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ORIGINAL ARTICLE

The historical context of science and education at the American Museum of Natural History

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Abstract In this article I critically examine the historical context of science education in a natural history museum and its relevance to using museum resources to teach science today. I begin with a discussion of the historical display of race and its relevance to my practice of using the Museum's resources to teach science. I continue with a critical review of the history of the education department in a natural history museum to demonstrate the historical constitution of current practices of the education department. Using sociocultural constructs around identity formation and transformation, I move to the present with a case study of a teacher who transforms the structure of science education in her classroom and school as a result of her identity transformation and association with a museum-based professional education program.

Keywords Museum education · Museum history · Urban education · Teacher education · Identity

Introduction

> You have little idea in walking through these halls what labor they have involved, what sacrifices men have made and are making for them today in all parts of the world, how much the workers in this Museum are imbued with what may be called the spirit of the institution—the desire to extend the call and vision of nature (Osborne, 1927a, p. 271).

Recent scholarship has focused on the role that identity plays in the learning that happens during a museum visit—identity as a motivation for visiting museums and determining how people interact with and learn from exhibits. Rounds (2006) views the museum as a

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site for ''identity work,'' ''the processes through which we construct, maintain, and adapt our sense of personal identity, and persuade other people to believe in that identity'' (p. 133). I interpret this as people finding objects and exhibits in a museum that confirm their existing identities and/or expand their identity to include aspects of new objects and resources they may encounter. In addition, when people visit a museum they are enacting a specific identity in relation to their visit. As a teacher educator in a museum, the visitors I often encounter are teachers visiting to participate in professional education activities. In agreement with Rounds' (2006) notion of identity work, and the idea that learning expresses identity (Falk, 2006) these teachers are enacting a science teaching identity—whether by choice or mandate—when they attend the workshop to learn to teach science. I will add that the process of learning and identity work in a museum is also a process of creolization and hybridization as teachers learn to use museum-based resources to teach and expand their identities to use these kinds of resources to teach science.

I believe that these theories and constructs are all very important when considering the role that museums can play in formal education. While certain education visits—whether it is teachers visiting for a workshop or classes visiting with specific learning goals—remove some of the ''free-choice'' aspects of learning in a museum, the notion of ''identity work'' could be a key factor in how ''formal education'' visitors relate to a museum and the objects contained in the halls.

Race and historical displays in the museum

In my daily work in a great natural history museum, I enjoy my interactions with objects of science, human culture, and history. I also realize the value of the Museum as a science teaching and learning resource for teachers and schools, however I do feel personal oppression when I look at some of the ways that people of African descent are depicted and interpreted in the Museum. While I realize that these objects are a reflection of an historical era, they are nonetheless present and have to be dealt with for the value of what they represent to people who see them, especially people like me who may view them as a form of symbolic violence and interpret them in oppressive ways.

To describe this oppression, I can begin with the statue at the main entrance to the Museum. Adorning the entrance of the Museum is a statue of Theodore Roosevelt on horseback in oxidized bronze (see Fig. 1). An African and a Native American man flank him, both on foot. Proudly mounted on his horse, his back is slightly turned away from the African, who wears almost nothing and has a downcast gaze toward Central Park. The Native American chief—wears a grand headdress and is draped in a blanket, he too gazes into the park. Roosevelt's position on the horse indicates to me that Roosevelt is aware of the African's existence, but has a desire to ignore him; also ignoring the significant contributions that African people have made to this country and to the knowledge contained within the Museum.

When I enter the Roosevelt Memorial Hall and look at the murals painted on the walls up to the high ceilings, I am confronted by murals that depict grand scenes of great European men on horses and foot, collecting animal, mineral, and vegetable treasures in order to display in this great building the wealth of the worlds and peoples they have conquered. These murals represent the greatness of Western civilization with stories of great white men—science and culture—told, interpreted, and displayed from a white, masculine point of view (Levin, 2002). While many find this hall inviting because of the expanse and natural light, I am disconcerted by the depiction of people of color in

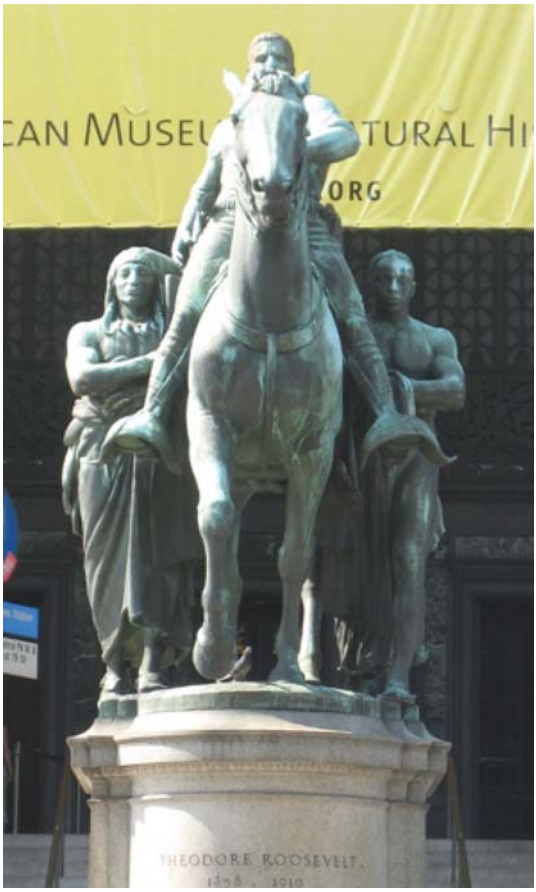

Fig. 1 The Theodore Roosevelt statue

subordination to the white explorers on horseback. I often wonder if students and teachers of color see themselves in subordination on these walls too? I also wonder if some students and teachers see the history they have learned about themselves in school reinforced on this great wall. Sometimes when I look at the statue and murals, I feel a sense of pain in the wealth and culture that was stolen from many people and appropriated for the advancement of the Western cause. Perhaps some people sense this same discomfort when visiting the Museum on their own. In my ''web of reality'' the meaning that I construct from the statue and from these murals is that to the colonial Western mind, the ''other'' cultures seem only to be as great as the exotica they produce (Kincheloe, 2001).

