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Discussing biodiversity in dioramas: a powerful tool to museum education

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The important role of Natural History dioramas in biological learning

(Photo: A. Scheersoi)

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ICOM–NATHIST Gerhard Winter (chairperson)

Editorial

We consider that natural history dioramas are one of the most effective museum exhibit genre for the teaching and learning of many aspects of biology. Dioramas have been, hitherto, a rather neglected area of museum exhibits but a renaissance is beginning for them and their educational importance in contributing to children's understanding of the natural world. Even though many dioramas have been dismantled, curators interviewed by Paddon do admit they can reach a wide audience and increase access to biological knowledge.

Creating dioramas. Dioramas are, just like photographs, a snapshot in time of plants and animals in their natural surroundings. Although created to provide a sense of place and a show piece for the trophies of wealthy big game hunters, not as lone exhibits but in habitat groups. Marandino et al. highlight that dioramas came to show the relationship between specimens and their environment. Nowadays, dioramas play an important role in reminding the public to preserve nature and in enabling contact with an environment that many of the visitors may never have experienced first-hand. Indeed, educational programmes have been embarked upon by building a set of dioramas mainly highlighting local natural environments and their biology inhabitants to redress this issue of lack of local biological knowledge, like Borg's project in Malta. The creations of such natural history dioramas are, as Morris mentions, time consuming and expensive.

Information contained in dioramas. The biological knowledge ranges from recognition and identification at some level of species, plant, animal or fungi together with the recognition of physical phenomena such as rock formations, soil types and the flora and fauna. Holmes discusses even meteorological phenomena which can be learned from dioramas and applied to the everyday world.

Dioramas not specifically constructed to tell natural history stories also often contain information of a biological nature which visitors use in their making sense of what they see. The agricultural dioramas in the Science Museum, London provide an exemplar of such occurences (Tunnicliffe). Ten year old children noticed biological phenomena in the relevant dioramas and showed a surprising lack of vocabulary to explain what they saw, such as using the word 'dirt' for soil. However, they appreciated the human activities displayed and commented on aesthetic aspects of these classic dioramas.

Environmental changes. Dioramas reflect in the manner of photographs, which is discussed by Morris, a moment in time, which, as in many dioramas in the American Museum of Natural history, reproduce a known place which can be visited today. Indeed, such representations enable biologists to identify the changes in these habitats over the past century thus providing invaluable information in conservation biology work, as does the DNA in the skins of the animals.

Biological interaction. Dioramas are thus depictions of reality albeit specimens perpetrate in a perfect "Garden of Eden"-state, as Tunnicliffe points out. The specimens are arranged to illustrate concepts such as vegetation of biomes and the adaptations of animals that live there in a fictitious scene. Moreover, dioramas can illustrate behaviours such as predator-prey; symbiotic relations who cannot be told using live animals.

Museum/Exhibit learning. Visitors respond to dioramas as they do to other museums exhibits. However, there emerge distinct patterns of behaviour. They will experience some type of interaction to the exhibit albeit such ranging from looking quickly and walking on because there exists no draw for them to the person who becomes absolutely involved in looking and talking about the story depicted, as Scheersoi discusses. Such interaction can span several generations as Stern describes in her observations of visitors at the Peabody museum. Learning requires the learner to be active for further understanding of the topic in question to be constructed. Such developing of concepts frequently occurs through the mediation of something or somebody. It can be a label or other input or a person such as a chaperon, teacher, friend or enactor, as illustrated by Tinworth's description of such programs. This concept of 'Significant other' as Vygotsky named the phenomenon, is important in considering the effectiveness of natural history dioramas, and indeed other genres of exhibit in museums in the widest sense.

Connections to visitor's prior knowledge. Visitors at dioramas and exhibits in general display distinct patterns of response. In natural history dioramas, visitors who come with previous knowledge and understanding and not each as a 'tabula rasa' initially seek to discover, usually through looking, if there is anything in an exhibit that interests them. If they locate something they match the object to something about which they hold an existing mental model, which may or may not be 'correct' in terms of existing biological knowledge. Visitors name things, this is a basic human need irrespective whether or not the categorisation is biologically correct. Visitors find the name of nearest fit, so a goat was the name given for example to an Arabian Oryx, because the salient diagnostic features were hair, horn and hooves, according to the information held by that particular set of visitors which made this identification. If visitors remain at the dioramas after an initial viewing they usually start identifying other specimens and features, relating them to other similar objects from their past experience, as Mifsud and Scheersoi both show. Aesthetic responses, to the colours or shapes for example, also are often heard at natural history dioramas.

Narratives. Should visitors stay longer they construct narratives triggered by what they see which elicits memory. This phenomenon is often observed inter-generationally as Stern describes. Frequently, in the case of children, their imagination is intertwined with direct observations into personal narratives (Tunnicliffe).

Inquiry science. Researchers have noted that if children unprompted are allowed to dwell and in fact 'stand and stare' at these dioramas they enter into inquiry science, as was witnessed at the now dismantled Rowland Ward Dioramas in London by Tunnicliffe. Following observation and matching observation with held knowledge children raise question and formulate hypotheses. In educational situations they can, using various resources, seek answers to their hypothesis and evaluate their idea against the facts discovered.

Visitor studies. Educators are often interested in what message visitors take from the dioramas. There are various ways of eliciting such information, questioning, open interviews and recall post visit through telephone conversations, and pieces of writing or drawing for example. Mifsud describes a technique of using drawings executed by children before a visit to natural history dioramas to determine prior knowledge and expectations and then afterwards to find out what they remember and how they interpret such.

This compilation of articles, covering a wide range of activity at natural history dioramas, seeks to set this genre of museum exhibit firmly in the museum world as a key with tremendous, often as yet underused, educational potential. They are 'minds on' exhibits as opposed to 'hands on' in which the physical interaction frequently becomes the exhibit. The computers in many hands on exhibits can be interacted with elsewhere, such as in the home. In contrast, the dioramas are windows into nature and to a natural world, which many of us will never see whether home or abroad. Such dioramas hold a fascination for visitors. Dioramas are indeed 'snapshots', thus they are a moment frozen in action so visitors can view and ponder and look again, unlike live animal exhibits in zoos, which perform a different function for their visitors. Moreover, in contrast with the single taxidermically prepared animal, the specimens in natural history dioramas are shown in their natural context and many messages are there for visitors to interpret. These three different types of biological exhibit complement each other.

The museum world should cherish dioramas as wonderful treasures. Encouragingly, new dioramas are being constructed, such as those showing the development of the flora and fauna of Scotland from the last ice age in Edinburgh and the ones of the everyday natural history of Malta.

Sue Dale Tunnicliffe and Annette Scheersoi

Dioramas – an untapped educational resource

The art of reproducing natural settings has for long been a substantial part of museum displays. Dioramas may depict actual locations or fictitious scenes and can vary in size from small showcases to large displays. The topic varies according to the themes represented. In our case the setting is a natural one. These mainly static displays in many natural history museums have always attracted the attention of the lay person as well as students. With this in mind, the National Museum of Natural History housed in an 18th Century Magisterial Palace in the old city of Mdina, Malta, embarked on an educational programme by building a set of dioramas mainly highlighting local natural environments and their biota.

Fig. 1: North. hemisphere sea birds

Six local themes have been chosen as well as three foreign themes including: a northern hemisphere seabird colony showing an adult Northern Gannet as its centre piece and several representatives of the Alcidae family (fig. 1), a north African desert scene with an immature Lanner Falcon as its focal point and a similar sized showcase depicting oriental arboreal bird species. The latter three displays measures approximately 1x1x2 metres.

On a larger scale a local approach was chosen and these dioramas highlight the following habitats; Coastal Seacliff highlighting bird migration representing egrets, wades and other birds and breeding birds represented by an adult male Cory's Shearwater. The Rural Courtyard scene is more mundane and represents different biota both wild; butterflies and various other insects, sparrows, geckoes and an Etruscan Shrew as well as domesticated ones such as a cockerel present in such an environment, the following theme is agriculture (fig. 2) and the role of rubble-walls as shelters for various animal groups; birds, insects and mammals are represented here.

Fig. 2: Agriculture

The high valley walls and bottom host a wide range of species and here one can find species present close to water courses such as frogs, snails and some bird species (fig. 3) and further up the cliff walls other species predominate.

The Sandy shore is most probably the more familiar but the fauna find there is still alien to most children and adults. Waders, gulls and other bird species are represented as well as some floral species. The fortified bastions in a night

setting (fig. 4) is one of the more popular highlighting nocturnal species such as Barn Owl, Nightjar and different bats and moth species. These dioramas measure approximately 2x3x2metres.

Fig. 3: Valley bottom

Fig. 4: Nocturnal fauna (Bastions)

What...no panels?

The main characteristic of the first dioramas is the lack of interpretation panels. This approach has been chosen as a means to observe child perception and observation skills. Children coming from an urban environment find it more difficult than children from rural areas to seek, locate and identify many specimens in the displays. Some that may appear plain obvious to the trained eye are usually overlooked. Another interesting result from these observations demonstrate that urban children may not know the species as a living animal but may identify it with for example a television character. One such case being the Hedgehog. Some urban children did not realise that this was an actual living, breathing animal and not a cartoon character. In fact many children refer to the hedgehog as *Xummiemu* the Keep Malta Clean character that featured in many cartoons and illustrated material. This approach at presenting nature to the visitor, being school children or lay persons serves as a medium along with actual field work to instil observation skills and a respect towards the natural environment. A respect which in the Maltese islands is still wanting.

