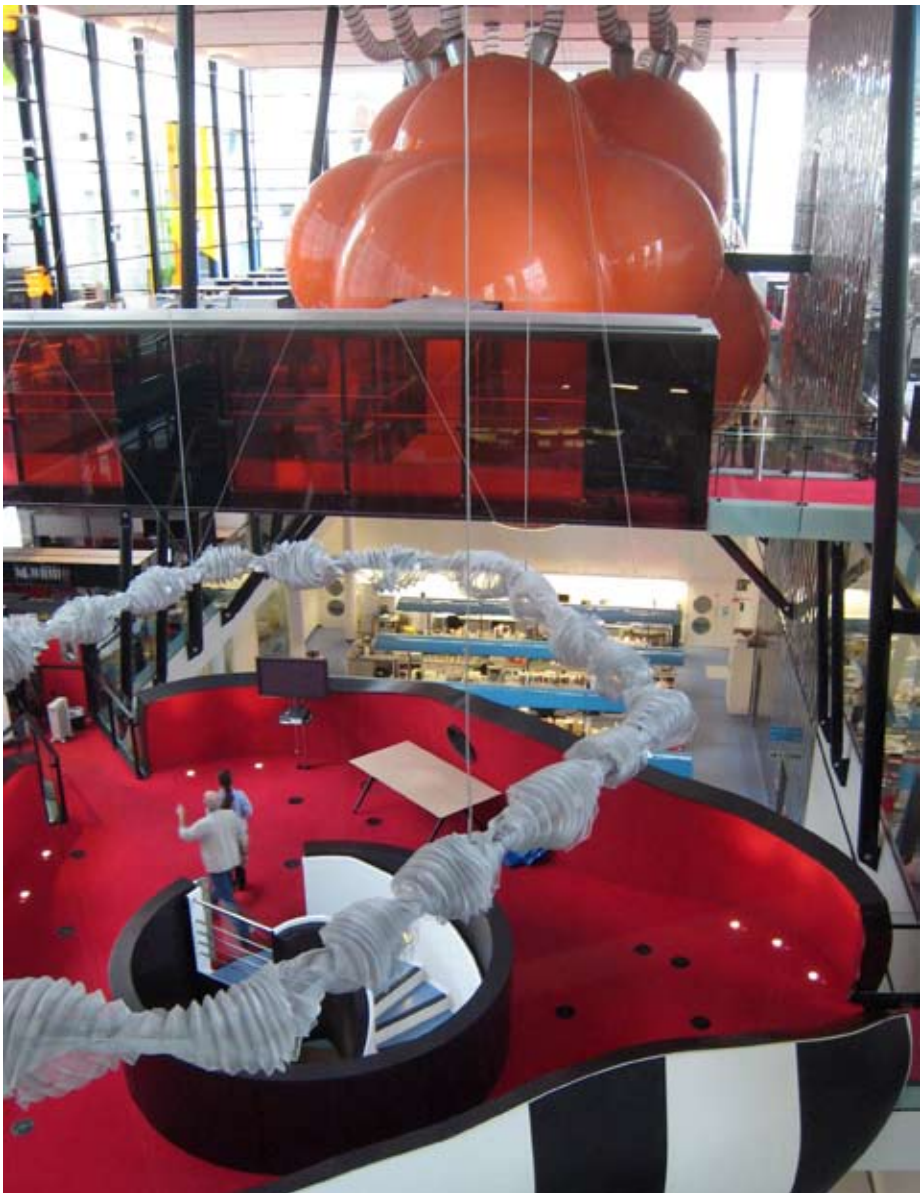
Bishops Park College, Essex

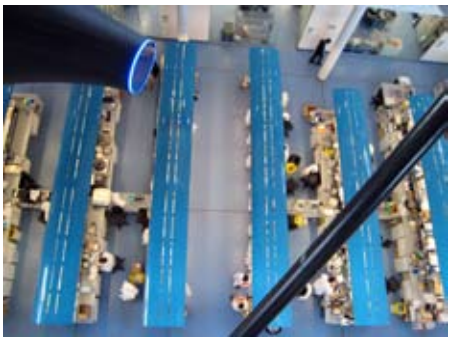
Bishops Park College uses the national curriculum to provide goals for its students, but subjects are not taught as discrete lessons. The curriculum at Bishops Park College has been planned from the perspective of a student engaged in inquiry across a swathe of ideas and competences. The College Principal, Mike Davis describes it as a 'tartan', with the national curriculum subjects woven seamlessly together. Teachers plan work around a particular theme for each half-term – 70% of class time is spent on theme work. The themes meaningfully connect the learning content and skills, rather than separating knowledge into compartments.

