LEARNING AT NATURAL HISTORY DIORAMAS: A MODEL FOR INTERPRETING MUSEUM BIOLOGICAL SETTINGS

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Abstract

The research attempts to conceptualise natural history habitat dioramas as potential models for biological learning of local flora and fauna. A cohort of 9-year-old students from Malta was asked to draw in class a place with local animals and plants, another drawing at the NHM of Malta and a third drawing of their favourite habitat diorama. One-to-one interviews were conducted, during which the children were asked to elaborate on their drawings and comment on their choices. Drawings were analysed semi-quantitatively and qualitatively using the data analysis package Altas.ti. The inclusion of particular types of fauna (birds) in drawings was influenced by prior knowledge and culture. A progression from drawing from imagination in class and at the museum before viewing the diorama, to increasingly drawing from observation was noted. The educational potential and role in biological learning of dioramas has previously been reported in literature. Results indicate the sound potential of natural history habitat dioramas to act as scientific models for biological learning. A major contribution of this research was the creation of a novel interpretation model for museum settings.

1. Introduction

Habitat dioramas are three-dimensional museum displays presenting imitations of biological landscapes. These displays typically show preserved animals in their natural foreground with freeze-dried or modelled flora of some form set against a painted background. The diorama's integrated montage of animals with their surroundings is a means of bringing natural history to 'life', but at the same time exposing human attitudes toward nature and so also perform a function in the cultural construction of our world (Wonders, 2003: 89).

Various researchers have recently documented the educational potential and role in biological learning of dioramas (Ash, 2004; Insley 2007, 2008; Peart and Kool, 1988; Piqueras et al., 2008; Reiss and Tunnicliffe, 2007; Scheersoi, 2009; Tunnicliffe, 2002, 2005 and 2007). Skilfully constructed natural history dioramas can still provide a significant opportunity for fundamental acquisition of science knowledge (Stern, 2009: 15). Dioramas are a powerful potential tool in science education and should be developed as such (Tunnicliffe, 2009: 20). Dioramas have great potential for learning in Biology, particularly in aspects of biodiversity, ecological relationships and ecosystem ecology.

While limited research has dealt with the educational value and role of habitat dioramas, it has not considered how dioramas can enable the visualization of animals and plants. This thesis is an attempt to conceptualise habitat dioramas as a potential model for biological learning of local flora and fauna (Gilbert, 2005: 12, 2008: 6).

The main research questions are:
Do children's drawings about animals and plants in local habitats change after their interaction with NHM dioramas? If so in what way do drawings change?
Which aspects of their experiences do visitors rely on to interpret a museum setting?

2. Theoretical Framework

2.1. Dioramas and Mental Models

Natural history dioramas are still an underutilised educational resource and have been dismissed as old fashioned and irrelevant by non-educator management officials enticed by effective technological innovations. Dioramas are a powerful potential tool in science education and should be developed as such (Tunnicliffe, 2009: 20). Dioramas have great potential for learning in Biology, particularly in aspects of biodiversity, ecological relationships and ecosystem ecology.

When properly designed, dioramas allow lone visitors and small groups to carry their own interests to the exhibit and to connect with them in a way that provides a measure of control (Tunnicliffe and Reiss, 2007:1). Through their 'stillness', dioramas offer opportunities to "stand and stare" and serve as a focus for biological understanding in an out-of-school environment. Dioramas potentially motivate visitors to stay longer at an exhibit and to facilitate their understanding of the object's functions, meanings or associations. Visitors may also relate their previous experiences to the scenes and artefacts presented in the diorama, which thus become 'appealing, invite exploration and therefore facilitate learning' (Scheersoi and Tunnicliffe, 2009).