John J. Borg, Principal Curator, National Museum of Natural History Malta

Wildlife Dioramas from Malta

In his best seller, *Last Child in the Woods,* Richard Louv (2008) calls the lack of nature in the lives of today's 'wired' generation as 'nature-deficit' and links it to some of the modern negative childhood trends, such as the rises in obesity, attention disorders, and depression. He discusses research indicating that direct exposure to nature is essential for healthy childhood development and for the physical and emotional health of children and adults and such is particularly relevant to Malta, which possesses sparse endemic wildlife and over a third of its surface area is occupied by building., Dioramas are particularly valuable to the urban community in constructing understanding of the different habitats and interactions between organisms (Tunnicliffe, 2005).

Theoretical framework

Constructivism is a theory of learning based on learners constructing rather than absorbing new ideas, and developing or modifying existing ideas (Bell, 1993). At the core of the educational process are the way learners are aided to construct meaning from new information and the way the learner conducts dialogue with the self (Tunnicliffe, 2002). Current believe amongst educators is that subject matter should be learnt through knowledge constructed by the learner d rather than passive reception.

Children's learning about animals may be investigated by examining the mental models revealed through their talk and drawing when they come face to face with live or preserved animals. The mental model is the person's personal knowledge of the phenomenon. This knowledge will in certain aspects bear similarities and in others differences to scientifically accepted knowledge, which in the case of this paper is the appearance of the animal and its ecological habitat (Reiss & Tunnicliffe, 1999). Children are mostly stuck by anatomical features while viewing animals. These features may be revealed from the child's representations of the authentic specimens as constructed through the interrelation between the real object, mental model and the representation (fig. 1) (ibid).

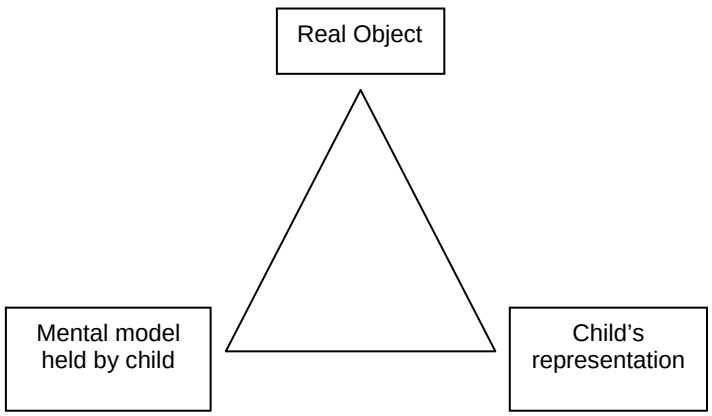

Figure 1. (adapted from Reiss & Tunnicliffe 1999, pg 143).

The representations may be written descriptions, verbal descriptions, drawings or three-dimensional models. In this context, observation emerges as an essential skill for scientific learning, which is here understood to mean active looking in search of understanding (Tomkins & Tunnicliffe, 2006). Tomkins and Tunnicliffe are particularly concerned that present day science education is lacking observation skills in biological sciences and stress the importance of the skill.

Most of the methods employed for gathering information on pupils' understanding of scientific phenomena rely mainly on speech and writing. Very few empirical studies have made use and evaluated the potential of drawings in elucidating scientific understanding. This is not to state that drawing is necessarily superior to other means, but it does have advantages. One is the relative ease of obtaining a rich mass of data that related to the children's mental models. Another is the international suitability of drawing that transcends the huge diversity of languages (Reiss et al, 2002). Drawings may be as rich a source of evidence as language and open a window on children's thinking in all curricular areas. It may also serve as an alternative to verbal expression for children that are often able, through drawing, to show things that they cannot put into words (Lewis & Green in Bowker, 2007). However, finished drawings cannot portray the thinking, talking, social interaction and mark-making sequences that form a fundamental part of the process (Coates & Coates, 2006). Drawings may also provide insights into children's cognitive, affective and social development (Bowker, 2007).

Methodology

At the Natural History Museum in Malta the children were lead into the diorama area in small groups of 2 or 3 pupils at a time. Conservations were audio recorded using an inconspicuous MP4 device. Children were asked questions to clarify points and in some cases to initiate the conversation with shy groups. On the same day of the visit back at school, children were asked to produce a drawing representing a scene from the dioramas of the NHM. All drawings were labelled with name, age and school on the back of the drawing.

Analysis of drawings

Most pupils drew a bird, a snail, a butterfly, a rooster, a bat and a starfish. Other animals drawn were molluscs, rabbits, rats, spiders and hedgehogs. Most recognisable animals were birds, rabbits, butterflies, snails, rats, hedgehogs, bats, shells, starfish and spiders. Many drew a tree and a flower and about 90% of drawings showed evidence of some form of habitat seen in the dioramas. Most drawings had an identifiable diorama setting seen at the museum with the most commonly represented being the beach (47%) and the town house yard (58%) (fig. 2 and 3).

Figure 2: Photo and drawings of the beach diorama

Recorded conversations reveal child knowledge not seen in drawings. Mentioned but sparsely noted in drawing were the lizard, owl, moth, grasshopper, beetle, chameleon and weasel seen in the dioramas. Plant life was rarely mentioned, except for trees in a few instances.

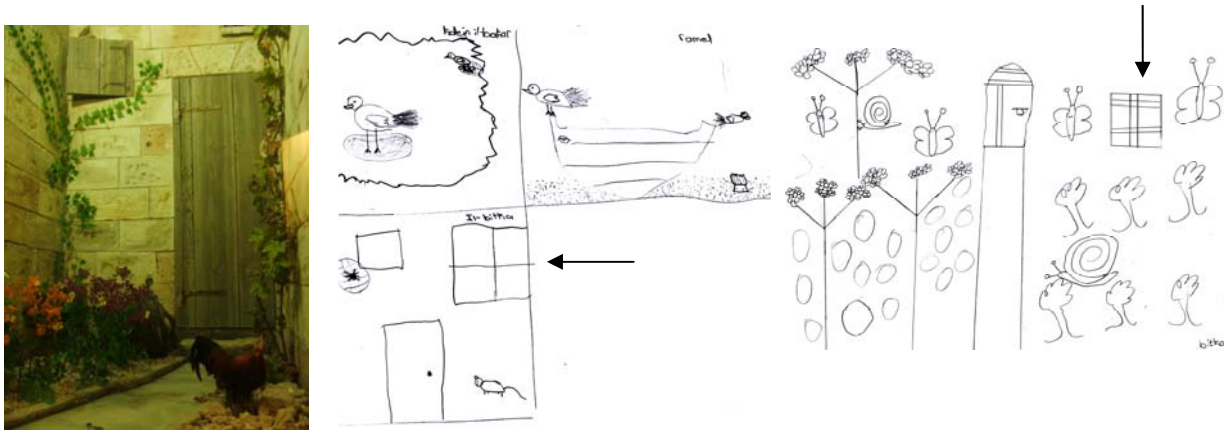

Figure 3: Photo and drawings of the house yard diorama

Conclusions

The inclusion into the drawings of features ***not*** present in the dioramas indicates that the children are matching what they see with their existing related mental models. Some of the children drew added features so as to compose a more complete picture of the scene. For example, the beach diorama (showing the colourful boat) ***does not*** have a painted background of a blue sky with the sun and the palm trees, but the children drew them anyway (fig. 2). This study was conducted in Malta, an island where children are used to the predominant sunny weather with blue skies all year round and very limited cloud. It seems that the children produced a representation of a typical Maltese beach from their memory with the usual blue sky and the sun. The drawing in the centre also shows a fisherman's net thrown over the boat's side.

Children thus inserted what they thought should be there although the way some children drew the house yard window on the right, when this was actually on the left side of the door as can be seen in figure 3, is difficult to explain. The drawing on the left also shows a different type of door than the one present in the diorama perhaps reflecting the children's experiences at home?

Some other children drew unusual things like guns and syringes, items associated with hunting or capture of animals but not present in the dioramas. The viewing of the dioramas acts as a trigger for children to assemble their related memories about the topic and compile a personal representation of the topic. They do not just recall the actual substance of the diorama accurately.

References

Anning, A. (1997) Drawing Out Ideas: Graphicacy and Young Children. *International Journal of Technology and Design Education*, 7 (3), 219-39.

Bowker, R. (2007) Children's perceptions and learning about tropical rainforests: an analysis of their drawings. *Environmental Education Research*, 13 (1), 75-96.

Bell, B. F. (1993) *'A constructivist view of learning' in, Children's Science, Constructivism and Learning in Science (pp. 23-29).* Waikato: Deakin University.

Coates, E. & Coates, A. (2006) Young children talking and drawing. *International Journal of Early Years Education*, 14(3), 221 – 241

Richard Louv (2008) *Last Child in the Woods*. New York: Algonquin Books of Chapel Hill.

Reiss, M. J. and Tunnicliffe, S. D. (1999) Building a Model of the Environment: How Do Children See Plants? *Journal of Biological Education*, 33 (3), 142-148.

Reiss, M. J., Tunnicliffe, S. D., Andersen, A. M., Bartoszeck, A., Carvalho, G. S., Chen, S.-Y., Jarman, R., Jonsson, S., Manokore, V., Marchenko, N., Mulemwa, J., Novikova, T., Otuka, J., Teppa, S. and Van Rooy, W. (2002) An International Study of Young Peoples' Drawings of What Is Inside Themselves. *Journal of Biological Education*, 36 (2), 58-64.

Tomkins, S. P. and Tunnicliffe, S. D. (2001) Looking for Ideas: Observation, Interpretation and Hypothesis-Making by 12-Year-Old Pupils Undertaking Science Investigations. *International Journal of Science Education*, 23 (8), 791-813.

Tomkins, S. P. and Tunnicliffe, S. D. (2006) Bring back the Nature Table! *Environmental Education*, 82, 8-11.

Tunnicliffe, S. D. (2002) 'The educational value of natural history collections in learning about biodiversity. *The Biology Curator*, (22), 27-40.

