Earth Science Place-Based Education at the American Museum of Natural History

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1. Queensborough Community College, CUNY 2. American Museum of Natural History 3. Riverdale Kingsbridge Academy 4. Franklin D. Roosevelt High School

Graduate Students: Masters of Arts in Teaching

Graduate students obtaining a Master of Arts in Teaching (MAT) degree in Earth Science participated in exploratory small group activities.

1. The immersive activities increased motivation, high-order thinking (Leinhardt & Knutson, 2004), and supported students in developing their own activities for secondary students.
2. Investigations using the museum's dioramas of reconstructed landscapes inspired connection to particular locations, while also forging connections to the museum and community for a multidisciplinary experience (Woodhouse & Knapp, 2000; Semken et al., 2017).
3. Follow-up discussions with their cohort and museum scientists reinforced the process of doing science, definitions, and questions scientists are trying to answer (Lawrence & Tinkler, 2015).

Fig. 2. MAT students determine fossilization potential of environments using dioramas representing different locations and environments.

Fig 3. MAT students explore plate tectonics in the Hall of Planet Earth.

Left: Fig. 4. MAT students find locations on topographic maps in the Hall of North American Mammals.

Above: Fig. 5. A follow-up discussion about fossilization with a museum scientist Dr. Melanie Hopkins.

Undergraduate Students: Queensborough Community College

The culmination of an introductory geology class required urban community college students to independently travel from Queens to Manhattan to visit the AMNH Hall of Planet Earth and complete a worksheet representing 20% of the students' laboratory assessment.

The visit supported learning, a sense of place, and career options:

1. Placing the visit near the end of the course and providing a self-directed worksheet scaffolded the activity for maximum support of learning (Andre et al., 2017).
2. Many visited with new classmates making it a social outing while student interactions built cultural and intellectual resources (Leinhardt & Knutson, 2004).
3. Traveling to AMNH expanded many students geographic range within the city.
4. The visit widened students' sense of career options (NRC, 2009).

Fig. 6. Community college students explored course content in an informal setting, self-selecting topics to interact with. The novel aspect of this visit elicited positive emotional responses (Sobel, 2004) while building content knowledge. Photo credit: D. Finnin@AMNH

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Introduction

In this study, the authors leverage place-based science teaching for students ranging from high school to graduate school through the use of the American Museum of Natural History (AMNH), a local space for students to construct a sense of meaning and attachment to science.

The several field trips to AMNH utilize its familiar landmark status in New York City to reveal meaning and relationships with science content knowledge and skills and build on its familiarity to connect science with physical, social, and cultural influences (e.g., Apple et al., 2014). In several field trips, the informal educational setting of AMNH also allows students to gain more knowledge about the process of doing science and engage directly with scientists.

Not only does this study advocate for the use of place-based teaching, the authors also indicate that cultural institutions like AMNH have a critical role in urban settings to attract diverse and underrepresented groups in science studies and careers (e.g., Dalbotten et al., 2016).

Fig. 1. Students visiting from Franklin D. Roosevelt High School posed for a group photo at the American Museum of Natural History's Theodore Roosevelt Memorial Hall.

Discussion

- The majority of science learning occurs outside the classroom (Falk & Dierking, 2010), in *Informal Science Environments,* or ISEs, including museums.
- Adult Americans have some of the highest rates of science literacy in the world although the U.S. has declining education funding compared to other countries (Barshay, 2017). This paradox likely results from the array of free-choice learning opportunities available to the general public.
- An advantage of place-based learning is that it can be adapted for many different settings. This is an especially useful strategy for Earth Science since much of what we teach is associated with specific locations.
- Place-based education in a natural history museum can help to bridge the disconnect separating the lives of our students and school (Smith, 2002). Providing a context helps the student synthesize new information and add it to previously-existing schema (NRC, 2000).
- In today's cultural climate with rampant science skepticism and a proliferation of scientific misinformation, it is vital that educators design and execute field trips that are as meaningful as possible. When students are enjoyinging themselves in an ISE, they are more open to new ideas and new ways of thinking.
- On field trips, by accessing prior connections to places and fostering new place connections, there is the potential for students to develop what can be lifelong positive associations with cultural institutions like AMNH (Semken & Freeman, 2008).