The sociocultural and the constructivist frameworks inform this research. Learning in a constructivist manner may be understood as the building and refining of mental models,

however also acknowledging the importance of social interaction in developing these models. The link between constructivism and socio-cultural theory is interesting due to its potential to explain children's development of knowledge in terms of its individual and social construction under the influence of social and cultural practices (Jaworski, 1996: 6). Perhaps Falk and Dierking (2000) offer the most explicit combination of the two theoretical perspectives in their Contextual Model of Learning (CML), which states that learning is personally, socially, and physically situated. Students and teachers need to understand how science and science education are always a part of larger communities and their cultures, including the sense in which they take sides in social and cultural conflicts that extend far beyond the classroom (Lemke, 2001: 301; O'Loughlin, 1992: 816).

When children are allowed to interact with the dioramas, they stop to observe, notice the different forms of animals and plants, the anatomical features of each organism and possible relationships between animals and plants or animals and animals. The child forms his or her concept of animals and plants in general and more specifically a concept of the particular organisms featured in the exhibit. The child's personal knowledge of a phenomenon or main features of an object are held in the mental model formed. When asked, the child can produce a representation from the mental model (Cox, 1992: 88-91; Reiss and Tunnicliffe, 1999: 142).

During learning we habitually use external representations surrounding us to construct internal representations in our minds. We use external representations, such as habitat dioramas, to build an internal representation or mental model. There is no direct evidence of the existence of mental representations, other than when these are reproduced in some external form (Rapp and Kurby, 2008). Often we are called to convert our mental representations into external presentations during communication, for example when writing a scientific paper or composing an email (Gilbert, 2008: 33). Representations are very frequently used in science education and we can make sense of these when we are able to visualise what the representation is meant to show. Any person studying science needs to be able to visualise a phenomenon through a representation such as a model. The key aspect of 'metavisualisation' is the ability to make meaning of (visualise) a representation in the different special dimensions it may occur (Gilbert, 2008: 3). Observation, visualisation and learning are closely linked.

2.2. Interpretation Models

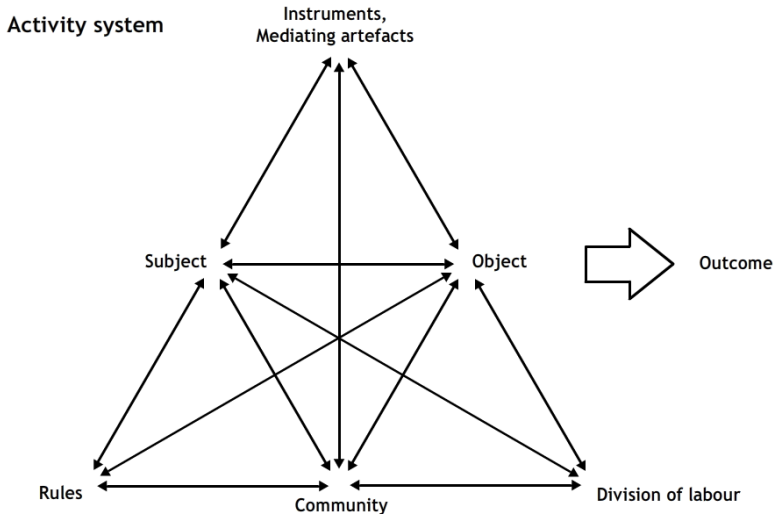
Some major and well accepted interpretative models commonly encountered in science education and informal learning literature are: a) Contextual Learning Model (Falk and Dierking, 2000), b) Acuity Model (Patrick, 2006), c) Model Based Learning (Buckley and Boulter, 2000) and d) Activity Theory (Leont′ev, Engeström, 1999).

We consider the Activity System that originates from Activity Theory (Leont'ev and Engeström, 1999) as the most appropriate and adaptable in the case of interpreting a museum exhibit such as a habitat diorama. Based on this, we propose our own model, which we present in the Results section. Figure 1 is an illustration of the components of the system and the interrelation between them.