Tunnicliffe, S. D. (2005) What do Dioramas Tell Visitors? A Study of the history of Wildlife Diorama at the Museum Of Scotland. *Current Trends in Audience Research and Evaluation*, 18, 23-31.

Edward Mifsud, Malta

Biological interest development at Natural History dioramas

Specific features in natural history dioramas draw the attention of visitors and cause them to stop, look and begin interpreting the biology and other features portrayed. Such situational interest is crucial in learning, especially in non-formal learning environments where individual visitors may be regarded as independent learners.

As a starting point for our studies, we use the Person-Object-Approach to Interest (Krapp 1999, Schiefele 1991). According to this approach, interest is a relational construct (see fig. 1). It refers to a "person-object-relation" which is characterized by several specific features including both, feeling- and value-related aspects. An object of interest can refer to concrete things, a topic, a subject-matter, or even an abstract idea. The realization of an interest requires a situation-specific interaction between the person and the object. This interaction can be a concrete hands-on engagement with the object, as well as an abstract cognitive working on a specific problem (e.g., the analysis of a scientific question) or the occupation with certain ideas without conscious control (e.g., day-dreaming).
There are two types of interest. These reflect differing amounts of knowledge, feelings, and value: firstly, interest that emerges in response to situational cues (= situational interest), and secondly, a deeper interest that has developed over time and resides with the individual (= individual interest).

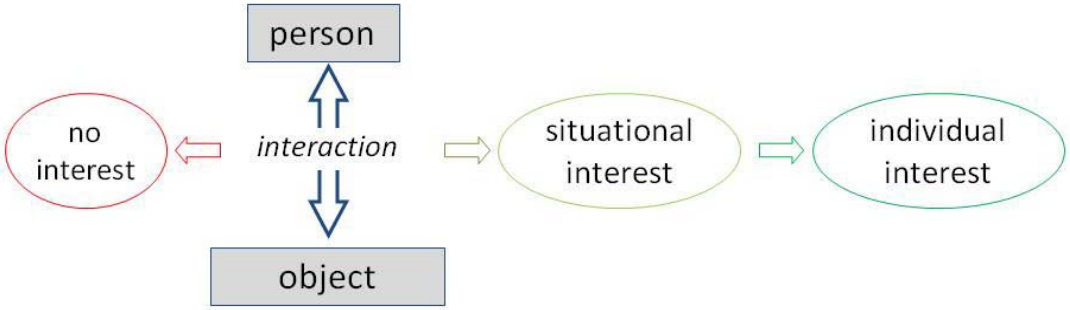

Fig. 1: Person-Object-Theory of Interest (POI, Krapp/Schiefele), main constituent parts.

Educators can have an enormous impact on the development of situational interest, and research (see f.e. Hidi and Anderson, 1992) has shown that an interest-triggered learning activity leads to better learning results, especially with respect to qualitative criteria such as a higher degree of conceptual or deep-level learning.
Based on this theoretical background, we wanted to know which specific features in dioramas support the development of situational interest by attracting visitors and encouraging focused observations and continued curiosity.
The study presented here considers selected data from work in several Natural History Museums, using both, quantitative and qualitative methods: Quantitative analyses are based on data from observational techniques – the behaviour of visitors looking at dioramas was observed and their spontaneous comments were recorded. The qualitative analyses are based on retrospective interviews with a smaller number of randomly chosen participants from the main study – after the visit, structured interviews were conducted to find out which dioramas the visitors liked most, and why, and if they were willing to acquire more knowledge about the subject presented. Additionally, children were asked to draw their favourite diorama and

comment about their drawing to identify aspects in the diorama on which they focused and to find out why these are relevant to them.

The data indicate that the development of situational interest depends on the quality of subjective experiences and the immediate emotional feedback during the visit. Situational interest is engendered by recognising either the familiar, seeing young or big animals, or by the unexpected (e.g., human traces in the wildlife scenes, such as a beer bottle in an elk diorama at Senckenberg Museum in Frankfurt). Visitors spontaneously name certain specimens and scenes, comment about that to which they relate personally, interpret – mainly anthropomorphic – and use narratives to share their knowledge. They show emotional reactions concerning the animals presented (=> affective), the diorama design and arrangement (=> aesthetical) and historical aspects or human traces presented in the diorama (=> cultural, experiential). Drawings of children record selective features, those which they find most relevant. These are in general connected with their personal experiences, including every day observations of animals around (pets, farm animals, local wild animals), media representations and narratives. These features vary strongly between the individual children. Figure 2 shows a diorama from Fulda's Vonderau Museum, figures 3 and 4 represent children's drawings of this same diorama.

While the girl (drawing fig. 3) focuses on colourful flowers and butterflies, for the boy the most relevant object seems to be the deer (drawing fig. 4). The children's comments about their drawings revealed that these selected diorama features connect to former personal experiences and to existing individual interests.

Fig. 2: Farmland diorama (Vonderau Museum, Fulda)

Fig. 3: Diorama drawing, girl (8 years)

Fig. 4: Diorama drawing, boy (8 years)

We conclude that dioramas stimulate situational interest if they evoke emotional responses and provide different anchor points which enable visitors with varying individual background to relate previous experiences to the scenes or artefacts presented. Person-object-engagements with this sort of dioramas result in visitors' feelings of enjoyment, involvement, and stimulation which are the most typical emotional aspects of an interest-based activity.
Educators, formal and informal, can build on the situational interest evoked at these dioramas to encourage and support the learning of biological science. Further studies will be conducted at Natural history dioramas, to find out which sort of learning activities can be used to deepen the engendered interest and thereby optimize the educational endeavour.

References

Hidi, S. & Anderson, V. (1992). Situational interest and its impact on reading and expository writing. In K.A. Renninger, S. Hidi & A. Krapp (Eds.). The role of interest in learning and development (pp. 215-238). Hillsdale, NJ. Erlbaum.

Krapp, A. (1999). Interest, motivation and learning: An educational-psychological perspective. European Journal of Psychology of Education, Vol. XIV, no.1, pp. 23-40.

Schiefele, U. (1991). Interest, learning and motivation. Educational Psychologist 26, pp. 299-323.

Annette Scheersoi, Goethe University, Frankfurt/Main

An afternoon among dioramas at Yale Peabody Museum

The young mother walked slowly along the edges of the dimmed room. She kept up a running commentary aimed at the baby facing forward in the carrier on her chest. Her words were in Japanese, but they were unmistakable to any parent – she was describing the scene in each diorama she approached. It is easy to imagine her words. "See, there's a rabbit with big ears in the marsh…Oh, look at the pretty bird in the tree... There's a turtle near the water...what else can we find here in the forest?"

Located on the campus of Yale University, Yale Peabody Museum serves as a home for the university's extensive collections of specimens representing all aspects of natural history, including geology, anthropology, botany, zoology, and paleontology. The dinosaur fossils on display feature the type specimens of Brontosaurus (Apatosaurus) and Torosaurus. Rudy Zallinger's exquisitely rendered 110 foot-long Age of Reptiles mural is recognized around the world. But the museum offers additional treasures – it houses dioramas created by gifted artist J. Perry Wilson. Wilson's unique dioramas, appearing in a number of American museums, are well-known for their amazing background landscapes. He styled a method of painting that portrayed natural looking perspectives, visually inviting the viewer to "step into" the scene. Wilson's talents serve to enhance the experiences of visitors to the Peabody encouraging interactive family dialogue.

A recent survey at the Peabody included not only the young mother noted above. There were a number of intergenerational family groups examining dioramas in the Southern New England Hall of the museum. A 62-year-old woman had brought her teenaged grandchildren from Florida to share some of her childhood memories. Their conversations focused on the scene before them – a 35-foot long panorama of a typical coastal region. The adolescents asked her, "What was it like when you were little? Did you go to this beach?" They were eager to hear what their grandmother had to say about her early experiences, and asked many follow up questions. One of the grandchildren took note of Wilson's depth of field. "Grandma, look! You can walk right into it."

Another family was led by a verbal 3-year-old girl. "Look here, Nana!" Her grandmother responded by expanding the descriptive language, asking the child to look for a big brown bird in the tree. The little girl scanned the dense forest scene, trying to follow the clues she was given. Her pointed finger shot out as she yelled, "An owl!"

A Latino graduate student had brought his parents to the museum, and they quietly discussed the familiar animals they recognized.

A mother with two toddlers in tow shared that she remembered seeing these dioramas as a girl. She had brought her young children because she wanted them to "learn more about their neighborhood and the stuff that lives there," just as she had done.

These engaged families brought an innate sense of comfort and trust to the learning opportunities presented by the rich visual presentations before them. Not only were multi-generational connections reinforced by the shared experiences of observing and identifying familiar animals, but elemental aspects of science inquiry were touched upon as well. All of the discussions that took place around the dioramas embodied basic science processing skills: observing, communicating, classifying, inferring, and hypothesizing. Science is more than a body of facts or collection of principles. Science inquiry is a structured and directed method of asking and answering questions. For many people, learning to focus on the details of science inquiry need not – or, possibly, cannot – occur among the overwhelming sensory input found in many of today's science museums.
Skillfully rendered natural history museum dioramas continue to provide an important avenue for fundamental acquisition of science knowledge.