The American Museum of Natural History (AMNH), a New York City and American treasure, contains a wealth of cultural and scientific knowledge both in the halls and behind the scenes. But, like many great things of our nation, there is some darkness in its past. When classes visit the classic diorama halls, we (museum educators and explainers) are quick to point out that the stuffed animals (taxidermy) displayed were collected at a time when it was acceptable to kill and collect animals for sport. Theodore Roosevelt was known for his fondness of hunting. We explain that while random collecting is no longer practiced, we were able to gain a wealth of knowledge about the diversity of life on Earth from this past practice. The newer Hall of Biodiversity displays the range of this wealth—the Spectrum of Life wall exhibits representative specimens from each phylum of life on

Earth. Individual items, which number in the hundreds of thousands, are stored as a part of the Museum's collection in their respective scientific departments. While some people are still upset by the collecting practices of the past, many are comforted in knowing that this does not happen (at least to the extent that it did during Roosevelt's time) in the present climate of conservation and preservation. People do not take these halls personally.

However, although the murals and cultural halls also contain a wealth of information about the past and important lessons for us to learn today, people take these halls personally. The Theodore Roosevelt statue offends me. Intellectually I understand that the statue and murals that depict people of African descent (and other people of color) in subordinate roles are historically constituted—they represent the ideology of the era of imperialism and colonial and racial superiority. However, for me, as a person of African descent, this history is embodied and therefore seeing such monuments evokes within me a visceral feeling of oppression and pain, as if I am the individual that is on display—I cannot help but feel personally affronted when I see the culture of a primary branch of my ancestry displayed and interpreted in such undignified ways. We can explain the past of the scientific halls in ways that are acceptable to folks today. How can we explain the cultural halls and murals in a way that is acceptable, if not liberating to all of those who visit the Museum? This is necessary if we are going to continue to dialogue about using this museum and other great museums around the city as an important part of urban teaching and learning.

Historiography

In my practice as a museum educator in science, I use the Museum's resources to support science teaching and learning and until recently, I rarely accessed the cultural artifacts in my practice. However the cultural and historical artifacts—like the mural, statue, and interpretations of the ethnographic collections—are present and a part of the Museum's structure and therefore have implications for any teaching and learning that happens in the Museum's space. How people perceive the Museum and such objects can constrain the science teaching and learning that occur in the Museum. As an example, if a person of African descent enters the Museum, notices the statue, and has a similar visceral response to mine, it could affect how she approaches the scientific objects in the Museum, for the Museum has now become racialized and perhaps is even mistrusted by the viewer. In addition, these racialized objects in an authoritative institution such as a museum can reinforce the ideology of Western superiority—both in science and culture—shutting down the viewer from the opportunity for expanded agency in science as, ''the knowledge Western science produced became the benchmark by which the productions of non-Western civilizations are measured'' (Kincheloe, 2001, p. 475). I have heard of college students who were training to be explainers in one of the Museum's summer internship programs reading some of the text in the Hall of African Peoples and becoming highly offended and angry at the stereotyped interpretations of African culture. Although they continued in the program and became star explainers during that summer, I am sure that this experience affected how they viewed themselves within the Museum.

As an educator, I have had to deal with my own feelings about the legacy of racism both in my personal experiences and how those experiences are replicated in the historical display of people of African descent and their artifacts—I have had to keep a constant vigil against internalizing racism (Brock, 2005) and thereby recognizing its oppression and historical significance. In order for me to understand the Museum as a teaching and

learning resource for all students, it is important for me to learn and understand the historical constitution of the Museum as presented in the objects and the halls. As a researcher, in using the Museum as a resource for teaching and learning, I have had to reconcile my feelings of race with the history of the institution and conceive new ways of using those very objects as teachable moments to help myself and other people move beyond being defined by others—''when you define your existence based on the ideals of others, you give them power'' (Brock, 2005, p. 39). Unbeknownst to me in my oscillation between the Museum's past and present, I was engaging in historiography, which Villaverde et al. (2006) describe as a method to ''delineate the larger constructs which inform the ways [a researcher] makes sense of the past, present, and future'' (p. 316).

Through historiography, using the power of my individual story in relation to the objects in the Museum as well as the collective endeavor of the Museum to present scientific and cultural knowledge to the public, I have been able to change my culture in relation to accessing and using the Museum as a learning resource, and hopefully influence the culture of students and teachers wishing to do the same (Villaverde et al., 2006). A critical examination of the historical context of the Museum can be both informative and transformative. Informative in that it helps us to understand how situations came to exist in ways that inform our actions (Villaverde et al., 2006) and transformative in that an understanding of historical structures helps to develop a critical consciousness that is potentially liberating. As Hooks (1994) explains, combining the analytical and experiential is a richer way of knowing. In speaking of the critical pedagogies of liberation, by tapping into our personal experiences we can look at/analyze the societal structures that seem to continue the domination politics in such a way that gives us a ''purpose and meaning to struggle'' (Hooks, 1994, p. 89). It can allow us to examine the social, political and economic conditions that are at odds with the individual's will to freedom (Villanueva, 1993).

Borrowing Lemke's (2001) question of ''what practices, beliefs, and values constitute the culture of science/science education in a given time and place, and how does this culture change across historic time?'' as a framework, I describe the history of the education programs, the ideology that shaped the pedagogy and content of the programs, and how the programs have evolved in response to the changing ideology of education and the needs of the public schools. By comparing and contrasting the education programs from the founding years of the Museum to the present decade, I will demonstrate that some of current practices are constituted in the past, however transformed to accommodate the Museum's present relationship to teachers and schools.

New resources, old history

Museums are often thought about in a context of their physical structure—the visible and tangible resources as well as the buildings that contain these objects as these structures are often of historical and/or architectural significance. Salient are the dialectical interactions of objects and ideas, interpretations and ideology, scientists and public audiences. Seeing the Museum through sociocultural lenses, the Museum becomes a field—an arena for the enactment of social life. In this context, the structure of the Museum expands to include invisible as well as visible structures for which museums are renowned.