- Object is the objective of the activity system. Object refers to the objectiveness of the reality; items are considered objective according to natural sciences, but also have social and cultural properties. In interpreting a museum exhibit this becomes the *focus* or the main theme of the exhibit.

- Subject is the actor or actors engaged in the activities. Likewise, the *subject* is the person interacting with the exhibit.
- Community is the social context; all actors involved in the activity system. For a museum exhibit this would be the *group* with whom the visitor is viewing the exhibit such as family or a class.
- Mediating artefacts (or concepts) used by actors in the system. Tools influence actor-structure interactions and they change with accumulating experience. Tools are influenced by culture, and their use is a way for the accumulation and transmission of social knowledge. The museum exhibit or diorama is the *artefact* that is conveying the message or the theme.
- Division of labour refers to social strata, hierarchical structure of activity, the division of activities among actors in the system. Not applicable to museum exhibit interpretation.
- Rules are the conventions, guidelines and rules regulating activities in the system. There are social norms and practices that apply to museums.

Figure 1. Activity System



The Diorama Interpretation Model is derived from Activity System, which has been adapted to become applicable to museum exhibits with the inclusion of other features that are presented and explained later in this paper.

3. Research Design and Methodology

This research is a mixed method quantitative/qualitative case study. The participants in this research were sixty-three (N=63) mixed ability 9-year-old students from a state co-educational primary school in central Malta. The pupils were coming from the middle to working class social strata. These pupils did very little biological science in school and their performance was not determined in a formal way. A few had relatives who own a piece of land and so they had experience in the countryside, but most pupils had little direct contact with nature. None of the pupils had ever been to the NHM in Malta before this study. Malta was the context of the study since one of the authors in Maltese and no such research had even been carried out in Malta. The school was selected after the authorities granted formal permission, while pupils selected formed the entire fifth grade cohort.

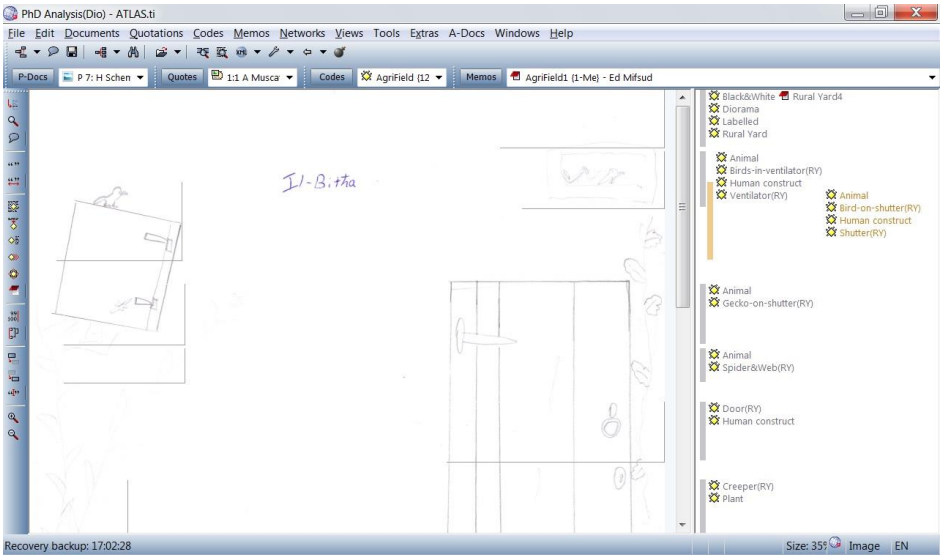
Children were first asked to draw ‘a place with local animals and plants’ in class. A fortnight after they visited the Natural History Museum of Malta, where they first produced another drawing before observing the five dioramas in groups of four pupils selected at random. Right after leaving the diorama area, the pupils were asked to draw their favourite diorama. A one-to-one interview was conducted a week after the visit, with each interview lasting 8-10 minutes. Each student was asked to explain the three drawing produced and comment on the choice of features and other points of significance to the student. Interviews were transcribed and content analysis conducted to elicit common categories that inform the interpretation model (figure 2).