Terri Stern, Curriculum Specialist, Yale Peabody Museum, New Haven (US)

A "could observation expedition" at dioramas

Clouds in a diorama (Meeresmuseum Stralsund), (photo: A. Scheersoi)

Through a program funded by the US National Oceanic and Atmospheric Administration the American Museum of Natural History has been working with sixth grade English Language Learners in the New York City school system. This program was to take advantage of some of our visualization technology and production capabilities to increase weather and climate literacy. One product of the project was a DVD with global cloud animations created from satellite images, but the Museum has some other cloud visualizations, dioramas. In particular, dioramas in the Hall of North American Mammals. These dioramas are spectacular scenes created near the height of the Museum's Diorama development. The displays depict some classic scenes of geological interest populated with a wide variety of some of North America's iconic mammal fauna. But looming overhead are the clouds: cumulus, stratus and wisps of cirrus. Students are introduced to cloud formation through classroom activities that have been shared with teachers

during professional development sessions at the Museum. Then students go on a "cloud observation expedition" to the Museum and record their observations of clouds in various geographic locations around North America. Geography skills and knowledge are also addressed through plotting these locations on a map and measuring distances between various points.
The Cloud Expedition takes advantage of the draw of the dioramas, the animals and places, to excite students and develop their observational skills. The three dimensional aspect of the dioramas draws them into the place, and puts them beneath the western sky with bison and bears, to look up. Once they return to school they continue to "look up" and investigate the clouds and weather above their own world.

J. Holmes, Natural History Museum New York

Inquiry at Natural History Dioramas - useful resource in science education

When people look at biological exhibits, be they in a science museum, botanic garden or zoo or organisms on a field trip, they construct meaning from what they see, what so ever it is, animal, vegetable or mineral or constructed artefact, and they label it (Bruner et al. 1956).

People view the object, identify it and make their sense of it within a context of meaning. Then they may raise questions about it, ask why, how and what and hypotheses. This sequence in visitor's verbal interactions with exhibits has been identified through studying conversations and analysing their content and usage.

Visitors come to the diorama on their visits with some knowledge relevant to the content in most cases. In their view their knowledge is pertinent to the exhibit and they often use this and only this on their interpretation of what they see. What the visitor holds in their mind is their mental model. What they saw, or draw, about the exhibit is their expressed model (Buckley, Boulter & Gilbert, 1997), which calls on information held within their mental model. Families and school groups do ask some questions of each other as they make meaning out of dioramas (Tunnicliffe, 1995)and such questioning can either enable movements towards scientific understanding or hinder it. Schools could also use the observations and discussion of their pupils as a starting point for inquiry science.

Cosgrove and Schaverien (1996) identified the processes of science occurring in the conversations of children when engaged in science work. They subdivided the types of conversations into descriptive, factual and

explanative conversations to peers or teacher about an investigation. The type of conversations moved through asking why and how questions, often associated with episodic memories, to conversations, which raised and tested hypothesises to lastly philosophical conversations. When visitors look at exhibits, especially dioramas, these varied types of conversations are present. Moreover, if pupils are provided with the opportunity and encouraged to observe for a period of time rather than just look they make relevant biological observations, raise questions and form hypotheses (Tomkins and Tunnicliffe 2001) and relate what they see to what they already know (Tunnicliffe and Tomkins 2005). Hence the form of the conversation can indicate to a listener, particularly a science educator, whether the visitors is raising questions, making scientifically based and relevant observations, in other words involving themselves spontaneously in inquiry science.

Family and school groups visited the three African dioramas in the Rowland Ward Pavilion at the Natural History Museum London The dioramas were situated at the end of the Evolution gallery on the first floor of the museum. They were dismantled in the autumn of 2004 as was the Evolution gallery to accommodate the Entomology Department whilst their building is demolished and Darwin 2 centre built. This unforeseen plan prevented further comments from being collected. Children of school age were asked, after permission was obtained from their family's or carers as leisure visitors, to tell the researcher, one at a time, if they were in a group or only one member the group, what the dioramas meant to them. The walk round the three dioramas took about 10 minutes. The researcher recorded the conversation. Then the researcher returned to the entrance to the pavilion and asked the next group who entered. There were three dioramas constructed by the British taxidermist Rowland Ward.

The first diorama was of an African Water hole and focused on animals gathering around it. There was a mother and baby giraffes, a kudu with an oxpecker on it, some baboons and a variety of birds. The second diorama was of the rain Forest. It had a bongo and an okapi amongst the trees and a water chevrotain but there was a scorpion some butterflies some birds amongst the foliage, which was dense. The last diorama was on Grassland in Angola and featured antelopes. A Giant Sable Antelope was standing on top of an earth mound and there were ant hills. There were other types of antelope neared the form of the exhibit (fig. 1). All exhibits were behind glass. An information panel was in the Pavilion but not directly by weak dermas and hence few people read it or even notice the information provided.

The number of conversations collected were: 58 commentaries at the Water hole, 51 at the rainforest and 54 at the Grassland. Thus a total of 164 commentaries were recorded and then transcribed. Most visitors spoke about all three dioramas, the process taking about 8 minutes, but a few young children only spoke about one of them.

Figure 1: Grassland diorama, Museum of Natural History, London (dismantled)

Age and Numbers of comments made at the three African dioramas:

Age	Total	male	female
4 years	5	5	0
5/6 years	55	36	19
7 years	12	3	9
8 years	30	15	15
9 years	13	7	6
10/11	21	6	15
Total primary children	134	71	63
Secondary12-14 years	20	8	12
Adults	9	0	9
Total commentaries	163	78	84

Number of naming comments in which observation is inherent:

Age group	Boys	Girls
5-8	156	136
8-12	111	165
12-18	16	21
adults		20

Number of comments other than naming which are inherently observation:

Describe Structure/scene	Describe behaviour	Interpret (including affective interpretation)	Science process (other than observation)
218	175	102	77

A boy aged 9 listed what he recognised, and hence matched to his mental model of the animals thus enabling him to name them. "Giraffe and its baby; few monkeys and small birds". At the Grassland scene he adopted an inquiry science approach at the large Sable antelopes by saying "that looks like the alpha male, it has big horns", hence observing information and raising an hypothesis that the male with the big horns way stage dominate animal, he went on to compare several animals and raise another hypothesis, "It looks like the younger ones [were smaller ones, he concluded that small might be young and not another species] are a bit lighter than that one which could be a female."

Children allocated names according to the salient and criteria features, which they recognised in a mental matching process. A nine-year- old girl said at the Angolan grassland "I can see... animals I don't know their names. That one looks like a bull [gnu] that one looks like a horse with big horn [Giant Sable Antelope] and this one looks like baby antelope [adult of a small species]". Thus children were making observations and seeing patterns a key aspect of biological inquiry.
Whereas a boy aged 9 years remarked, "Not sure, I think that is an antelope of sorts", thus raising a hypothesis.

Fantasy has its place in the interpretation given by some visitors and some see the three dioramas as part of an overall story. A girl aged 8 commented at the Water hole: "I think they are being friendly to each other. The Mother and the giraffe always stand together they never go part. It tells a story about being kind." She then went on to explain and raising hypothesis as to why the animals are kind, "Because no predators come and there is water." At the next diorama, the rain forest," Different this is only green it is jungle, not much water only one puddle [all identification and description]. Tells me that the animals into being friendly and walking away". Whereas at the Angolan grassland she said, "This is desert he [the Great Sable Antelope] is master of all the land and he [the wildebeest] is eating the grass and the big one [the Sable Antelope] seems to say "You all obey me!" but one is answering saying, "No way I'm not going to bow down to you." Then the girl raises a hypothesis to explain her interpretation. "Maybe he [the Giant Sable Antelope] only let them have a certain amount of water?" Younger children made similar science inquiry statements other than the observations noted. There were 77

comments, which indicate the science process other than observation, and description, which revealed explanation and interpretation

The boy who raised the hypothesis as to the species of an animal could have then pursued his ideas had suitable scaffolding materials in terms of keys, a facilitator who would ask the appropriate questions of necessary features to be held in order to belong to a certain group of animal could have helped him confirm or not. The dialogues heard show that children notice both biological specimens and artefacts and label them according to their exiting knowledge. They then interpret that which they see and will produce narrative again interpreting the scenic in terms of their won understanding. Once this process sis over they begins to ask questions, raise hypothesis and postulate answers. If children are giving the opportunity to stand and stare (Tomkins and Tunnicliffe, 2001) inquiry begins. This situation provides a starting point for further study and research in the museum or back at home or school. It is our opinion that these natural history dioramas are a much underutilised educational resource and have been dismissed as old fashioned and irrelevant by non educator management persuaded by effective technology sales advances. The dioramas are a powerful potential tool in science education and should be developed as such.

References

Bruner, J. S., Goodnow, J. J. and Austin, G. A. (1956) *A Study of thinking.* New York, John Wiley, Science Editions, Inc.

Cosgrove, M. & Schaverien, L. (1996) Children's conversations and learning science and technology, *International Journal of Science Education*, 18 pp. 105-116.

Buckley, B., Boulter, C., & Gilbert, J. (1997) Towards a typology of models for science education. *In J. Gilbert(Ed.) Exploring models and modelling in science and technology education* .pp.90 –105. Reading, England. University of Reading.

Tomkins S.P and Tunnicliffe, S.D (2001). Looking for ideas: Observation, interpretation and hypothesis making by 12 year old pupils undertaking science investigations. International Journal of Science Education. 23 (8). 791-813

Tunnicliffe S. D. (1996) *A comparison of conversations of primary school groups at animated, preserved and live animal specimens.* Journal of Biological Education 30 (3) pp 1 -12

Tunnicliffe, S.D. (1995) *Talking about animals: Studies of young children in zoos, a museum and a farm.* Unpublished PhD thesis. King's College, London.

Tunnicliffe S.D. and Tomkins, S.P. (2005) The Nature Table Project. *Teaching Ecology Newsletter*. Issue 31. Pp2-4

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Creating a unique visitor experience through enactors

A study was designed to assess qualitative and quantitative impacts of the enactor program on visitor experiences at the Denver Museum of Nature and Science (DMNS). Of interest was capturing the unique visitor experience that enactors provide by combining visitor engagement, education and interaction.