Using the word ''culture'' in reference to the Museum can have different connotations. It can refer to the ethnological display of cultural artifacts from around the globe, or it can refer to ''high culture'' and the association with visiting museums with Eurocentric, elite culture (stemming from the history of museums as places to display collection by and for

members of an elite class, Melber & Abraham, 2002). While both of these definitions have implications for discussing the history of the Museum as well as the Museum as a resource for teaching and learning today, I use a sociocultural definition of culture as a system of schema and practices enacted in relation to power and structures within a given field (Kress, 2005). Culture gets enacted in a field and is responsive to the visible and invisible underlying structures. While the visible structures of a museum are obvious in the presence of the building and the objects it contains, the invisible structures have to be identified and theorized. Anthropologist Miriam Kahn's (2003) notion of third space can be used to describe the invisible structures in a field; ''everything takes place in this lived space, a space that is active and reactive, fluid and dynamic, open and expansive'' (p. 308). Kahn (2003) sets up the third space as a dialectic of perceived and conceived space—a space that is at once realized and imagined. She continues to describe the space as ''simultaneously past and present, physical and mental, immediate and mediated.'' These intangible structures shape and enable the activity that takes place in this field, including the teaching and learning that can be enabled or constrained based on one's perceptions of the Museum. I bring to the forefront the past or history that simultaneously is present, as the history of the Museum is always present—both in visible structures, such as the old dioramas and invisible structures like the ''spirit of the institution'' as I quoted Osborne (1927a) at the beginning of this paper.

Historically, the Museum has always been a place for the acquisition of new objects and the production of new scientific knowledge. A defining characteristic of a cultural field is that it is dynamic and changes as new resources and culture are enacted in the field. Throughout decades of the Museum's existence, it has been a place where people come into contact with new resources. Whether it is seeing a new object, or learning new or different science content through observation and/or research, the Museum has always been a source of science-related interactions between objects and people. As a cultural field, these interactions lead to the re/production of culture. People also bring culture into the Museum that gets enacted in the halls, in the classrooms, and behind-the-scenes in spaces like the scientific labs. This enacted culture subsequently changes the structure of the Museum. Culture that I enact views the Museum as an ideological space that represents the ideas and interpretations from a culturally specific point of view being—that of Western civilization. This is implicit in an early statement about the role of the Museum—early Museum leaders saw the Museum as having the important social conviction of bringing nature to those who were not able to get out and experience it for themselves, ''very few people, even among those who have the means to travel, really see nature in the sense of understanding it, and to the millions within the cities, nature is practically unknown, so we [museum scientists and exhibit developers] are *interpreters*'' (emphasis mine) (Osborne, 1927a, p. 271). It is curious that this statement contradicts another statement by Osborne (1927a), ''the peculiar teaching quality of a museum is that it teaches in the way nature teaches, by speaking to the mind direct and not through the medium of another mind'' (p. 281). Osborne omits the role that interpretation plays in ''speaking directly to the mind.'' Perhaps this is because in agreement with the notion of science as objective, the study of nature as a science is objective and therefore any interpretation of nature is unbiased. However I view interpretation as culturally situated—a selective activity as it is the interpreter who decides what information gets conveyed and the interpreter as a cultural being is not free from ideological bias. As a public space, the Museum could be a space to begin the discussion about the ideology of the Museum and, as it has done in recent decades with culture, it can bring to the forefront the notion of having different interpretations and explanations of scientific data and phenomena.

Kahn (1995) notes, ''all museums are exercises in classification and it is precisely from their position as ''classifying houses'' that museums become institutions of knowledge and technologies of power'' (p. 324). As classification is an *interpretation* of characteristics and the creation of categories based on these interpretations, these practices reflect a specific ideology of science based on a Western, Eurocentric notion of science. To science and the Museum, classification is a way of knowing. It is a way of naming, describing, and categorizing living things with the goal of creating a catalogue of life on Earth. This is also the case for the science of anthropology and the Museum, as classification becomes the means by which human culture is characterized and grouped. This is important to keep in mind in examining the history of the Museum's education activity as the Museum presents a culturally specific way of seeing the world, which can conflict with other cultures that students and teachers bring into the Museum.

Early American museums: enlightenment of the citizenry

Founders of early American public museums saw it as their mission to enlighten the American public through access to objects. Evolved cabinets of curiosities, these early museums displayed objects from the private collections of the elite class. As tools of empirical research, possessions of a diversity of objects raised the social prestige of the owner (Müsch, et al., 2001). These objects—both science and cultural artifacts—were collected from travels and expeditions around the globe, most of the objects originating from European colonies, such as East Africa and parts of Asia. With these objects, the early museums attempted to produce an overall picture of the world (Müsch et al., 2001), and formed heterotopias—combinations of different places as though they were one (Kahn, 1995). Humanistic in thought the cabinets and the subsequent museums aimed to achieve ''a comprehensive encyclopedic archive and repository which will yield a total knowledge'' (Kavanagh, 1991, p. 104). In other words these collections would reveal the truth about nature and human existence, a truth that was once reserved for the wealthy owners of such revealing objects.

Charles Wilson Peale, a naturalist, an artist, and a collector founded the first American museum with objects from his private collection. Peale's museum, which opened in Philadelphia in 1784, was a ''secular temple'' where the ''most perfect order in the works of a great Creator...'' was displayed (Levin, 2002). Arranging objects in context—stuffed animals posed against painted backgrounds, wax figures dressed in traditional clothing—Peale wanted visitors to leave his museum ''happily amused and certainly instructed'' (Levin, 2002). In keeping with the culture of the social efficacy zeitgeist, Peale's museum inspired citizens through, ''charming models for every social duty...'' rendering man ''more content in the station where he is placed'' (Levin, 2002). Figure 2 shows Peale dramatically revealing his temple with a welcoming hand, but daring gaze as if he is saying ''enter at your own risk''; which leads me to ask, what would one risk if they should dare to enter?