Figure 2. Information elicited from interviews

Diorama	No time	Difficult	Why was diorama chosen	Favourite	Other	Wanted to draw	Other comments
AF	1	1	Due to presence of rabbit in setting others too difficult	No	Rural yard	Bird and chameleon	
AF			Favourite setting	Yes		Did not draw features since she forgot them	Very shy and quite girl, needed constant probing
AF		1	Favourite setting, family has field	Yes		Forgot some of the animals	Drew bird and erased it
AF		1		No	Bastion	Bastion and Sand dune but difficult to draw	Shows features from AF and RY
AF			Favourite setting, liked birds in field	Yes			Very shy and quite boy
AF			Favourite setting	Yes			Very shy and quite girl
AF	1		Likes rabbits	Yes			Web not completed due to lack of time
AF		1	Found the agrifield easier to draw, grandad has field	Yes	Rural yard	Animals	No animals since they are too difficult to draw
AF			Favourite and was the simplest to draw	Yes			
AF		1	Simpler to draw	No	Valley floor	Forgot many of the birds we noted	VF since it has many birds
AF			Favourite setting, dad has a field	Yes			
B	1		Favourite and was the simplest to draw	Yes	Rural yard	Rural yard; weasel and rat	Started to draw rural yard but stopped cos couldn't view it
B	1		Favourite setting	Yes			Very shy and quite boy
B	1		Favourite setting	Yes			Very knowledgeable but quiet boy; reads lots about wildlife
B		1	Favourite setting	Yes		Weasal, but too difficult	
B			Favourite setting	Yes		Weasal even though not very conspicuous	Remembered most animals
RY			Favourite setting	Yes			Remembered many details
RY			Remembered the RY better.	No	Sand Dune	Sand dune.	Very well drawn picture; only one animal and plant.
RY		1	Favourite setting	Yes			Left out features because too diffcult to draw.
RY		1	Simpler to draw	No	Sand Dune	Sand dune; was too difficult and stopped.	Forgot some of the animals while drawing, mistook rooster for a hen
RY			Favourite setting	Yes	Agrifield		Picture shows aspects from both dioramas.
RY		1	Favourite setting	Yes	Agrifield	Forgot some of the animals; others to hard to draw	Picture shows aspects from both dioramas.
RY		1	Favourite setting; easier to imagine so easier to draw	Yes		Butterflies, rooster, yellow and lilac flowers	Remembered other animals but hard to draw; afraid of rats; very communicative
RY			Liked all dioramas except sand dune.	No	Rural yard		Drawing shows aspects of ALL the dioramas
RY	1		Favourite setting	Yes			
RY			Favourite setting	Yes			Very shy and quiet girl
RY		1	Favourite setting	Yes			Omitted what was difficult to draw
RY			Favourite setting	Yes		Wall	Did not see the rooster
RY	1	1	Simpler to draw	No	Bastion	Shrew, beetle, gecko and more trees	
RY		1	Simpler to draw	No	Valley floor	Vine	Drew what he was able to draw
RY	1		Favourite setting	Yes		More features	Very shy and quiet boy
RY			Favourite setting	Yes	Agrifield		Drew what he was able to draw; said he drew field but picture shows the rural yard
SD		1	Simpler to draw; nice objects such as boat's eye	No	Agrifield	Agrifield but was too difficult to draw	
SD			Favourite setting; likes sea birds and wild settings	Yes		Sea weed	Very knowledgeable, reads about wildlife; very communicative
SD		1	Favourite setting; easier to draw and likes the beach	Yes		Bird flying; forgot other items	Loves, swimming and goes to pool in winter.
SD		1	Favourite setting	Yes	Agrifield		Left out what was hard to draw
SD			Favourite setting	Yes			Very shy and quiet girl
SD	1	1	Simpler to draw	No	Bastion		Started on Bastion and switched to SD but ran out of time
SD		1	Favourite and was the simplest to draw	Yes		Shells, snails and other birds	Features hard to draw or forgot them
SD		1	Favourite setting	Yes			Others were too difficult to draw
SD	1	1	Simpler to draw	No	Bastion		Not enough time to draw all features
SD			Favourite setting	Yes			Left out what was hard to draw
SD		1	Favourite setting	Yes		Flying bird; erased since not satisfied with result	Was concerned he was not drawing properly;
SD			Favourite setting; loves the sea	Yes			
Non-Dio		1	Only one duck drawn. Liked museum lots.		None	Remembered many animals, but none drawn	Wasn't sure what to do, has very good memory.
Non-Dio		1	Only one duck drawn.		Rural Yard		Too difficult to draw, since they are large
Non-Dio		1	Three birds from museum bird hall		Bastion		Didn't draw diorama cos could not remember features in it
Non-Dio		1			Sand Dune		Started but stopped since wasn't satisfied and drew other
Non-Dio		1			None	Settings too difficult to draw	Very shy and reserved girl