Starting in the summer of 2008, the enactor program began to be implemented throughout DMNS' diorama halls. Aligned with the 100th anniversary of the Museum, the enactor team began to portray turn-of-the-century characters to engage and educate visitors in the dioramas and permanent galleries:

1) Miss Margaret Winters is a club woman, one of a growing number of women in the early 1900's who got together to study nature and promote conservation. Miss Winters can often be found sketching birds or flowers in the dioramas and teaching visitors about how to observe nature.

2) Miss Florence Epp is a young adventurer who grew up in Africa. She draws inspiration from her late 1800's counterparts, Mary Kingsley, Isabelle Eberhardt, and Gertrude Bell, women who explored foreign lands and studied indigenous cultures. Miss Epp is most at home in the Botswana Hall, telling stories and teaching games from Africa and showing her collection of "money cowries."

3) Mr. A.J. Rappaport is a freelance reporter from Leadville Colorado, here at the Museum to write an article about the brand new Colorado Museum of Natural History and possibly attend the 1908 Democratic National Convention. You'll usually find Mr. Rappaport showing visitors photos of the original building and dioramas, and discussing the natural sciences and new inventions while taking quotes "for posterity."

The Visitor Programs Department, who manage the enactor program, outlined several goals for the program in the diorama halls prior to the study:

1. To bring attention to the richness of the dioramas and to the individual objects/specimens within them.
2. To connect the visitors to those dioramas and objects through discussion and participatory activities.
3. To allow visitors to chose their level of involvement and to have the opportunity to drive the direction of the discussion content.
4. To make the experience personally relevant to the visitors by putting them at the center of the interaction, having them participate rather than just observe.
5. To enrich visitors' understanding of the themes, concepts, and content of the exhibit and of the Museum.

Several methods employed throughout the study — including visitor surveys, observation, tracking and timing, and enactor focus group — shed light on these goals.

Visitor surveys

Ninety-two (n=92) visitors were approached while exiting the diorama halls and asked to complete a 2-page self-administered survey. Fifty-four (n=54) of those sampled had interacted with an enactor in the diorama halls, while thirty-eight (n=38) had not. It is important to acknowledge these small sample sizes while interpreting the results below.

Visitors were first asked why they chose to visit the diorama halls on the day of their Museum visit. Visitors cited many different reasons, including interest in wildlife, finding the halls in the course of their visit, looking for the gnomes painted in the diorama backgrounds, and entertaining/educating children in the visitor group. One visitor specifically mentioned the enactors as the reason for visiting the diorama halls (and referred to them by their characters' names), as they had interacted with them before on a previous visit.

Though not statistically significant, visitors who interacted with an enactor in the diorama halls ranked how powerful, unique, and personal and/or meaningful the dioramas felt to them more highly overall than did visitors who did not encounter the enactors.

Below are quotes taken from the survey responses, where visitors were asked how their/their group's interaction with the enactor in the diorama halls affected their experience:

Excellent! She was delightful and VERY informative.

I enjoyed it. He was very good and I learned more about the museum itself than I expected.

It made me and my daughter want to spend more time looking at the detail of the dioramas.

It was fun and unique. We learned some things we wouldn't have noticed on our own. He was also good at interacting with young children.

That is the very best way to learn history. She is passionate about the period that she represents.

Wonderful addition to diorama experience – helps one to consider diorama from new perspectives. Good learning experience. I hope the "actors" continue to interact with public.

If the actors weren't there the students would have just looked and left.

Though anecdotal, these responses are indicative of the successful implementation of many of the enactor program goals. All fifty-four of the visitors who interacted with the enactors wrote in positive comments about their interactions — stressing in particular the uniqueness, educational value, interactive element, and personal relevance/connection that the interaction brought to their Museum experience. Additionally, the visitors spoke to the ability of the enactors to interact effectively with children.

Approximately one-third of the sample (n=15/42; 35.7%) demonstrated a **personal connection** to the dioramas. This included a visitor relating the interaction they had with the enactor or the diorama to themselves or their group, e.g. *an adult visitor commented that his brother lived in Alaska and hunts/mounts animals; he pointed out the similarities and difference with taxidermy.**

Just under half of the sample (n=20/42; 47.6%) **travelled while interacting** with the enactor in the diorama halls. This means that a visitor group went to more than one diorama or hall with an enactor as part of their interaction, e.g. *a group started their interaction for 2 minutes with the enactor at the front-entrance to the diorama hall, and then continued inside the hall — spending 11 minutes at a grasslands diorama and then 4 more minutes at a river diorama.**

About a fifth of the sample (n=10/42; 23.8%) addressed **conservation or the human effect**. This included a comment or question connected to conservation or the human effect on habitat or wildlife, e.g. *a family group discussed how human's created dioramas as a form of conservation — at one time it was the only way to be exposed to other parts of the world and certain animal species.**

Over two-thirds of the sample (n=28/42; 66.7%) addressed **Museum history**. Museum history included a comment or question related to the historical context of their experience, the diorama, or visiting the Museum when the visitor was younger, e.g. *a little boy was very excited to see old photographs of the Museum from 100 years ago and noted that some of the old architectural features could still be seen today at the Museum.**

Over half of the sample (n=25/42; 59.5%) demonstrated **critical thinking** within their interaction with enactors in the diorama halls. This included any comments, questions, or conclusions demonstrating assessment or analysis; it also included debating with the enactors, e.g. *a young boy used the enactor's old-fashioned binoculars to find prairie dogs in the diorama. He found baby birds in the grass and deduced that they must nest there*

*because there was no tree nearby. He also asked, "How old are these binoculars? I think you need to polish them!"**

Over half of the sample (n=24/42; 57.1%) demonstrated **enthusiasm**. This included enjoyment or enthusiasm shown during the visitor groups' interaction with the enactor, or a comment made following the interaction, e.g. *a little boy followed an enactor around eagerly, even after the interaction had ended, and continued to ask the enactor questions.**

Over half of the sample (n=22/42; 52.4%) demonstrated a **past-to-present connection**. Past-present connections included connecting a past, historical issue with a present, current issue, or a future, similar issue, e.g. *when asked by the enactor if they arrived at the Museum by train, a family group explained, "No, by Chevrolet." They then talked about changes to travel and transportation over the years.**

In addition to the specific elements identified in the visitor group observations, demographic collection was collected. Over two-thirds (n=28/42; 66.7%) of the observed visitor groups had children as part of the group and these children were part of the enactor interaction. Many of these children were young (under 5 years old). The enactor program may provide a way for young children (including those who do not yet read) to have an educational, meaningful, and interactive experience in the dioramas without relying entirely on verbal and written language (i.e. signage).

Nineteen percent (n=8/42) of the visitor groups included non-Anglo visitors. Three (7%) of these groups spoke English as a second language, or were monolingual, non-English speakers. This percentage is similar to that of the Museum's visitorship overall, however the enactor program may provide a way for visitors with limited English language to, as above, interact in a way that is less reliant on verbal and written language (i.e. signage).

Timing

A random sample of 50 visitor groups in the diorama halls were tracked and timed to establish how long, on average, Museum visitors spend in diorama hall/area when enactors are not present. None of the visitors observed saw enactors or interacted with them. While the time visitors spent in a diorama hall varied greatly (from 37 seconds to just over 20 minutes), on average visitors spent about 4 ½ minutes (4:36). As a comparison, 42 visitor groups who did interact with an enactor in the diorama halls were tracked and timed. Again, while the time visitors spent in a hall varied (from just over 1 minute to just under a half an hour), on average visitors with enactor interaction stayed in a diorama hall for almost 8 minutes (7:50). While a 3 ½ minute difference may not seem substantial, time spent in the dioramas almost doubles when visitors interact with the enactors.

*example from the observations

This result may have several implications. Those who have a personal interaction with an enactor may connect at a deeper level, perhaps due to the enriched powerful, personal, and unique opportunities intrinsic to the experience. This may lead to greater time spent inside the exhibition (*dwelltime*).

Enactor Focus Group

In order to supplement the data collected from interactions observed with visitors, the three enactors who worked within the diorama halls during the study participated in a focus group. Several key themes came out of the focus group: 1. enactment as unique; 2. enactment as educational; 3. enactment as empowering; and 4. enactment as limitless. Additionally, the enactors provided insight on potential ways the program could evolve (e.g. having an area or space within the Museum where visitors could locate the enactors, setting up set times for programming (i.e. storytelling) and increasing the number of enactors per day).

Conclusions

Research and evaluation of the enactor program empirically and statistically show that the program meets its established goals and objectives. Qualitative data also supports that goals and objectives are being met.

- Visitors find enactors unique, engaging, educational, fun, and memorable.
- Exhibitions and Museum spaces are perceived as more powerful, unique, and personal/meaningful by visitors who interact with an enactor.
- Interacting with an enactor increases perceived knowledge gains about objects and specimens as well as themes, concepts, and content.
- Enactors have a unique ability to communicate themes, concepts, and content to young children, non-English speakers, and other subpopulations within the Museum's visitorship.
- Enactors are perceived as a welcome addition to the Museum by those visitors who have interacted with them.
- Visitors are more likely to spend longer in exhibitions and Museum spaces as a result of interacting with an enactor.

The study showed that the program was successful in both meeting and exceeding its objective and goals, as well as being highly regarded both by visitors and those who work within the program.

Kathleen Tinworth, Denver Museum of Nature and Science (DMNS)

Curatorial responses to natural history dioramas

Research I have carried out recently into curatorial opinions of natural history dioramas reveals the important role this form of display can play in contemporary museums. Dioramas allow for multiple interpretations on numerous levels. For example, curators acknowledge the ability of dioramas to reach a wide audience and increase access; 'It's actually a great form of non-literary communication...dioramas have such a major role to play in communicating without words'. It is this form of display, the diorama, which is used to place natural history specimens in an 'environmental tableaux that illustrate[s] the plant communities and geomorphology of specific regions, animal adaptation and relationships, and landscape transformation' (Wonders 1993: 17-18).