Subsequent American public museums were funded by philanthropists, such as Field, Bishop, Peabody, Carnegie, and Smithson, several of them including objects from their personal collections (Melber & Abraham, 2002). As Melber and Abraham noted, John Smithson's will desired that his ''worldly goods be used to 'found at Washington an establishment for the increase and diffusion of knowledge among men''' (p. 46). These public institutions enabled a wider range of people to view objects that were once reserved for an elite class—beginning the democratization of American museums. Early founders of

Fig. 2 Peale's museum. Reprinted from Virginia Center for Digital Literacy, University of Virginia

American museums saw them as egalitarian places welcoming all classes of people with objects and displays *they* believed were enlightening, important, and somehow connected to everyone's lives. For the early American museum visitor, the founders controlled what was displayed and its interpretation. The visitors were simply viewed as recipients of philanthropic displays of knowledge.

Western science ideology: the foundation of the museum

According to Swartz (1997) even science itself—''self-proclaimed highest expression of objectivity'' (pp. 117–118)—is produced within the framework of a field. In other words, science is culturally produced in a field where the struggle is for control of knowledge. Arthur Spears (personal communication, 7/16/2006) argues that it is by historical accident that the leading practitioners of science are located in the ''West.'' Therefore, science is ideologically slanted to support the vested interests of Western European dominance (Kincheloe, 2001). Kincheloe (2001) describes science ''as a force of domination, not because of its intrinsic truthfulness but because of the social authority (power) that it brings with it'' (p. 476).

Villanueva (1993) describes science as a ''modern folklore'' conscripted into the service of hegemony. Defined, as ideological domination by consent, science, or at least the hegemonic view of science, which is often represented in museums and other institutions that exist in ''civil society,'' is a part of the modern folklore that needs to be exposed. Science is a culture and language is a means of transmitting culture (Falk, 2001). Perhaps we can help our students to create a language that will allow them to question the Western

hegemonic worldview of science. Only by framing the [science] museum experience within the larger context of an individual's life can one begin to truly understand the nature and impact of that experience (Falk, 2001).

Although museums are described as democratic places, they are sites for the creation of a science ideology, and they help to mold much of what we understand about science (Vackimes 2003). According to anthropologist Sophia Vackimes (2003), ''science museums in the United States have remained attached to merely presenting materials as wonders of nature or as technological feats'' (p. 8)—leaving out the cultural situatedness of the interpretations (as written in the text and/or communicated by scientists) of these wonders and feats.

As with other early American museums, The American Museum of Natural History (AMNH) was founded on the ideologies and power of the dominant culture. As the term *founding fathers* suggests, the Museum was patriarchal in its position of power and authority over the knowledge of science and the natural world. In its position of power, it presented a culturally specific way of seeing the world. According to Kincheloe (2002) it is important to understand science as a ''social construction, produced in a particular culture in a specific historical era'' (p. 472). The Museum as a scientific, cultural, and historical institution has been shaped by the dominant ideology on which it was founded. In next section I describe some of the early programs of the AMNH's ''service'' to schools.

The founding decades of the education department at AMNH

The AMNH is one of the oldest of its kind in the United States. As with other American museums, the AMNH was founded with the ''notion of public education clearly in mind (American Association of Museums 1984, p. 55 in Melber & Abraham, 2002). As indicated in its mission statement, the AMNH aimed to make the education of the public central to its operations:

> The American Museum of Natural History founded April 6th, 1869 for the purpose of establishing in said city a museum library of natural history; of encouraging and developing the study of natural science; of advancing the general knowledge of kindred subjects, and to that end of furnishing popular instruction. (AMNH, 1930)

The Founders saw the importance of conveying to the public the great work and discoveries of the Museum's scientists and collecting expeditions. One of the founders who continued to make his mark on the development of the Museum's education programs was Albert Bickmore. When the Museum opened its doors in 1878, Morris Ketchum Jesup was the President and Bickmore served as superintendent of the Museum. In 1880, the State Department of Education enthusiastically approved the Museum's proposal to offer a series of lectures to primary school teachers and principals. Thus, in January 1881, Bickmore began a series of lectures in zoology and natural history, establishing him as the Museum's first public educator.

Jesup saw the value of the Museum's content as going beyond a monetary value, and it was his belief in the ideals of science and his desire that ''they should be brought within the comprehension of all classes of people'' (Osborne, 1911, p. 29). In 1884, the Museum's Department of Public Instruction was officially established. This department would contain, ''all those features of the Museum which are instrumental in articulating the work of the Museum with the public at large and *especially with the educational system of the City*'' (emphasis mine) (Osborne, 1911, p. 116). Through the creation of this department, the vital link between the City's schools and the Museum was established. With this newly

established department, grant money from the State Department of Public Instruction was appropriated ''to establish and maintain a course of free lectures to the teachers of the common schools of New York City and to the teachers of the common and normal schools throughout the State, who wish to avail themselves of this training'' (Quotes from the grant proposal in Osborne, 1911). Professor Bickmore was appointed as the Museum's first Curator-in-Chief. The school year of 1884 was greeted with 10 lectures on physiology, zoology, and botany in a course of study presented by Professor Bickmore.

Equity and access—connecting the museum's resources to the public schools

Serving as the first curator of the Department of Education, Bickmore is credited with developing a series of lanternslides and lectures on natural history for public school teachers. Inspired by his youth, growing up in the woods of Maine, Bickmore felt that, what he called ''the visual method'' of education was a vital way of allowing students and teachers who didn't have access to nature to be able to see and make observations and connect with the natural world. In 1895, the State issued an act to provide ''The Visual Instruction Method'' to common schools in the State. Accordingly, access to Bickmore's lectures was far reaching. For the lectures and distribution, Bickmore reproduced ''lantern slides'' from the best photographs taken on the Museum's famed expeditions. Bickmore himself traveled to ''remote lands'' of the world in order to gather information and take photographs. He also collected negatives from world travelers, ''there was not a traveler of note who came to New York, whom he did not seek out and ask for negatives'' (Sherwood, 1927, p. 317). Professor Bickmore's slides, some of which were ''beautifully colored,'' served as the basis on which the Museum's lanternslide collection was developed. These lanternslides later served as an important piece in the Museum's service to New York City public Schools.