Drawings were analysed semi-quantitatively and qualitatively using the data analysis package (CAQDAS) Altas.ti (Friese, 2012). A coding method was developed for analysing the drawing, in principle similar to emergent analytic coding developed by Haney et al (2004: 252). A list of features that the drawings contain was drawn; each feature was assigned a specific code as shown in figure 3 below. Main code categories, such as animal and plant, were assigned. In the case of animals, taxonomic sub-categories were added to better classify the organisms included. Each animal included in the drawing was linked in the appropriate taxonomic sub-category for example mammal, insect or bird.

Figure 3. Coding using Atlas.ti



We analysed the three drawing set produced by each pupil to determine the sort of developmental progression (if any) from Class, through Pre-diorama to Diorama. We based our analysis on a similar one performed for a large-scale study at the London Zoo aimed to assess the formal learning program offered by the ZSL London Zoo (Jensen, 2011). We studied the drawings for changes in quantity and categories of biota presented as well as abiotic features and diorama details. We found noticeable development in the types of fauna and flora pupils drew, how they elaborated the biota and whether or not these were presented in a habitat. Figure 4 below shows an excerpt from the analysis.

Figure 4. Analysis of drawing sets

4. Results

In the class and pre-diorama tasks, children were asked to draw ‘a place with local animals and plants’ and they drew more animals than plants (mainly birds, mammals and arthropods), but also wrote far more animals than plants. The ability to recall animals in preference to plants could be due to various factors such as a greater knowledge about animals, and a general disregard and lack of sensitivity for plants. However, Maltese children mentioned more animals than they actually included in drawings, with much greater variety likewise dominated by birds and mammals. Emulating the famous Ausubelian maxim (Bell 1993: 6), Freeman (1997) holds that “the child knows more than he draws”. The proportions of

animals, plants, and the other objects written in the webs (81%, 13% and <1% respectively) were almost identical to those given by Yorek, Sahin and Aydin (2009).

The animals were generally represented in a similar form to that reported by Golomb (2004). Trees are seen in 'lolly-pop' shape, with disproportionate trunks and flowers as 'sunflower', long stalk and prominent petals. Animals were almost only drawn in their standard sideways orientation, highlighting the distinctive features of the subject. Four legged animal drawings showed some degree of figural differentiation and display the right-angular directions seen in humans. For example; mammals were drawn in horizontal body displayed in side view, head in frontal view, four straight legs and an occasional tail. Fish were drawn as an oval with the usual sideways fish-mouth, one or two eyes and a tail. Birds were typically shown in aerial view with head, body, and tail aligned horizontally with wings extending vertically.

