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AUTHOR	Sumption, Kevin
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ABSTRACT

The most ubiquitous of contemporary interactive multimedia (IMM), the Internet, is making steady progress as an interpretive tool within museums.However, its major impact is being felt beyond museum walls. As an outreach agent, the Internet has captivated many museums and particularly their educators. As a communication medium, the Internet allows museum educators to enter the homes and schools of students without their ever needing to visit the museum. Some museum education products try to simulate the spatial and social experience of visiting a museum. However, this approach is just one of many resource "types" educators have deployed as they grapple with the promise and reality of on-line education. This paper explores why and how museums are using the Internet for education outreach, as well as the diversity of emerging on-line education expressions. It also reviews current research into the unique interface, navigation and content preferences of various learners and discusses best practice teaching and learning strategies to help museum educators develop more effective on-line educational resources. (Author/AEF)

PAPERS
Museums and the Web 2001

"Beyond Museum Walls" -- A Critical Analysis Of Emerging Approaches To Museum Web-Based Education

Kevin Sumption, Powerhouse Museum, Australian Museums On Line, Australia

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Abstract

"An effective educational museum might be described as a collection of labels bearing instructions, each of them illustrated by a carefully selected specimen." George Brown Goode, Assistant Secretary at the Smithsonian, 1896 (Alexander, 1979).

Although Goode's assertion may look naive by contemporary pedagogical and museological standards, I'm sure many of us wish that the process of museum education were indeed that easy. However, we know that such assertions are anathema, as both the primacy of the object and our understanding of learning have advanced considerably in the last 100 years. Since the arrival of photography in the mid nineteenth century, the interpretive pre-eminence of artefacts has been steadily eroded by a succession of media. More recently, interactive multimedia (IMM) have penetrated homes as well as museums, transforming visitor expectations as well as the way modern museums approach education.

The most ubiquitous of contemporary IMM, the Internet, is making steady progress as an interpretive tool within museums. However, its major impact is being felt beyond museum walls. As an outreach agent, the Internet has captivated many museums and particularly their educators. As a communication medium, the Internet allows museum educators to enter the homes and schools of students without their ever needing to visit the museum. So it's not surprising that some museum education products try to simulate the spatial and social experience of visiting a museum. However, this approach is just one of many resource "types" educators have deployed as they grapple with the promise and reality of on-line education.

As part of the research team developing Australian Museums On Line's new Education Gateway, I have spent considerable time examining why and how museums are using the Internet for education outreach. In this paper I will explore these, as well as the diversity of emerging on-line education expressions. I will also review current research into the unique interface, navigation and content preferences of various learners and, just as important, discuss best practice teaching and learning strategies to help museum educators develop more effective on-line educational resources.

Keywords: Museum education, Direct-experience learning, Active

Learning, Electronic outreach, Education meta-center, Expository learning, metacognition, Generative learning, Electronic field trips, Anchored instruction, Video conferencing, Museum learning networks, Collaborative learning, Creative play

For all but eight of its first 100 years, my museum - the Powerhouse Museum - was part of the New South Wales Department of Education. Not surprisingly, then, interest in the use of objects in teaching here has a long history, dating back to the 1890s, and still remains a critical component of Powerhouse Museum education practice. However, in the last 100 years our understanding of the complex interplay between visitors and objects that gives rise to learning has changed as epistemological and pedagogical research has evolved. From this, a number of educational theories have developed to explain how learning in object-orientated environments such as museums can take place. Today the direct-experience model is the one widely accepted, particularly in science and technology museums.

Direct-Experience Learning

Direct-experience-based learning divides our world into two distinct realms: the physical world where objects exist and events happen, and our minds which are capable of memory and conscious thought. By allowing visitors to encounter *real* objects, labels and a variety of media, we immerse them in a physical world where they see, hear, touch, taste, smell and do. It is human nature that visitors should then seek to understand these 'direct-experiences.' This means they must use their minds to find regularities and relationships between these new primary experiences and existing concepts and principles. In turn, these experiences help visitors develop a range of skills from observation and reporting to deduction.