During Bickmore's leadership, the Department's service focused on instruction for teachers. Teachers attended evening lectures on natural history, geography, and industry supplemented by the Bickmore slides and teachers were allowed to pick and borrow from these slides for use in the classroom. Through the education of teachers and the lending of the slides, the Museum's collections and scientific knowledge were extended to thousands of public school teachers and students across the city and state.

During the time of the establishment of the Museum's education services, the New York City public schools were under the leadership of Superintendent William Maxwell. Described by Cuban (1993) as a pragmatic school reformer, he is credited with establishing a broader and more uniform curriculum in the public schools. He sought to give the City's children as many educational opportunities as possible and opposed reformers who compared the education of children to that of manufacturing industrial goods (Ravitch, 2000). He expanded the role of the public school by adding afterschool programs and services for kids with disabilities. Maxwell also served as chairman for the Committee of Fifteen who championed the cause for a humanist curriculum ''constructed around the finest resources of Western Civilization'' (Kliebard, 1986, p. 17). These fine Western resources included the objects and collections of the AMNH. Since the City increased its financing of the Museum's operations the Museum felt that is was ''proper...to give its attention, first to the needs of the City's schools...'' (Sherwood, 1927, p. 317). Spurred on by a request from the New York City Teacher's Association,

the Museum commenced a series of lectures to school children to supplement classroom work in geography, history, and natural science.

Meeting the needs of the City's curriculum reforms, a nature study curriculum for elementary school was established. The Museum was able to supplement this curriculum with the oldest, and at the time, the most extensive aspect of its service to schools—the circulation of its nature study collection. Wooden cases containing representative specimens of various animals, such as mammals, birds, and insects, and samples of minerals and woods, as well as public health charts and exhibits—were made available on loan to schools. They were designed so that the specimen could easily be removed and handled by students. Also made available were museum-developed mini-dioramas called ''habitat group types.'' One example, ''Birds that are Our Friends'' presents a group of native birds, including a Screech Owl with a mouse in its beak displayed against a painting of the natural environment and types of trees and plants that would be found in the habitat. The nature study collections were accompanied by literature describing the animals and their relationships to each other and to humans as well as a bibliography of popular books on the subject. These teaching tools were available, free of charge, on loan to schools. This loan program enabled close contact between the education department and teachers; this led to the Museum's greater understanding of how it could best serve the City's schools.

The Sherwood era: expanding the museum's service to schools

In 1906, George Sherwood, began his service as Curator-in-Chief of the Department of Education. Described as a practical teacher who believed that the ''training of children is the most important vocation in the world'' (Sherwood, 1927, p. 320), under Sherwood's leadership the Museum developed a comprehensive service to the schools. The scientific departments of the Museum provided the content for the education programs. Sherwood believed that ''it is the function of the department of public education to digest this material and present such portions of it as will be useful to teachers and pupils.'' Sherwood (1927) distinguished two main branches of the Museum's service to schools; one designated as extramural—services that occurred in places outside of the Museum and included the previously described lantern slide service, the circulating nature study collections to branch libraries and branch schools, beginning in 1904 and 1914, respectively. The distribution of films, and lectures in the schools were also included in the extramural services. Special exhibits were made available for loan to public libraries. The primary purpose of these exhibits was ''to stimulate children to read good books'' (Sherwood, 1927, p. 329). These exhibits included specimens such as animals, artifacts, and industrial models that could be used to illustrate books on travel, geography, nature study, and a host of other subjects. The intramural branch—services that took place within the Museum, included lectures, services for blind students, and instructors in the exhibition halls. Of the lantern slide service, Sherwood believed that ''the use of the slide in the classroom and assembly simplifies the teacher's task and enables the pupil to absorb information more quickly and permanently'' (Sherwood, 1927, p. 327). Sets of slides of curriculum topics were developed and accompanied by lecture manuscripts enabling teachers with limited preparation time to use the slides with minimum effort.

Sherwood found the nature study collections most valuable to teachers and students. He recounted teachers who found them useful in teaching facts about nature and doing language work, particularly with teaching English to foreign-born students. He believed that the greater service was ''giving city children a glimpse of the great outdoors'' (Sherwood,

1924, p. 272). Many of the children at the time rarely left the city and had almost no references to the great outdoors. Sherwood illustrated the urgency of this matter in the following example:

> The class was reading a poem dealing with the ''signs of spring,'' daffodils, frogs, etc. The children did not comprehend the meaning of the phrase [signs of spring]. Finally, the teacher asked how do we know that spring is here. Johnny was the only one who raised his hand. ''Well, Johnny, how do you know that Spring was here?'' ''Because I saw them hanging the swinging doors on the saloons.'' Certainly the nature study collections from the Museum helped to give Johnny a new conception of spring. (Sherwood, 1924, p. 272)

Sherwood (1927) described these exhibits as having the ability to ''awaken the spirit of research'' and encourage students and their families to visit the Museum and go back to the library for further reading. Sherwood (1927) mentioned that this program formed the basis of cooperation between the libraries and local schools; in other words, this initiative brought the Museum to the community and made it accessible to those students who could not afford to visit the Museum. As a part of its extramural services, the Museum also provided lectures to schools, but due to limited staff, these mainly took place in centrally located schools where kids from surrounding schools could visit and have the benefit of a quality museum lecture, supplemented by slides and specimens from the education collection, without expenditure of carfare. Again this points to the importance that Sherwood placed on accessibility to the Museum—''a very serious matter in many families'' (p. 329).

Shortly after Sherwood began his service, Henry Fairfield Osborne was appointed as President of the AMNH in 1908. An eloquent and prolific writer, his theory of ''creative education'' facilitated lasting changes in the presentation of museum exhibits that in turn influenced the Museum education pedagogy. As Sherwood established the Museum's services to schools, Osborne's ideas greatly influenced how the Museum's resources were presented.