The results from this research point toward a more comprehensive idea of what qualifies as an 'animal' for Maltese 9 years olds than reported in literature (Bell, 1981: 56). Maltese students refer to a greater variety, compared to their foreign peers, of species that they consider as an animal. The general archetype animal of most pupils is the large terrestrial, four-legged vertebrate, mostly mammal species (e.g. cow, cat, lion, elephant) and animals found at home as pets, on a farm or in the jungle. The class drawings presented the subordinate groups (taxon) *amphibian, bird, cnidarian, crustacean, fish, insect, mammal, mollusc* and *reptile*, while the museum drawings presented the subordinate groups *bird, echinoderm, fish, insect, mammal, mollusc* and *reptile*. Birds (37%), mammals (24%), arthropods (16%) and fish (13%) were the animals mainly drawn in class, while birds (60%), arthropods (18%) and mammals (13%) were mainly drawn at the museum. This research also shows that arthropods such as ant, bee, butterfly, ladybird and spider ranked more highly in frequency among Maltese children compared to foreign peers.

In this study, differences in number of species was not so striking; class drawings yielded 15 different species of mammals, 11 species of bird, 5 species of arthropods, while museum drawings yielded 16 different species of bird, 10 species of mammals, 4 species of arthropods. The mammals drawn in this research were mostly endemic or domesticated species (cat, cow, dog, donkey, hamster, horse, bat, rabbit, rat) and far less exotic species (elephant, leopard, lion, tiger, monkey, kangaroo, squirrel). In accordance with another study, Maltese children very rarely drew aquatic/semi-aquatic mammals such as dolphins, whales and seals (Tunnicliffe *et al*., 2008).

In both class and museum, children drew far fewer plants than animals with far less variety too and mainly seeded types. In class drawings the following plants were noted: moss, palm, tulip, reed, sunflower, daffodil, apple, olive, orange, peach and pine tree, compared with apple, cherry, pine, rose and sunflower in museum drawings. When they couldn't give a particular exemplar, children referred to the vegetative specimen as simply 'plant' (Bell, 1981). The findings seem to strengthen the view that plants are of no immediate importance to children (Bowker, 2007:91 and Johnson, 2004:79) that seem to have what has been referred to as *'plant* blindness' (Wandersee and Schussler, 2001). The general trend showing that animals are the most noticed and plants appreciably less was observed in each diorama drawing. A good number (75%) of drawings featured a least one plant, but the total number of plants (14%) was half that of animals (32%). Human artefacts (man made structures) seem to be more important to children than plants. Few drawings showed anthropomorphic features. In class, drawings of human features were present in 63% of drawings (33% in

museum), most of which were man made objects such as a boat, rubble wall, house, glasshouse, road, aquarium, airplane, barn and tools.

Looking at each child's set of three drawings we could notice appreciable changes that occurred throughout the tasks set. Almost half the pupils (47%) show a development toward greater variety and increased habitat representation, while almost a third (28%) show greater detail in organism representation without enhanced habitat representation. The rest of the pupils' (25%) drawings show an opposite effect, that is, loss of habitat, reduced variety or more basic organism representation.

I consider *Activity System* to be most appropriate and so I base my model on it, with the inclusion of additional features as suggested by empirical evidence from my research. Figure 5 below shows the Interpretation Model as we propose it, which presents six interrelated factors. Focus, Artefact, Group and Subject emerge from Activity theory, while Culture, Previous Knowledge, Mental Model and Expressed Model emerge from data. This model may be used to interpret museum objects or artefacts and particularly in this case the habitat dioramas.

Figure 5. Interpretation Model for cultural tools.