Conclusion

Elements of the AMNH field trips were meaningful for all students:

- Deliberate leveraging of sense of place, using museum exhibits to connect to particular locations, while also forging connections to the museum. Using the museum to contextualize place with the science.
- Scheduling the field trip so that it aligns with curriculum and accesses prior learning.
- Using available resources from the museum (e.g., meet a scientist, arrange for a cart with objects that students can touch and handle).
- Planning immersive activities to increase motivation and higher-order thinking.
- Incorporation of fun in a visit to elicit positive emotional responses.
- A debrief with a scientist or teacher on-site or in the classroom to process what students have learned and observed on the trip. This will also be helpful for students who were not able to go on the field trip.

High School Students: Riverdale Kingsbridge Academy

At the end of the Rocks and Minerals unit, all Earth Science classes (mostly 10th graders) visited AMNH in February. With booklets that encouraged exploration and choice, students investigated the rock exhibits in the Hall of Planet Earth and then visited the Hall of Mexico and Central America to see how these Earth materials were used in ceremonial and everyday objects.

This visit supported exploration, fun, and choice, connecting with science, as well as sense of place:

1. In the science and cultural halls, students selected objects to draw and write about. Giving students a lot of choice makes learning more fun, facilitating retention and assimilation of new learning (Deci & Ryan, 2002, NRC, 2009).
2. Connecting with science occurred as students discussed how Earth materials are used in common objects with museum scientist Dr. Steven Jaret (Woods-Townsend et al., 2016).
3. The Hall of Mexico and Central America was chosen as a place to visit because many students at RKA have deep cultural roots in this part of the world. Connecting to place facilitates a connection to science (Semken & Freeman, 2008).

Fig. 7. Students chose rocks they thought were interesting to sketch. The element of choice is one of the aspects of ISEs that make them so effective in learning (NRC, 2009).

Fig. 8. Students enjoying the social aspect of a field trip can improve long-term learning potential of a field trip (NRC, 2009).

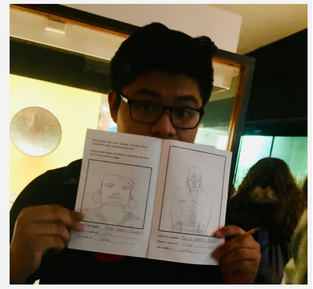

Fig. 9 and 10. Students sketched objects in these booklets. Drawing is the Swiss army knife of teaching tools. It enhances student engagement, reveals understanding, aids in organizing knowledge, to name a few of the benefits (Ainsworth et al., 2011).

High School Students: Franklin D Roosevelt

For the case study of FDRHS students, the field trip served as a summative activity to review the unit Dynamic Earth and serve as a reference for the upcoming unit Rocks and Minerals. During this field trip, students engaged in several strands of informal science learning to better develop their science identities through interactive, structured activities and create personal scientific meaning of the city they live in.

Fig 11. Students are seen experiencing excitement about the natural world in the Butterfly Conservatory and engaging with Strand 1 of informal science learning (NRC, 2009).

This visit supported informal science learning, scientific meaning-making of the local environment, and participation in the scientific process.

1. To generate excitement and motivation, students visited the Butterfly Conservatory at the beginning of the field trip. While not directly relevant to Earth Science, this memorable opportunity to interact with butterflies from around the world primed the students for learning about natural phenomena (NRC, 2009).
2. Students met with scientist, Dr. Steven Jaret, to contextualize the geologic history of Manhattan by visiting outcrops in Central Park. This interaction enabled students to not only develop a scientific sense of place for the city they live in (Semken & Freeman, 2008), but also interact with a scientist to normalize perceptions of scientists as people (Woods-Townsend et al., 2016).
3. In the Hall of Planet Earth, students completed a self-directed guide. Students manipulated interactive displays, made observations about models, and developed their science learner identities through several strands of information science learning (NRC, 2009).

Fig 12. The Central Park portion of the field trip and meeting Dr. Steven Jaret served to reinforce student understanding of plate tectonics in the context of New York City (Semken and Freeman, 2008). Students engaged in several strands of learning and over a month later retained knowledge of metamorphic rocks (NRC, 2009).

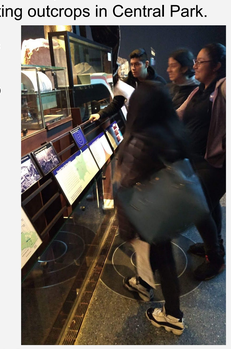

Fig 13. Students engage with interactive exhibits in the Hall of Planet Earth and are tasked with making observations and generating explanations (NRC, 2009).

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