At a first glance at Osborne's creative education theory, one could easily think that Dewey influenced him. His theory situates the learner in an active role in her education and the teacher as the one who provides the experience for the learners to explore and discover her interests. Osborne based his assessment of his students on ''inherent interest of the subject'' believing that ''once captivated by the subject, a student needs to be held back rather than pushed forward!'' (Osborne, 1927b, p. 309). During his years as a professor of comparative anatomy at Princeton University, Osborne stated that he had practiced creative methods before he thought it into theory. He taught experientially and used objects in the classroom to demonstrate concepts—he taught the way he best learned. It was through his reflection on his own learning and teaching that he realized that the basis of education was built on seven principles which are essential to the ''creative and productive mind,'' truth, beauty, learning, observation, reason, expression, and production. ''The principle of seven cardinal elements of education is my own,'' he stated, ''it is the product of fifty years of experiment and observation as a teacher, not by reading what other people have written about education'' (Osborne, 1927b, p. 311).

Osborne saw the Museum as a great silent teacher, ''...every specimen, every exhibition, every well-arranged hall speaks for itself'' (Osborne, 1927b, p. 240). During his tenure, he placed an emphasis on exhibit design and hired artists and sculptors to express the beauty found in nature in the Museum's halls. He described a successful museum teacher as ''one who is able to teach without speaking, as nature teaches, or as art teaches'' (Osborne, 1927a, p. 235). Louis Agassiz, a Swiss scientist greatly influenced Osborne in his theory.

He often quoted one of Agassiz' favorite mottos: ''Study Nature not Books.'' Osborne's professor of comparative anatomy, Agassiz believed that his students should make all of their direct observations on a specimen *first* before consulting a teacher or textbook. Osborne transferred this philosophy to the Museum where he paid great attention to the arrangement of the exhibits and the halls so to inspire people in the way that he believed nature did, and to encourage people to study nature further. Osborne saw his exhibit designers as educators, and the exhibits and halls as the strongest part of the visual instruction method of the Museum. He wanted the Museum to be a place to ''bring a vision of the world to those who otherwise can never see it'' (Osborne, 1927a, p. 244). Osborne made exhibit design, and school and public instruction central to the job and functioning of the Museum.

In 1926, over 170,000 students and teachers attended lectures at the AMNH. As a part of its intramural activities, these lectures provided a valuable resource ''designed to supplement the work of the classroom teacher, not to replace it'' as Sherwood mentioned on numerous occasions (e.g., Sherwood, 1924). Using the New York City public school curriculum as a guideline, these lectures were designed for elementary students and dealt with topics primarily in history, geography, and natural science. They were illustrated with the lanternslides and corresponded, whenever possible, with exhibits at the Museum. Upon questioning the value of the courses, Sherwood found through testimonies from teachers that they were truly valuable. One teacher even asked for the unused lecture programs, which she distributed to her students who took them home. This sparked parents' interests in the subject matter; one mother commenting that the Museum lectures so inspired her children that they could not stop talking about them and consequently ''they all gathered around the table at home to read the story books based on the Museum lectures'' (Sherwood, 1927, p. 331). For the high school students, special lectures were given during Regents' Week on biological topics after which the students were sent to the exhibition halls with questionnaires for further study.

Through a special endowment, the Museum dedicated a special branch of its work for the education of blind students in the New York City public schools. Under the guidance of a special Supervisor for the Blind, the Museum's visual education program was adapted to the needs of the students, who had the opportunity to listen to lectures and touch specimens from the nature study collection. ''The results from this work are gratifying,'' Sherwood (1924) wrote, ''often they are read in the children's happy faces.'' The children's delight also was evident in their essays based lessons at the AMNH. One teacher wrote of the impact the trip had on her students:

> Children of little experience in life and meager opportunity for general information speak with ease and familiarity of animals, birds, people and customs. You can scarcely realize to what extent you are broadening their horizon. (Sherwood, 1924, p. 272)

This era of expansion saw the Museum's resources become widely available to teachers, and students, inclusive of those who were not able visit the Museum. Recognizing the value of the Museum's service to schools, in 1909, the City's Board of Estimate and Apportionment designated funds, which provided for the construction of the School Service Building to provide facilities for organizing the Bickmore slide teaching collection and film distribution services and space for classroom work and other intramural activities. The building, according to Osborne, provided the means to accomplish the chief public mission of the Museum, ''to bring the wonders and beauties and truths of Nature from every land and every sea, to exert their broadening and uplifting influence'' (Osborne, 1922, p. 3).

Children of little experience

Early education programs focused on recreating experiences with nature for those who were lacking in opportunities to get out and see it for themselves. It appeared that early Museum educators and leaders viewed urban life as uninspiring, and fraught with cultural deprivation and viewed themselves in the superior position of being able to provide poor urban students with the experiences they were missing. Photos from this era often depict poor and immigrant students utilizing the Museum's nature study programs. Figure 3 shows a group of underprivileged ''children of little experience and meager opportunity for general information'' (Sherwood, 1924)—a group of mostly African American students observing objects of nature. Viewing the children as culturally deprived, the idea was that these students would be uplifted through having the experience of seeing and touching these natural objects. There was little idea of them interacting and bringing their personal experiences to bear in their interactions—according to the Museum gentry at the time, these children did not have any valuable personal experiences.

The example of Johnny and ''signs of spring'' from the previous section clearly devalues students' lived experiences in comparison to the view of nature that the Museum had to offer. Johnny's practical knowledge of signs of spring (swinging doors on the saloons) was subjugated to the daffodils and frogs present in the nature poem. For Johnny's urban life, he did not need to know about nature's signs that spring has arrived for it had no bearing on his day-to-day experience. Knowledge of daffodils would not impact Johnny's survival, although it may give him an alternative (though not necessarily superior) view of what spring means.

Visual instruction and observation were prevailing themes in the programs outlined in the Museum's early offerings for schools and teachers, however it was assumed that students and teachers would be enlightened and learn just from being able to see the objects. There was no notion of learning with objects as an interaction between the viewer and the objects and less about the social interactions that occur and mediate learning in the museum setting. Osborne's philosophy of creative education came close to personalizing the museum experience, however it fell short in including the interactive/participatory aspect of learning. It was his assumption that nature would inspire and this inspiration would lead to learning.