Through the diorama visitors are exposed to new learning experiences, such as the iconic mode of learning described by Eilean Hooper-Greenhill (1994) in her seminal text Museum and Their Visitors. In this text she suggests that the iconic mode, where learning occurs through imagery as in the diorama, is a 'more concrete way of learning.' (Ibid 1994: 144) and therefore these displays can provide valuable opportunities for education in museums.

Aside from their visual and learning qualities, dioramas can also provide opportunities to interpret collections historically, charting for instance 'the history of taxidermy'.

However, research interviewees corroborate that contemporary museums, with collections of natural history including ornithology, mammalogy and botany, are 'shifting away from dioramas' as a form of display towards an emerging trend where specimens are displayed on 'neutral mounts', much more clinically and stylistically than the contextual diorama. The repercussions of this disconnection of natural specimens from their environmental context provides redisplay teams with further challenges, 'In order to try and interpret the objects without the diorama-type setting it's much more difficult.'

Although increasing numbers of diorama are being disbanded throughout Britain, museum staff concur that there is still a place in the contemporary museum for good natural history dioramas, if not for their vast educational potential and invaluable historic presence, as an alternative form of displaying natural history specimens.

References

Hooper-Greenhill, E. 1994 Museums and Their Visitors, Routledge: London

Wonders, K. 1993 Habitat dioramas: illusions of wilderness in museums of natural history, Acta Universitatis: Uppsala

Hannah Paddon, PhD research student, Bournemouth University, UK

A window on the world – wildlife dioramas

CREATING DIORAMAS

For most of the 19th century, the focus of museum taxidermy displays lay in showing variation within species and how each species differed from others. For this purpose, birds especially were set up in identical poses to aid comparisons. By the 1870s the idea of 'habitat groups' had developed, showing animals in a representation of their immediate surroundings. Dioramas grew out of this, to be re-creations of whole scenes, within which the animals were posed. The individual specimens often became almost subsidiary to the overall display, which was intended to convey a sense of place rather than a catalogue of species. Major American museums, in particular, vied with each other to develop bigger and better dioramas, each generation being even more realistic than the last. Exhibits were often financed by wealthy big game hunters, such as George Eastman (founder of the Eastman Kodak Company) almost like giant souvenir postcards of their expeditions.

Creating a diorama is a multidisciplinary task, requiring technical input from artists, zoologists, botanists, and lighting specialists, to say nothing of the carpenters, taxidermists and model builders needed to physically build them. For added realism, samples of soil and actual vegetation are often collected from the scene depicted and added to the diorama itself. Leaves and flowers will be photographed in the field and modeled later in wax or resin. Rocks will be photographed and casts taken so that lightweight substitutes can later be cast using polyurethane foam.

The taxidermy has to be right too. It takes upwards of six months to prepare an animal the size of a deer, sculpting an exact muscle-perfect copy of the body, taking a mould, then using it to cast an artificial body. Nowadays hard foams are used, but in the past the body was made from papier maché or chicken wire covered by plaster, with the skin laid on and modelled carefully to recreate wrinkles and folds in the body. This is a far cry from the concept of "stuffing", which many people assume still takes place, but which is as obsolete as the horse drawn plough. Sometimes small models can be inserted towards the background, enabling a group of elephants or giraffes, for example, to be accommodated within a modest space and also enhancing the sense of distance and perspective.

Like photographs, dioramas serve to bring the outdoors inside. They make accessible places and things that would otherwise be beyond the personal experience of most people. Both offer the viewer an opportunity to see details of the wildlife of six continents, juxtaposed and in close up, without discomfort, difficulty or the expense of long-distance travel. The most dangerous situations can thus be experienced by proxy, in complete safety. Today, television has become the principal medium for achieving this accessibility, but in the past, wildlife dioramas played a significant role and even today we can learn much from them. Nowadays we are so accustomed to seeing wildlife depicted on television, moving and in colour, that dioramas seem false and frozen in time. Yet when many of them were first built, they were hailed as a major escape from the even more false

depiction of nature provided by photography, offering only two dimensions and frequently lacking all colour.

Dioramas are a way of exhibiting preserved animals in a three dimensional display. Like photographs, they seek to convey messages about nature, but each medium succeeds, or fails, in a different way. Diorama exhibits represent a pinnacle of museum display technique, bringing wildlife to the people and recreating the illusion of nature - up to a point. Unlike photographs, they are three dimensional, life size and with real texture to the objects within. Good dioramas can be constructed to convey many messages about ecological context, habitat, behaviour, structure and movement, whereas a photograph is limited by what is actually happening in the frame at an instant in time. This is rarely as rich in messages as it is possible to create in a diorama. I have several times been asked for a photograph showing at least five species of mammals and birds, to illustrate "Biodiversity in Africa" for example. Even in the species-rich Serengeti it is almost impossible to achieve this. Animals big enough to recognise fill the viewfinder, but using a wide-angle lens to fit in some more means the smaller ones are no longer individually recognisable.

Yet in a diorama, animals can be grouped together in less space than is natural. Dioramas can show various forms of animal behaviour simultaneously, each of which a photographer might spend a week trying to capture on film. They can include the big and the small, because the latter can be inspected closely in way that is impossible in the wild - for example flies on the prey of a lion. Dioramas can also cheat the hours and seasons by sneaking a nocturnal species into the corner of the display, perhaps in its lair underground. Seasons can be cheated by showing birds in their full breeding plumage, when the surrounding vegetation would no longer be in flower in the wild. Photographers cannot cheat in this way and so their images will inevitably contain fewer messages.

Success depends on cheating perspectives to fit a thousand-acre view into a small room. Photographers can cheat perspective, by using lenses of differing focal lengths, but in doing so they achieve different effects to a diorama, particularly the foreshortening effect of telephoto lenses. Crucial to diorama design is solving the problem of linking the actual three-dimensional material forming the foreground, with the two dimensions of a painted scene background. Normally the latter is curved, to avoid the obvious unreality of having right angle corners in a distant view. However, making this curve blend with the foreground or a flat ceiling, without a visible joint is exceedingly difficult. Painting on a curve also requires the artist to adjust his style in subtle ways (for example on alignment of the horizon and its level in the overall view). Creating a realistic diorama is exceedingly difficult. Nobody notices when it is successful, but everyone is immediately conscious of the smallest failure. Photographers face none of these problems, but instead wrestle with depth of focus, an issue that doesn't arise in a diorama.

Lighting is also critical. In real life, as the photographer knows, light normally comes from above, but simple top lighting in a diorama causes awkward shadows and destroys the illusion of space. The light has to be diffuse and sometimes augmented from lower down. Hidden spotlights can be used to create special effects, lighting up a patch of ice in a gloomy winter scene for example. Some forest dioramas even have lights concealed inside tree trunks to obtain subtle lighting effects that mimic nature in an extraordinarily effective way. Some early dioramas in Sweden still rely on diffuse natural light, so they look different at different times of day in a very natural way (but are almost invisible at night or during the long winter!).

Dioramas can illustrate perspectives that would be difficult for a photographer to achieve in the wild, for example low down and close up in a herd of animals that normally are very wary of any approach. A diorama foreground can illustrate details of behaviour, for example the 'bill up' display of albatrosses or their single egg, whilst the receding scene and background depicts the regular spacing out of nests within a large colony. A photographer has difficulty accommodating such depth and also ensuring that the distant details are still recognisable. Dense tropical forests pose special challenges. Convincing dioramas are extremely difficult to create, just as photographs of the real thing are frequently disappointing. Natural light levels are very low indeed, creating a green gloom that looks very dull in photographs. Addition of artificial lighting to the diorama overcomes this, but at the expense of naturalness. By contrast, the wide-open spaces of grassy plains are well lit, but often have no detail in the foreground. Both a photograph and a diorama will be enhanced by framing the view, using a foreground tree or shrub to create proximal detail and add a 'side' or 'top' to the scene. Underwater scenes are especially difficult to create as dioramas. Even the addition of flickering lighting fails to mimic the true sense of being submerged. Sometimes a diving bird or seal will be shown in a diorama. In life they would, be glistening with air trapped among the fur or feathers and be accompanied by a stream of moving bubbles. These effects add greatly to the dynamic appearance of underwater photographs but are virtually impossibility to recreate in a diorama. Fish often look dull (and sometimes dusty!), colourful invertebrates such as corals are hard to depict, and translucent specimens such as jellyfish rarely look convincing. By contrast, we are now so used to wonderful underwater photography, that we scorn the diorama's attempt to persuade us that we are in a watery realm.

The purpose of a diorama is to depict a whole scene and the actual specimens of birds or mammals seem almost an afterthought, although they are central to the artistic composition of the whole. Often scale models are built to try out various postures and positions for the key characters, just as a photographer might move his models about in the studio before pressing the shutter release. The difference is that a photographer can take a dozen different versions of his scene because each costs only a few pounds. A

diorama costs many thousands of times more; so the preliminary planning has to be right. There can be not second tries!
All this attention to detail can be severely undermined by a few specks of dust on the glass eyes of a bird or beast. Shiny leaves and lustrous petals become dulled by dust. Some dioramas are hermetically sealed to avoid this, others have their own air conditioning; expensive features that are invisible to the museum visitor. Ironically, it is air-borne dust that often forms a vital part of reality, and may play a key part in imparting dynamic to photographs of moving things. This is normally absent from dioramas, one of the things that makes them look staid and static. Yet a diorama in the Denver Museum of Natural History features a cheetah pursuing leaping antelopes. They are suspended in mid air, with no evidence of support and there are puffs of real dust hanging in the air bellow the galloping feet. Reality recreated, almost!