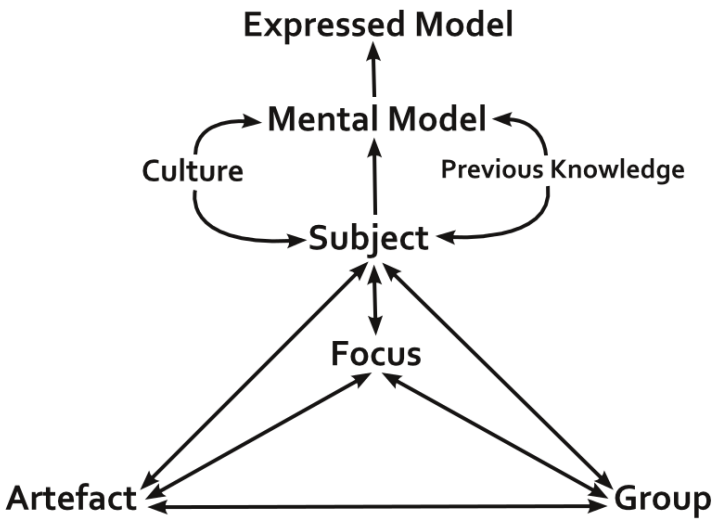


Table 1. Interpretation Model terms defined

Subject	The person observing the diorama, i.e. student or visitor.
Artefact	The mediating tool; a diorama, picture, 3D model or other media forms.
Focus	The idea, topic or location represented by the artefact and of interest to the subject and/or group, such as 'habitat'.
Group	The group of people i.e. friend or family, with whom the subject experiences the artefact.
Mental model	The personal representation of the artefact or focus held in the subject's mind.
Expressed model	The external representation of the mental model.

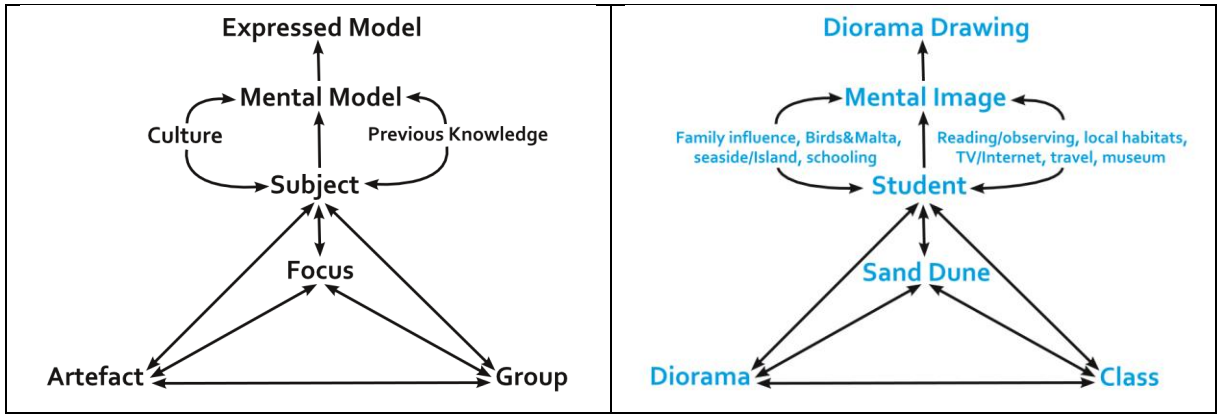
Culture	The sociocultural imprint of the family, country and society.
Previous knowledge	What the subject already knows about the focus.

4.1. The interpretative model applied

The figure 6 below shows the Sand Dune Diorama and the representation of it in a drawing. Figure 7 shows how the interpretation model can be used to show how the pupil interpreted this particular setting.

Figure 6. Sand Dune diorama and drawing.

Figure 7. Applying the Interpretation Model.



In this case the model was applied (right hand side) to the drawing produced by a boy who chose to represent the sand dune habitat diorama as show in figure 6. Here the model was employed on this diorama as the museum artefact, with the biological focus of a sand dune that was viewed and studied as a group of students (the class). The subject (person) viewing is the pupil whose mental image is influenced by the cultural elements of family, school, birds in Malta and sea around the island. It is also influenced by knowledge from reading, observation, local habitats, TV and internet, travel to foreign countries and museums.