Fig. 3 Children studying nature at the Museum. © The American Museum of Natural History

Education in the museum: The present decades

In a 1911 address to an audience of schoolteachers of New York, Osborne stated, ''the future ideal for the Museum is to provide at no cost a little journey on this planet and among the heavens beyond it'' (Osborne, 1927a, p. 268). Today, the Museum has grown in both size and scope from its early decades of educational programs for students and teachers. With the openings of new halls, such as the Hall of Biodiversity and the Hall of Planet Earth, the Museum endeavors to put the public in contact with cutting-edge scientific discoveries. While the basic pedagogy of learning with objects remains intact, recent research about learning with objects and in museums has great bearing on how the information in the halls is presented to schools and teachers. It is now understood that it is the *interactions*—that of the object and learner, between learners, and of the learner and the space—that make the learning experience in a museum unique and motivating.

A primary focus of the present years has been to educate teachers on how to use the resources of the Museum for teaching and learning. In agreement with Rennie and Williams (2006), teacher education in the Museum now affords teachers gaining an understanding of ''science as a process of building explanations about natural phenomena,'' (para 3), however it falls short on presenting science as culturally contextualized. Nonetheless this way of thinking about teacher education in the Museum enables the teacher to move from being a passive recipient of the Museum's resources/knowledge to an active participant in the Museum's education community. As a participant in the Museum's professional development, a teacher is positioned to become familiar with the Museum's schema and resources and thus to feel confident in her ability to use the Museum as a resource for her classroom and her own learning. The Museum becomes a source of identity creolization as a teacher develops a hybridized culture of museum and classroom-based teaching and learning. It is this notion of teachers as partners in education (rather than recipients of a service as in the Museum's programs of the founding decades) that have shaped the current relationship of the Museum to schools and teachers.

An era of partnerships

Partnerships put the Museum's education goals in a position to be transformed by the schools and classrooms that it aimed to serve. The Museum could no longer silently teach but rather museum educators would have to extend and transform their practice to suit the needs of the classroom by developing programs that were responsive to classroom standards and assessments. Additionally, the Museum had to be receptive to the different cultures that students and teachers bring to the Museum, which included home and classroom cultures. The Museum educator's role would be to mediate (rather than interpret) the learning that took place with objects and in the halls. Partnerships afforded an exchange of cultural resources between the Museum and schools—the Museum's artifacts, scientific and human resources were exchanged for the school's resources of curricula, learning standards, and extended contact with teachers and students. The Museum's Director of Professional Development noted,

> Partnerships with schools give us, as a museum, the opportunity to really understand how a museum can help schools. We deal with the standards and assessments that are guiding schools so we are more connected to what schools need and do. It teaches us how we prepare ourselves to really help schools over the long haul. We are looking for evidence that we can actually do things for schools.

By paying attention to the needs of students and teachers in the partnerships, the Museum was afforded the opportunity to transform its teacher education programs.

The museum school—the first partnership

In the 1992/1993 Annual Report (AMNH, 1994), the Museum's education department stated, ''major objectives that underscore the department's systemic change initiatives are improving teacher education in natural history, thereby facilitating an understanding of scientific endeavor'' (p. 63). Use of the word *understanding* in this statement indicates that the Museum as an institution realized that it has to do more than just present content. As a facilitator (rather than silent teacher) the Museum community had to engage/initiate learners in the practice of science thus facilitating an understanding of science as a process and not as a static entity. For teachers this meant allowing them access to the culture required to effectively access and appropriate the Museum's resources as teaching tools. Additionally, the Museum would have to recognize and accept the value of the experiences that teachers and students bring into the Museum. The era of partnerships began to change the structure of both the Museum and the schools. Through partnerships, classroom teaching became a part of the schema and resources of the Museum. Teacher education focused more on teaching teachers how to adapt the Museum's resources to their classroom needs rather than the didactic method of presenting information about the objects.

With this stated goal, the Museum began its partnering relationships with public schools. The first initiative was dubbed The Museum School, which was formed to ''create a unique inquiry natural history education model for middle school students and their teachers'' (AMNH, 1994, p. 63). This initial partnership included 90 6th grade students and 18 teachers from several of the public middle schools in the community district where the Museum is situated. Teachers in this partnership collaborated with museum educators on creating units that were museum-based and connected to the learning standards and lesson topics for middle school. Classes in this partnership experienced ''weekly museum sessions using constructivist and cooperative learning theories to investigate intricate natural science concepts'' (AMNH, 1994).

The museum as an extended classroom

The Museum School was a partnership with AMNH and several schools whereas the New York City Museum School (NYCMS) was a partnership with one school and several museums designed to take advantage of an array of museum resources in the City. According to the co-founder of the school, which was established in 1996, the NYCMS was designed ''to take full advantage of museums, both as classrooms and models of learning environments with a goal to equip students to be lifelong learners.'' The partnership with AMNH was meant to strengthen the science portion of the program. It was unique at the time in that it was based on a module system that allowed classes to spend an extended period of time in the Museum on a particular topic, affording an in-depth study of science. The collaborating museum educator described the mission of NYCMS as ''to give the students the opportunity to visit the Museum and have an extended period of observation. To synthesize, question, research—the goal is just to provide an alternative opportunity to learn a curriculum—using the galleries and resources as an extended classroom.'' The collaborating science teacher added that the goals were ''to get all

students [including a wide range of income and ethnicity] interested in the Museums and to get them excited about learning in museums—learning and being there. Black kids from the projects etc. To get the whole range excited in learning about the Museums and learning in museums.''

Cultural enactment in the museum and in the classroom

The culture associated with practices in a given field can be enacted in other fields. Hence, partnerships between the Museum and school afford the exchange of culture. Collaboration between the Museum and the school was key to the success of the partnership, which enabled the exchange of schema and practices as museum and classroom educators became efficient agents in both fields. With the partnership, museum educators and school-based educators worked in each other's cultural fields, enabling the exchange of capital and schema that subsequently transformed their respective fields. The Museum educators and teachers also demonstrated a cultural hybridization in being able to effectively access and appropriate the resources of the classroom and museum fields at once. A Museum educator in the partnership noted, ''any time you are in a collaborative experience you will pick up ideas. Everything is collaborative and has played a big role in my pedagogy ... played a significant role in my growth as a teacher.'' The collaboration between teachers served as a model for students as they collaborated with their peers on projects. The collaborative nature of the partnership enabled both the teachers and students to create spaces where discussions and interpersonal interactions were central to learning science.