PHOTOGRAPHIC NOTE
Most public museums will not allow photographers to use lights and tripods to take photographs during visiting times. Photographing dioramas as a normal visitor is quite a challenge. Some modern dioramas have sloping glass to avoid reflections. More usually, the flat glass reflects a flashgun, so this has to be held well out to one side or high above the scene. Finger marks and nose prints on the glass, invisible to the visitor, are revealed by flash as though by magic! However, flash from outside the diorama represents a form of lighting that was not part of the original design concept, so the resultant photographs tend to be disappointing, not least because of the hard shadows that are cast on the supposedly distant background.

Pat Morris, Ascot (UK)

Discussing biodiversity in dioramas: a powerful tool to museum education

THE ORIGIN OF THE DIORAMA
From their conception, museums, in particular natural history museums, established a relationship with the diversity of life on Earth. Through their collections and exhibitions, these institutions served as the link between the public and the richness of this diversity. This legacy originated in the private collections of European nobility in the 16th century. Having no scientific purpose at that time, these collections bestowed prestige upon those who owned them and testified to the importance of their social position (MONTPETIT, 1996). The collections, comprised by plant and animal specimens and historical objects, were to become the famous Cabinets of Curiosities the goals of which were to exhibit all "things in the world". The 17th century was marked by great expeditions and a resulting increase in the collections of animal and plant specimens leading to the construction of buildings intended to house them (BRAGANÇA, 1988; MERHOFF, 1997).

This development continued in the 18th and 19th century where the establishment of natural history as a science led to the construction of numerous museums around the world which aimed to preserve life diversity by means of their collections. Up to this moment the collection was at the same time an exhibition; there was no practical distinction between them.

The 19th century marked a gradual autonomisation of the relationship between the collection and the exhibition. A modern epistemology emerged in which it no longer was sufficient for specimens and objects to be presented in a tableau of scientific knowledge; now, objects were arranged according to their role in the discourse which articulated them in a narrative, challenging and involving the visitor. From being rooted in specialised knowledge such as taxonomy, exhibitions now became based on references to real-life situations, reflecting the perception schemes that guide everyday conduct (MONTPETIT, 1996). The diorama, a three-dimensional, life-sized, simulated environment in which models or taxidermied animals are placed in order to depict a scene or an event (INSLEY, 2008), has its origins in this museographic notion of exhibiting a fragment of reality.

Since its conception, the diorama has been widely used in museums and as a result has been attributed different definitions. The literature that seeks to define dioramas generally emphasises the idea of *representation* (LURIE, 1983; ASENSIO & POL, 1996; ASH, 2004; BRESLOF, 2005); for some authors this representation includes the real object, the proper specimen, whereas for others this aspect is not so evident; however, they all underscore the importance of the scale of the objects that are presented in their real size and in a realistic setting. The diorama is thus based on a principle of analogy where the exhibited objects are arranged to in a visual representation of a real reference world (MORTENSEN, 2009).

Biodiversity in Museums

Natural history museums were virtually the first places to register and document life diversity. Mehrhoff (1997) points out that since part of what we currently know is based on what is contained in museums, they constitute important documentation of the diversity that has existed on the planet. In addition, the museums continue to provide new information because they continuously receive new specimens and have species classified in their collections. Mehrhoff further states that the real value of collections lies in the fact that they represent irreplaceable knowledge on life diversity in time and space, and to preserve them will help us to understand the richness of life on earth (ibid.).

In Mehrhoff's opinion (1997), rather than seeking to promote such understanding, museums should attempt with their exhibitions to arouse people's *interest* in biodiversity. In our opinion, this is the major challenge faced today by not only natural history museums but by any museum that exhibits biodiversity. Museums have developed a structure and organization with the specific aim of fitting their needs as a research institution to a relationship with the public *via the medium of the exhibition*. This clear intention to communicate to and educate the public in the best way possible has brought to museums a new type of professionalism and consequently new approaches to exhibition development.

An example of how a new scientific trend was historically reflected in natural history museums is the consolidation, which took place in the 20th century, of ecology as a scientific procedure. According to Van Präet (1989), at that time studies relating to the notion of *species* shifted from a focus on the organism *per se* to the relation between the organism and the environment. In order to exhibit this complexity, museums employed resources such as dioramas which could represent to the public the complexity of nature, including, among other aspects, new values such as conservation and biological relations that went beyond the diversity of organisms (VAN PRAET, 1989).

Dioramas as Educational Spaces

Exhibitions are particular places for the analysis of important aspects of museum education. Elements as objects, space, time and language must be considered to gain an understanding of the educational processes and to plan the educational actions that take place there (VAN-PRÄET & POUCET, 1992; MARANDINO, 2006). In this perspective, dioramas are convenient study objects and in our surveys, we have analysed them as important milestones in the progressive change of natural history museums from places that housed collections into material educational spaces concerned with teaching and mediating biological concepts.

Regarding the impact on the public, researchers point out that in addition to being environmental representations, dioramas play an important role in reminding the public to preserve nature and in enabling contact with an environment that many of the visitors may never have experienced first-hand (ASH, 2004; BRESLOF, 2005; QUINN, 2008). In our opinion, dioramas promote an interaction between visitors and the involved scientific aspects because the behaviour of a visitor to a diorama may be considered similar to how a naturalist observes a new environment. Quinn (2008) corroborates this view in his comment about the proximity that a diorama has with the natural environment and what reactions this may stimulate in visitors. In Quinn's opinion this potential is an outcome of the exactitude with which a diorama represents an environment: "This is possible because dioramas bring more faithful representations than zoos, for example, they re-create the space where organisms are found more precisely" (QUINN, 2008, p.1).

However, some researchers, including Van Präet (1989), discuss dioramas from another perspective: the ecological conceptions that the public form when observing a diorama are much closer to those of the museum staff who constructed the exhibition than those of scientists. The preparation of specimens exclusively for the exhibition, and not for research and collection as was traditionally the case, is important. Here, the models or taxidermied animals are shaped to show the public various aspects about their behaviour, their relation with other animals (specimens) and the environment. Taxidermists and museologists have a significant task in producing objects

that will mediate science concepts to the public based on the way they look and are placed in the exhibit. In others areas, such as palaeontology, the use of the combination of original specimens and replicas is related to both the way scientific knowledge is produced and the vulgarisation of science, revealing the tension between specialists and museologists in the construction of an exhibition (VAN-PRÄET, 2003).

Clearly, the intention of educating visitors through dioramas is common. However, we saw that although on the surface they may look like totally static arrangements, they implicitly embody a more interactive quality, reinforcing further their educational role. This characteristic resides in the potential to translocate the visitor to the natural environment reproduced there. The combination of scientific and artistic knowledge aiming at giving greater ambience to dioramas is also a strong indication that this exhibition type was conceived for educational purposes. The question of whether dioramas reflect the products of science or they are only recreations to entertain and teach concepts to the public emphasise how important they are for museums, and for us represents a significant indication of the educational intention of these objects.

Exhibiting Biodiversity in Dioramas

As the term biodiversity has been widely used for some time, it has become imprecise as a concept within the scientific community, in particular in biology. Although it has been a focus of discussion in scientific academia since its origin, many attribute such a wide scope as resulting from the *Rio – 92* meeting held in Brazil which ratified the "Convention on Biological Diversity" or CBD and recognized it as the first world agreement aimed at sustainable use of all biodiversity components.

According to Motokane (2005), although there is agreement on the meaning of the term, we still do not have a consensus on its use among biologists. Corroborating this idea, Gaston (1996) goes further, pointing out the unlikelihood of putting this into a common denominator. Weelie & Walls (2002) are categorical when they say that biodiversity is an ill-defined concept, being difficult to offer a simple or universally applicable definition of the term. They go on to say that it is not difficult to find scientific political or symbolic meanings being used by the same person.

The term biodiversity was blown out of proportion and goes beyond scientific limits with new meanings being incorporated. These new meanings have in turn demanded exclusive educational strategies from the places that intend to use it as a tool of articulation in education for science. The aspects found in the literature that defines biodiversity can be divided into two major axes: *biodiversity levels* – genetic, species, and ecosystem diversity and *biodiversity values* – economic, ecological and conservationist values (OLIVEIRA, 2008).

In our work we found dioramas presenting biodiversity in both axes. Two examples can be seen in figures 1 and 2.

Fig. 1: Detail of a diorama of Campo ecosystem – representation of the behavior of some species and their relation with the environment – Science and Technology Museum from PUC/RGS, Porto Alegre/Brazil (photos from Adriano Oliveira)

Fig. 2: Diorama about the relation between environment impact and social problems - representation of the garbage problematique in a poor neighborhood Capão da Imbuia, Natural History Museum/ Curitiba/Brazil (photo from Adriano Oliveira)

The Diorama as a Tool for Museum Education

According to the panorama showed, we can affirm that dioramas are excellent tools to discuss how biodiversity can be shown in museums exhibitions. During a visit, those aspects related to the different dimensions of biodiversity that appear in dioramas can be outlined in the exhibition discourse, but also in other education activities promoted on those places. In our work we developed a workshop called "Constructing biodiversity: the diorama as a didactical tool", given to teachers and educators from museums. Our objectives are to promote the diorama as a good didactical tool to approach the specificity of museum education, but also to deal with education in contents of biology, geography, geology and history, to discuss biodiversity education, and to stimulate visits to museums.

Divided into three parts, the workshop first presents what is a diorama and its history, then introduces the main activity: the construction of a diorama. The diorama can be about an ecosystem, a habitat, a phenomena such as predation or the adaptation of an organism, but also about the garbage problem in a city, global warming, and so on. The dioramas are then constructed by participants using conserved or taxidermied animals and plants or replicas and low cost materials such as coloured paper to elaborate the scenario. Finally, with the dioramas finished, we prompt a group reflection related to the objectives of the work shop, emphasising didactical and scientific aspects such as the biodiversity thematic.