5. Discussion

This research investigates the influence of natural history museum habitat dioramas on knowledge of biota and how this is expressed in drawing. Did the viewing of the dioramas in any way effect the way children drew? Drawing is certainly a valid representational and research tool, but it may be limited in showing a child's comprehensive knowledge.

We should not assume that children's drawings are print-outs of mental images (Jolley, 2010) and that children never just copy (Kress, 1997). Although we cannot exclude that some children do tend to copy from their peers' work, each drawing expresses a unique context for the visual forms and structures that are copied (Hopperstad, 2010: 447; Kress, 1997: 37). There is little evidence in our results that children actually copied and very few drawings by different pupils show clear similarities.

Some important conclusions that emerge from this research are that Maltese children has a better understanding of what an animal is by mentioning a wider range of species of organisms they think are animals. They also differ from their foreign peers in that they included more birds than mammals and also arthropods feature quite well in drawings. Malta has its own different culture with a long and deep-rooted tradition of bird trapping and hunting. The importance of birds is quite clearly evidenced in the data; birds are consistently the most frequently drawn animals in the three drawing tasks, which vary from what was reported in other countries in that mammals are the preferred class of animals.

The apparent disregard of child for plants has been previously reported in literature and was confirmed in this research too. Wandersee and Schussler (2001) coined the term *plant blindness* and argued that two possible indications of this might be: a) the idea of plants as just the backdrop for animals and b) failing to notice plants in the environment. Plants in the local habitat dioramas at the NHM in Malta are located in prominent positions and not just serving as a background for animals.

Studying carefully the drawings produced in class and the museum, we noted important changes. There is a progression from drawing from imagination in class and at the museum before viewing the diorama, to increasingly drawing from observation, but still showing signs of imagination in the diorama drawings. There is a greater sense of intellectual realism rather than visual realism as evidenced in the 9 year olds participants in this research. For almost half the pupils, the viewing of the dioramas had a positive effect on drawings produced.

The class drawings are an expression of their present mental model, of the flora and fauna of Malta. When observing and interpreting the dioramas, or any other museum exhibit, the visitor draws on his or her existent mental model. In other words, the visitor observes and interprets the dioramas through this conceptual lens. The novel museum environment was expected to have an effect on the mental model. Drawing at the museum confirmed this and for most children the mental model expressed did to a certain extent change, even if not for all in the same way. The mental model expressed in the drawings seems to be influenced by the place where children settle to create their drawings.

A development noted was the change from iconic to more realistically represented animals and in some cases also plants. This shows a desire to capture the object and represent it was evident in those pupils that drew one or two animals in greater detail (Golomb, 2004). Different children perceive and represent natural objects uniquely. Their attention to detail varies, with some children taking a more generalized view of the 'scene' depicting broad shapes and borders with little detail of plants and animals, but still using their own schematic graphics to represent them in some way. Others, albeit fewer, show greater detail as their attention is captured by the features of the organisms they observe. In this way, children's drawings became unique and personal, making generalization difficult while analyzing the drawings.

From the example provided, we show which elements seem to be invoked while interpreting a museum artefact such as a habitat diorama. These are presented in the Interpretation Model, which was developed, from Activity System, which is not directly applicable in our case but as modified it may be applied to interpret museum settings.

The strengths of the model lie in the manner it links together the elements involved in the interpretation of an artefact (mediating tool) to understand the message it conveys, for example Natural History Dioramas present flora and fauna in their habitat showing possible ecological relationships. It elucidates how a learner may understand a topic as mediated by an artefact to construct an intangible mental model to create a tangible expressed model (a drawing). The interaction with peers, the cultural baggage possessed and knowledge held may influence the mental model constructed. Potentially, this may apply to various topics as presented or modelled by 2D, 3D or virtual mediating tools. This may be done in different learning situations in science and other areas in formal, non-formal and informal settings.

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