However, the direct-experience learning model has limitations. First, the reader (visitor) must be sufficiently stimulated by artefactual encounters to want to engage cognitively with them. This is a problem for information technology objects such as microchips and personal computers, whose form is often uninspiring or masks function (Sumption, 1999). Critically, for contemporary museums, the direct-experience learning model is also restricted to the *real* museum. The moment we move beyond museum walls and into the realm of photo-mechanical and electronic outreach, where the reality of the object is supplanted by a mediated reality, the fundamental dynamic of the learning experience is changed.

The Outreach Revolution

As with education, outreach has been an integral part of many museums' core business. As early as 1891, my own museum opened its fifth satellite campus on the grounds of the Broken Hill Technical Education College. The Broken Hill branch was established to encourage the use of Australian products and Australian materials in the manufacture of articles for everyday use. To achieve this, Broken Hill was supplied with a series of taxonomic displays, all carefully selected and labelled by the central museum's staff. These were then dispatched, complete with hand-crafted cabinets and 2000 objects, to the remote and inhospitable plains of North Western New South Wales.

In the late Nineteenth Century, the limitations of communication media, combined with the uniqueness of the museum concept, meant that nothing less than a complete reproduction of an exhibit would have sufficed for outreach. But by the turn of the century, photography, and the process of its mass-dissemination - photogravure, had opened up new outreach opportunities and challenges.

Why Use Digital Objects?

Like contemporary travelling exhibitions, the painstaking reproduction of displays such as those used in Broken Hill ensure that museum educators and curators retain authorial control over exhibition content. However, the process of historical production, via print and film, is more problematic. As photography and printing physically supplant the reality of the object with a new mediated reality, curator or educator control is diminished by a set of intermediary authors - the camera, the lens, the film, the photographer and the designer. Also, in the late 1990s, when photo-mechanical outreach was itself transformed through digitisation, a further intermediary author was added. Through interactive digital outreach media, even the reader has become a powerful intermediary author. Nowhere is this more evident than in the latest generation of active learning resources now appearing on museum websites.

Since the privatisation of the Internet here in Australia in 1995, museums have increasingly sought to use the web to service the learning needs of predominantly secondary school students. To do so they have harnessed the computational power of modern personal computers via the World Wide Web to create a plethora of learning environments. Critically, these environments have tried to attract and hold students by supplanting the inherent pedagogically weak 'digital object' with more engaging interactive experiences. As was evident in the first generation of museum web pages, the process of 'object digitisation' can potentially strip artefacts of critical signifiers such as scale, weight, colour and texture. Without these material signifiers, the digital object is distorted in ways that can have a qualitative impact on learning. Therefore it is not surprising that more recently museums have enhanced, or even supplanted 'digital objects' with interactive multimedia affordances such as Java applets, streaming video and IRC, etc. As I will show, this shift has had a liberating effect on many museum educators who can now concentrate on the development of educational products centred not just on the objects, but on the students themselves.

Six 'Active Learning' Typologies

For evidence of this shift, look no further than the education winners of the Best of the Web. In 1998 the *Odyssey* website (http://www.cc.emory.edu/CARLOS/ODYSSEY/index.html), utilised museum object images and stories to 'inform' students of the daily life of Middle Eastern and sub-Saharan peoples. In 2000, the Puppets Action website, (http://www.childrensmuseum.org/artsworkshop/puppetshow.html) equipped students with tools to 'create' their own on-line puppet show. This shift from seeing the web as an information medium to seeing it as an active learning environment has consolidated. Now more than ever, many museums are creating web-based learning environments where users, not educators, are empowered to make decisions about the tasks, content, navigation, presentation and assessment activities they undertake. Thus a range of active learning web typologies has started to emerge. These typologies range from mature *education meta-center* products, which continue to utilise digital object images and records, through to immature expository resources, which have only tentatively embraced the active learning philosophy. What distinguishes one typology from the next is not just content and enabling technology, but also the cognitive strategies each employs. These are the generative, problem-based, creative play and expository methodologies that help learners to build on their own knowledge structures (schema) to construct new knowledge and understanding. These schema are consciously, and sometimes unconsciously, deployed by designers and educators with varying success. So by offering the following typological overview, I hope to provide a snapshot of current thinking and practice. In turn, I hope this will help museum educators understand the complexities, pitfalls and challenges of creating 'active learning' web resources for museums.