In sum, the workshop experience can be both enjoyable and stimulating for the participants and promotes insights into some fundamental aspects of museum education and biodiversity in museums. Dioramas integrate scientific and artistic knowledge and for this reason, they are great tools for promoting understanding of the relation between the public and museums.

References

ASENSIO & POL, E. (1996) Siguen siendo los dioramas uma alternativa efectiva de montaje? *Revista de Museologia*, 8, 11-20.

ASH, D. (2004) How families use questions at dioramas: ideas for exhibit design. *Curator* 47(1), 84-100.

BRAGANÇA GIL, F. (1988) Museus de Ciência. Preparação do Futuro, Memória do Passado. *Revista de Cultura Científica*. Lisboa, 3, 72-89.

BRESLOF, L. Observing Dioramas. In: http://www.amnh.org/learn/musings/SP01/hw2P.htm. Consulted in: 08/06/2005.

GASTON, K. J. (1996) What is biodiversity. P. 1-9 in: *Biodiversity: a biology of numbers and difference*. Blackwell Science Ltd.

INSLEY, J. (2008). Little landscapes: dioramas in museum displays. *Endeavour, 32*(1), 27-31.

LURIE, N. O. (1983) A Special Style: The Milwaukee Public Museum 1882-1982. *In: The Milwaukee Public Museum*. Milwaukee, WI.

MARANDINO, M. (2006) Éducation et communication dans les bio-expositions des musées de sciences du Brésil In: *Familles, écoliers et personnes âgées au musée: recherche et perspectives.* Ed. Paris: Éditions Multimondes, 115-126.

MEHRHOFF, L. J. (1997) Museums, Research Collections, and the Biodiversity Challenge. *In:* REAKA-KUDLA, M. L.; WILSON, D. E. & WILSON, E. O. (org.). *Biodiversity II: understanding and protecting our biological resources*. Washington, D. C.: Joseph Henri Press. Chapter 29: 447-464.

MONTPETIT, R. (1996). Une logique d'exposition populaire: Les images de la muséographie analogique. *Publics & Musées, 9*, 55-100.

MORTENSEN, M. F. (2009). *The use of education theory in science exhibition design: immersion exhibits as border-crossing environments*. Submitted for publication.

MOTOKANE, M. (2005) *Educação e Biodiversidade: elementos do processo de produção de materiais pedagógicos*. Doctoral thesis. Faculty of Education, University of São Paulo.

OLIVEIRA, A. D. (2008) *Biodiversidade e Educação em Museus*. Relatório de qualificação de Mestrado. Programa de Pós Graduação Interunidades em Ensino de Ciências: Modalidade Biologia da Universidade de São Paulo, Brasil.
QUINN, S. Transcript: History of the Diorama. In: http://www.amnh.org/exhibitions/dioramas/bison/transcripts/diorama.php. Consulted in: 15/02/2008.
VAN PRÄET, M. (2003) A educação no museu, divulgar "saberes verdadeiros" com "coisas falsas". *In: Educação e Museu: a construção social do caráter educativo dos museus de ciências*. Ed. Access. v.1, 233 p.
VAN-PRAET, M. & POUCET, B. (1992) Les Musées, Lieux de Contre-Éducation et de Partenariat Avec L'École. *Education & Pédagogies – dés élèves au musée*, No. 16, Centre International D'Études Pédagogiques.
VAN-PRÄET, M. (1989) Contradictions des musées d'histoire naturelle et evolution de leurs expositions. *In: Faire Voir, Faire Savoir: la musélogie scientifique au present*. Musée de la Civilization, Montreal, 25-33.
WEELIE, D. V. & WALS, A.E.J. (2002) Making biodiversity meaningful through environmental education. *International Journal of Science Education*, 24(11), 1143-1156.

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Agricultural dioramas and natural history - hidden messages!

Many dioramas carry natural history messages! Although the focus of diorama may not be natural history, some dioramas designed to inform visitors of overt messages also incidentally inform about natural history concepts. Educators and curators should be aware of such possibilities so they may advise schools and other groups as well as in the interpretation they provide. Educators in museums have the important role of assisting visitors in interpreting the exhibits. Furthermore, strategies can be designed and implemented it is crucial to understand both: what the visitors notice what sense they make for themselves of the exhibits in question.

Dioramas as a museum technique have a secured reputation but are expensive to produce and present some problems to museums - both old dioramas or newly created ones. Dioramas at their best are superb exhibits and one of the most powerful techniques for emotional access and effective learning (Insley, 2007). However, the knowledge and understanding which visitors bring to the exhibits influences both what they observe and how they interpret it. Thus, it is crucial that the museum understands theses aspects and research such so that they are fully informed for such information obtained

enables museums to understand their visitors and this approach is becoming more and more a feature of museum work.

The dioramas in the Agricultural gallery on the third floor of the Science Museum London were originally designed well over half a quarter ago to carry both scientific and contextual messages. What are the messages received by today's school children. What sense do they make of these messages? Therefore, it is important for both educators and curators to understand both that which catches the attention of these young visitors and how they make sense of what they see drawing upon their personal knowledge and experiences, their mental models so that relevant strategies can be provided to assist these visitors and their adult companions in learning more about the topic displayed.

These agricultural dioramas are 'little landscapes' in form (Insley, 2007), unlike most natural history dioramas. As such these dioramas are reduced in scale and sometimes with skewed perspective, such as the medieval ploughing scene based on the 14th Century Luttrell Psalter illustration. This example was made by Raphael Rousses, and has been in the museum since 1944. The bulk of the dioramas, which are on display, were commissioned for the post-war display of 1951.

The dioramas focus on several different aspects of agriculture. Some showed the different farming activities during a year. Others showed the development of ploughing techniques through the ages. Amongst the dioramas are cases with agricultural implements and models of equipment such as a hay wagon. We set out to discover what these dioramas meant to children who had not been briefed about either the nature of the dioramas nor their content before their visit and where biotical aspect were noticed. Such aspects are inherent in the dioramas.

A primary (elementary school attended between 5-11 years) school in a new town in South East England agreed to bring 4 children, two boys and two girls in Year 5 (aged 10) to the museum, with no preparation, to look at the agricultural dioramas and other exhibits.

The methodology was not that used as standard by the Science Museum's Visitor Research Teams. The sample size was very small and therefore not statistically relevant. The children were of varying interests and abilities, from a state (= USA public) school from a mixed socio-economic area. However, even though the results are anecdotal, they were thought provoking and useful as a starting point for future, more focused work. Each child first viewed the dioramas individually with one of the researchers and was asked to say what they thought the exhibit was about. Their comments were recorded in

writing and subsequently transcribed by the researchers. The transcripts were analysed using a read reread technique until categories of conversational content became apparent. Although these dioramas are focused on agriculture, some of them contain natural history information, such as the seasons of the year and the changes in the natural environment, the growing sequence of planting and harvesting as well as laments of the natural world such as soil. They also contained a substantial amount of design and technology, engineering information and other aspects of physical science, which could be explored with pupils.

The captured conversations of these children revealed that these young visitors focused on things they knew already, recalling their mental models and noting salient featured of the artifacts in the dioramas enabling them to make the comparison.

A girl remarked that the models of buildings were like dolls houses, the hayrick looked like a thatched cottage, cutting and storing silage compared to a large lawn near home A child reconsidered potatoes but said “Potatoes! Lots and lots - Mars looks like a potato."

Some things caught their eye and focused their attention such as a running hare in one diorama for example. Things at eye height (whatever that might be) caught the eye; things above eye height tended to be ignored. Interesting natural objects caught the attention, “I really like the tree!”

Bright colors or realistic backgrounds were very much liked. “The color of the background" in the Autumn scene.

Labels, as usual, were not generally read, photographs not generally looked at. The boys did not notice the people depicted or the domestic artifacts like houses.

Model people attracted attention, as did animals, particularly the women potato planters, as their depicted actions came across as hard work (fig. 1).

Figure 1:
Agricultural diorama, Science Museum, London (Potato planters)

Realism was important - mud on wheels of model tractors, winter scene had leafless trees, “The tree is the most striking - "Because it's big, and hasn't many leaves" "Quite big Potatoes look quite real. “The plants look quite good - what plants are they?” The dioramas depicting the farming year the maturing sconce and potato planting diorama attracted comments, which could be developed in studies of life cycles. Appropriate vocabulary was an issue "Four girls with forks in front, four with baskets gathering in…”. The use of the word gather when the scene depicted planting is an example of children’s the lack of appropriate vocabulary as is the referral to the soil as ‘dirt’, theses children not knowing it seemed the correct word but using that which they knew of nearest fit. The children noticed that people were planting things, potatoes; in the dirt (soil) and that these grew and were harvested. They also noticed the difference in the deciduous trees with the sequence of the agricultural year. They noticed animals. These dioramas could be utilized educationally for helping children learn about the seasons in the United Kingdom and the cycle of a plant from seed or tuber (vegetative reproduction and hence much botanical science to be explored which way into done in the interpretation of these dioramas) as well as discussions about nature in the built environment.

This small research project, of 10 year old children’s interpretation, shows the knowledge and understanding which pupils bring to an exhibit, in this case of natural history, through focusing on their verbal observations of these dioramas and thereby revealing the influences on their interpretation of the scenes and other artefacts. The data indicate what experiences, concepts and vocabulary such pupils held so that they can interpret the dioramas effectively to receive the information inherent within them. The opportunities for scaffolding their learning of natural history are apparent from the data. Leaning opportunities are missed by museums. Furthermore, the data suggest what additional interpretation could be usefully introduced to the gallery to assist learning and understanding of agricultural practices viewed by predominantly urban children.

Further reading:

Insley, J. (2007) Setting the Scene. Museums Journal 107(2): 33-35

Reiss M, & Tunnicliffe, S.D. (2007) Dioramas as depictions of reality and opportunities for learning biology. Talk given at NARST, New Orleans, April 2007.

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