The College is actually 3 distinct schools (with their own headteachers) that share some common facilities. These mini-schools of up to 300 students each provide the benefits of 'human-scale' learning and most of the economies of scale of a larger school. The schools are arranged around a central hall that is used for performances and for lunch (the three schools break for lunch at different times). Facilities in each school can be shared with the other schools. Two science technicians serve all three schools but each school has its own prep-room. With hindsight, this arrangement is considered a mistake because the size of the prep-rooms is inadequate. It would have been better to have had a centralised system.

Jaywick, the area the school serves is deprived but the human-scale architecture has had a positive impact on the students' behaviour and engagement. Students at Bishops Park appeared to be exceptionally motivated and contented with their schooling.

School of Medicine and Dentistry, Queen Mary College, U. of London





The School of Medicine and Dentistry, Queen Mary College, University of London offers a model for school science laboratories from the cutting edge of architecture for research. The space works on a variety of scales and both differentiates spaces for different activities and helps to present all scientific activities as a coherent whole.

The lab departs from traditional research and learning environments with an open plan science lab and the bold architectural language used to reinforce this strategy. A three-storey pavilion containing offices, research labs, seminar rooms and write-up areas is bridge-linked to the Institute of Cell and Molecular Science.

Transparency is the main theme of the project. The three-storey glasshouse allows students to look out at the world outside and passers-by to look in. The lab floor is divided into three areas: the closed-off units incorporating all the specialist equipment, the modular research units and the open-plan main area. In the modular units, the ceiling is kept as high as possible, conveying an airy feeling through the use of green lights in the central shafts. The flexible units encourage a more communicative way of using work space. From the open-plan area you can look up through the write-up areas and the offices on the first and second floors, past the surreal, space-age pods, to the sky. It is a stunningly dramatic view.

Four colourful three-dimensional pods float in the glasshouse like fish in a tank: Spiky, a surreal, star-like pod surrounds the seminar rooms, mushroom: from the lower lab level a spiral staircase lined with a deep red carpet curls up onto the open-top mushroom pod. This area functions as a relaxation zone, providing a welcome break from the lab and write-up areas; Cloud: an elliptical pod houses 2 meeting rooms; Centre of the cell: the largest of the pods is a shiny cluster of orange bubbles intended to be a visitors' centre as well as an interactive learning facility.

InQbate, Centre for Excellence in Teaching and Learning, U. of Sussex

InQbate is a facility that aims to support creative teaching and learning. The space is inspired by two models: 'white-cube' gallery spaces and theatre spaces. The former provides a container for a wide range of different content without imposing itself on that content and the latter provides versatility and a sense of control on users' experience. The space is enormously versatile and ready to be co-opted. The walls and the floor are projection screens and whiteboards. Users are encouraged to draw and write on any surface. Video and other digital content can be projected anywhere and can even be projected 'everywhere' to create a fully immersive experience. Digital content can also be directed to plasma screens. The digital content, the sound and the lighting are controlled from a touchscreen control panel. The shape of the space itself can be modified with hinged walls and net curtains (that also provide another projection surface). The floor has a surprisingly significant impact on the way the space is used. Initially there was resistance to the idea of making the floor white, but the designers persevered and found that it encourages new uses of space and allows better use to be made of limited space. Furniture is designed to allow the space to be transformed easily, which is why tables fold into the walls and beanbags are used for seating.

The experimental nature of InQbate means that a team of technicians and facilitators are required to help users make use of the resource. Extreme versatility requires a high level of support and this in itself means that InQbate does not provide a ready-made model for school laboratories. However, there is much for lab designers to learn from InQbate. In particular, InQbate offers an approach to the integration of technology in teaching spaces. Technology is totally integrated into the space but not in a fixed or final way. It acts instead like an enabling layer on top of the space itself.

Minnesota Museum of Science, St Paul

Several exhibits in the Minnesota Science Museum are linked visually to the Mississippi River, which flows past the window. The link helps visitors to engage with the exhibits and increases the museum's impact. In this way, they offer a model for schools because in schools too there is scope for adding value to science by making the links obvious.

For instance, as visitors pilot a virtual barge one popular exhibit, they can watch real barges chugging along the river. Without the visual link the exhibit would be just a rather simple video game. But linking the real and the virtual makes the exhibit genuinely interactive and engaging and provides a new perspective on fluid dynamics and hydrology.

An art-installation in the museum links real-time earthquake monitors to musical sounds. The installation doesn't explain seismology, but it has a powerful impact on visitors by connecting the museum to the rest of the planet.

Unlike other science museums (including the Franklin Institute) the Minnesota Science Museum locates its visitors in the world. By making the relationships visible, and even audible, it adds another dimension to the learning experience.

ALLIGAN

GOVED COMMUNICATIONS

Feilden Clegg Bradley Architects LLP

futurelab

soda

newton's apple

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