1. Education Meta-centers

Of the six museum education typologies I have identified, *Education meta-centres*, along *with Creative play resources,* are still primarily concerned with teaching and learning via museum objects and documents. However, as we shall see, best practice in both is now exemplified by activities which enable users to manipulate and interrogate both the physical and intellectual content of artefacts.

Education meta-centres are web-based resources that allow students to explore, investigate, compare and evaluate textual and pictorial information from museum collections and archives. Most utilise Online Public Access Catalogues (OPAC) to make museum information accessible via the web. However, the mere accessibility of such data doesn't in itself guarantee learning. Therefore, many developers of data-rich resources, such as the Museum of Victoria's *Butterfly* site (http://www.museum.vic.gov.au/bioinformatics/butter/), have adopted generative learning methods to help students convert raw data into useful knowledge products.

Supporting generative learning

Museum Victoria's *Butterfly* site allows middle and upper high school students to access a single database of 30,000 Victorian butterfly records via seven discrete searches. Each search is designed for students of a particular age and studying a particular syllabus, and culminates in a series of comparative activities that allow students to mentally experiment (generate ideas) with various data sets. Student experimentation and analysis is via a series of web-based mapping tools. These allow them to plot and overlay the distribution data of butterfly species with Victoria's vegetation, altitude, river and zoogeographic information. The result is a unique schematic of species and topological data which students can endlessly modify and interrogate. This allows them to develop learning outcomes built around their own interests, and in turn can result in deeper conceptual understanding and affinity with the subject.

2. Creative Play Resources

Like nearly all active learning resources, *education meta-centers* are primarily designed for secondary and tertiary students. Currently there are few museums developing active learning resources for under eights.

This is surprising as most museum educators agree that young children have just as much right to make sense of their world with digital media as do older children. Although small in number, there are a few examples of what I call *Creative play resources* for under eights. The Museum of Modern Arts' *Art Safari* (artsafari.moma.org/) is exemplary. *Art Safari* uses paintings and sculpture from MOMA's collection to help children develop their observational skills. The site includes creative activities which encourage students to examine and creatively respond to the forms, stories and characters in Rousseau, Kahlo, Rivera and Picasso artworks.

Playing to learn

Early childhood learning research points to the value of activities which stimulate and support creative play. Creative play is an important part of young children's learning and describes those experiences that encourage them to explore and test ideas through the process of making. Most project-based websites offer some degree of creative play if they allow students to create original written or oral compositions. However, for young children, drawing and painting-based activities are often the most effective. *Art Safari* supports this kind of creative play by helping children draw a portrait of a pet or a fantastic animal using a downloadable digital palette. Ordinarily, young children find this kind of activity very stimulating, particularly as it allows them to explore subjects that are close to their hearts. Pets, parents, brothers and sisters, etc., are all of deep personal interest to young children. These subjects, when combined with creative play, excite children to keep on investigating, listening, talking, designing, constructing, asking questions, reading and writing. (**Downes, et al, 1999).**

3. Electronic Field Trips

While *Creative play resources* are ideal for helping develop observational and hand- eye coordination skills, *Electronic field trips* are best suited for teaching complex cyclic, structural or relational concepts by immersing students in credible microworlds. Credible microworlds convincingly 'transport' students through time to historical sites; through space to the museum; or through their imagination to fictitious and fantastic worlds. The effectiveness of this transportation is in part dependent on audio-visual materials and interactive technologies to 'realistically' simulate an experience or environment. Be they imaginary planets, tropical rainforest or civil war battlefields, all these microworlds must not only capture the attention of students, but also engage them in stimulating activities for long periods of time. To achieve this, many *electronic field trips* utilise anchored instruction techniques.

Anchored instruction

Anchored instruction activities utilise sets of interconnected problems to encourage users to activate their reasoning, deductive and investigative faculties. An excellent example is Brookfield Zoo's *Go Wild* field trip (http://www.brookfieldzoo.org). *Go Wild* challenges students to solve the problem of finding a safe way through the Ituri forest of central Africa. To help, developers have provided four avatar guides who drive the narrative by bombarding users with questions. As with all anchored instruction activities, *Go Wild* challenges are based on *real* problems like using a compass and map, making barkcloth or choosing suitable forest foods to eat. The realistic nature of these problems is imperative to encourage students to take ownership of their dilemma, and in turn, responsibility for actively overcoming it.

4. Video Conferencing

Like *electronic field trips*, video conferencing activities utilise the connectivity of the web to transport students and teachers beyond their classroom or home. However, unlike current *electronic field trips*, video conferencing can utilise synchronous affordance technologies to connect students and teachers to the *real* museum's staff and exhibits, in real time. Here the microworlds created are not simulated, but utilise the performances and 'scenery' of staff and exhibits. Ultimately it is the photogenic nature of these displays, together with the affability and open-endedness of the student-presenter dialogue, which can determine the level of meaningful engagement.

Unfortunately video conferencing is bandwidth hungry. Therefore, museums need ideally to have access to high-speed networks like that of the New Jersey Department of Education's Distance Learning Network. This state-wide ISDN/ATM network allows schools from across New Jersey to link to the Liberty Science Center's (LSC) 250 exhibits. Currently, access to LSC exhibits is via a series of E-connection programs, e.g. the aquatic ecosystems package. This video conferencing activity links a class of upper primary students studying river ecosystems to a biologist based in the LSC's Hudson River aquarium. After a brief introduction, a camera scans tanks of toadfish, eels and spider crabs. A series of carefully choreographed activities follow, prompting students to ask questions about the habitat and behaviour of each species. Quickly a dialogue begins as the Biologist moves from presenter to conversation facilitator. As well as conversational ability, the presenter needs in-depth knowledge to create an active learning experience built around open-ended dialogue.

The nature of digitally based, open-ended experience is complex and ideally needs to be sufficiently stimulating to children to elicit many and varied responses and questions. To achieve this, research has demonstrated that digital resources need to be sophisticated enough to (1) encourage children to respond in thoughtful ways, (2) offer response to children's answers, (3) offer variations that are child-controlled, and finally (4) cater to each child's ability level, cognitive development and computer skills, as well as culture/s and language/s (Downes, et al., 1999). For all these reasons, we can see why human facilitation of genuinely open-ended learning experiences is still so necessary, and is a learning attribute of video conferencing unmatched by any other active learning typology.

5. Museum Learning Networks

Museum learning networks have been around, in internet terms, for a relatively long time. But surprisingly, they have yet to flourish, and indeed even today most museums are preoccupied with developing resources for students working independently, either from home or within a classroom, rather than working in teams. This is understandable as the complexities of building resources to accommodate more than one simultaneous user can be immense.

Learning networks like the Science Learning Network (http://sln.org/) or

STEM (http://www.nmsi.ac.uk/education/databased3/stem/stem/stemintro.asp) characteristically provide aggregated access to an array of field trip and expository resources themed around a single discipline like science, contemporary art or the environment. Twelve science centres from across Asia, Europe and the Americas provide content and manage The Science Learning Network (http://www.sln.org/) , established in 1996. Within SLN, students can conduct a series of genetic, solar, aviation and oceanographic experiments or participate in one of three collaborative projects, including *Monarchs and Migration* (http://www.sci.mus.mn.us/sln/monarchs).

Learning through collaboration

Conceptually *Monarchs and Migration* uses the natural phenomenon of migration to encourage an international community to build a rich textual, artistic and photographic snapshot of Monarch Butterfly migration. Classes in the USA, Mexico, New Zealand and Australia use galleries and tracking studies to share observations and photographs of migrating Monarch Butterflies. Whilst offering excellent content and tools, *Monarchs and Migration,* like many learning network activities, is limited in the 'genuinely' collaborative opportunities it offers. These are ideally activities that foster cooperative problem solving through continuous communication. This kind of collaboration is best facilitated via *real* meetings, or chat rooms and listserves, within which the process of creating a joint product is negotiated. These products can be anything from web-based scrapbooks and photo-albums to reports and diaries, but their design and structure need to be carefully considered to encourage mutual respect and trust amongst collaborators. An excellent example is the National Museum of Science and Industry's STEM project.

Users as authors

The STEM project is a learning network with a difference. Instead of museum educators and curators producing content, students and teachers do. Students and teachers who visit one of the National Museum of Science and Industry's three museums are invited to compete with one another to create a web resource based around their visit. Invariably those teachers and students who take up the challenge work in teams, both *real* and virtual. In this way STEM students create products that explore issues, ideas and problems that have roots in their unique experiences, interests and opinions. As in any active learning experience, given the opportunity to control content directly, students are much more likely to be internally motivated to explore issues and ideas close to their hearts. The bonus is that these very same issues are much more likely to be of interest to the resources' intended audience -- other students.

6. Expository Teaching Resources

Often found on science and technology museum websites, *Expository teaching resources* are only now beginning to embrace active learning principles. Primarily developed for children twelve years old or younger, *Expository resources* ordinarily are comprised of a series of highly structured computer-directed activities through which a set of principles, laws or theories is presented (expository).

The Australian National Science and Technology Centre's *Funzone* is typical. *Funzone* (http://www.questacon.edu.au/fun_zone.html) features a series of Macromedia-based puzzles, activities and laboratories where students can conduct web-based experiments. One of these asks students to observe a series of animated lines moving across their screen. After 60 seconds the lines stop moving; however, students observe a motion-after-effect. That is, the lines 'seem' to continue to move across the screen because the brain is so accustomed to the movement, it 'imagines' they are still moving.

Addressing metacognition problems

Interaction with other students and with the Macromedia animation itself has been deliberately constrained in *Funzone*. While this may seem at odds with active learning principles which traditionally encourage open-ended learning experiences, these 'closed' learning resources are not without merit. Potentially they can alleviate some of the metacognition problems often encountered by young children. Metacognition problems can occur when people lose sight of, or can no longer accurately monitor, the success or failure of their own learning because activities are not stimulating, or are too complex. A number of studies have indicated that poor metacognition can also arise when students fail to develop clear-cut learning goals because they are given total control of their learning experience. However, metacognition problems can be addressed through careful navigation and interface design coupled with rigorous remedial evaluation. While this type of work is often time consuming, it is undoubtedly worthwhile as the vast majority of younger children, like older children, still prefer to control their learning experiences.

Therefore the dilemma for *Expository resource* developers is to find a compromise capable of accommodating both the normal student's desire to explore (active learning) and a specific student's metacognition problems. While there are no easy answers, one possible approach is to try to enrich 'experiments' with layers of additional activity. In the case of *Funzone*, students could have been offered extension exercises with different coloured lines or lines moving at different speeds available under student control. This kind of 'value adding' to expository resources has the potential to lessen the likelihood of metacognition problems, as it supports limited student exploration and at the same time embraces active learning. Critically, this layering also has the potential to expand student understanding, as it more clearly defines the limitations within which phenomena such as motion-after-effect operate. An excellent example of this kind of *Expository* layering is the National Museum of Australia's *Ann Fibian* website (http://www.nma.gov.au/education/ann/index.htm). Here students investigate soil erosion and deforestation phenomenon via a series of expository activities having a carefully set mix of computer and learner controlled activity.

Do They Work?

As these six typologies demonstrate, there is no such thing as a sure-fire way to guarantee learning or teaching, only methods or devices (pedagogic or technical) which together facilitate the individual's endeavour (B. Whalley, 1995). Indeed, the deployment of any one of the cognitive strategies I've discussed is not in itself a guarantee students will even pay attention. The best museum educators and designers can do is to carefully consider these cognitive strategies, along with pedagogically appropriate content, design and affordance strategies. But even then we need to recognise that learning is still a process beyond the total control of museums, and is predominantly invested in the individual learner. So even if the mix has been carefully prepared, work can still be undone by the relatively unknown impact of users' unique cognitive, environmental and cultural characteristics. That is why I wish to close this paper with a plea for further research, particularly remedial and summative evaluation. It is not until we have a better understanding of *real* outcomes, against those intended, that museums will be able to advance the practice of active learning product development. However, I'm mindful that active learning environments are expensive to develop, as are evaluation studies. What's more, I've yet to come across a workable evaluation framework. So in a year when AMOL will be launching its own museum learning gateway, I'm very eager to talk to museums or universities interested in sharing costs and expertise to develop appropriate evaluation frameworks for active learning resources.

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