Importantly, the classroom teacher and students in the partnership received the symbolic capital of a museum identification badge that allowed free access to the Museum and special exhibits. The identification badges marked them as members of the Museum community—an integral part of the Museum's education structure.

A new field of museum-based resources for schools: Urban Advantage

With the two Museum/school partnerships the Museum's structure shifted to become more responsive to the needs of schools as it became an extension of the classroom (and the schools became and extension of the Museum). As teachers changed the Museum, the Museum moved to a position to be able to have more of an impact on teachers and classroom teaching. The most recent museum partnership, called Urban Advantage, demonstrated evidence of the mutual growth and exchange of resources between the Museum, teachers and schools, and the other partner science-rich institutions.

The Urban Advantage initiative was a response to the need to strengthen science teaching and learning in New York City's public schools. The dismal 2004 *Lost in Space: Science Education in New York City Public Schools* report by The Council of the City of New York (2004) cited a number of problems adversely affecting science education. These included too few qualified science teachers, secondary schools doing a poor job of teaching science, insufficient science facilities in the school, science education not being a high-profile, high priority issue, and outside resources not being used effectively. With minimal opportunities for science professional development and minimal support for science and science education, science in the City had become a reflection of the deficits that already existed in lower income urban areas—a picture of struggling schools, struggling teachers, and struggling students.

Recognizing the need to strengthen science teaching and learning across New York City, the City Council allocated money to AMNH to plan and facilitate a partnership between the New York City Department of Education and eight of the City's science rich cultural institutions—AMNH, Brooklyn Botanic Garden, New York Botanical Garden, New York Hall of Science, Queens Botanical Garden, Staten Island Zoo, Wildlife Conservation Society's Bronx Zoo and the New York Aquarium. Ironically, many of these institutions are situated in some of the city's most struggling school districts. This initiative was meant to increase equity and access to quality science education for the city's schools and students. As the name implies, this initiative was created to afford students access to the resources of these science-rich institutions and to expand the science resources available to New York City's public schools. The Urban Advantage initiative created a new field that afforded system-wide impact on science teaching and learning.

The Urban Advantage initiative was structured around an 8th grade assessment known as the Exit Project, which is a long-term science inquiry project that students complete for successful completion of middle school. Urban Advantage provided teachers with 50 h of professional education on using the cultural institutions to do Exit Projects with students. The initiative also provided science resources for teachers and students to extend their scientific research into the classroom.

Researching teachers learning to use museum resources to teach science

While most of the research around learning in museums has focused on individuals and family groups learning in informal settings, less has focused on school groups as units of analysis and even less has focused on teacher education in these learning environments. As a manager in the Urban Advantage initiative, I had the opportunity to work closely with a group of teacher participants called the Urban Advantage Lead Teachers. This position enabled me to expand the dialogue about the roles of museums and similar institutions by exploring the impact on the professional lives of participating teachers of a teacher education program enacted in a museum setting. Viewing teaching and learning to teach as cultural practice, I examined the experience the Urban Advantage Lead Teachers as they transformed their identities as science teachers to include out-of-classroom experiences in their teaching toolkits and create displays by re/producing the museum-based culture of objects and display in the classroom. Using critical ethnography as my lens and methodology, I aimed to reveal the social and cultural issues around using new resources to teach science and re/produce a leadership identity in science education within the structure of schools and the Urban Advantage initiative.

Violet, one of the Lead Teachers, emerged as a central participant in my research. Teaching in a school in the community were I was raised and currently live, I was interested in learning how her participation in Urban Advantage impacted her students and her school. Using the sociocultural constructs of identity and cultural creolization, enabled me to describe Violet's experiences in terms of the agency(structure dialectic. It also enabled me to view learning to use new resources and learning in new fields as a process of hybridization—taking on new cultures and identities—to create a creolized culture and/or a creolized identity. This was especially evident as I traveled with Violet between the Museum and her classroom while she was undergoing a process science teaching identity transformation while changing the structure of science teaching and learning in her school.

Creating a structure for science teaching and learning in a high-needs middle school: One teacher's enactment of museum-based pedagogy

The bathroom pass

While Violet was using PowerPoint to teach her students how to organize what they had learned from their research, a student raised his hand and asked for a bathroom pass. ''Write one out and I will sign it,'' Violet responded without missing a beat in her lesson. The student asked a peer for a piece of paper and she ripped a page from her Urban Advantage journal. When he presented the teacher with the pass, Violet abruptly stopped teaching. ''That is disrespectful! Urban Advantage gave us these resources and with Ms. Adams standing here you are going to use that paper for a bathroom pass?'' Embarrassed the student tried to explain that another student gave it to him (in true middle school fashion the young girl giggled because her peer was in trouble). ''You will apologize to Ms. Adams right now!'' The student apologized and sulked in his seat as Violet resumed her lesson. To Violet, these resources, especially the journals were sacred objects (Collins, 2004); they were imbued with the practices—observing, journaling, and keeping a science notebook—central to science inquiry in the cultural institutions, and sacred to the Urban Advantage community. To the student it was just a notebook to be used to meet immediate needs, in this case for access to the bathroom. However, to Violet the journal was a valuable science resource. The journals became central resources in Violet's class and to me their use was symbolic of the creolization of Violet's science teaching practice that happened over the year. Keeping science journals or notebooks were scientists' practices that were emphasized in Urban Advantage professional development sessions. Scientists use similar notebooks to document their insights and research processes. Teachers saw examples of scientists' journals and were encouraged to keep their own journals during the professional development as they learned science content and did their own Exit Projects. The journals and the resources were pieces of the Museum and pieces of Urban Advantage that became a part of the structure of Violet's classroom.

The pre-existing structure for science

Central Brooklyn Middle School is designated as a ''high needs'' school. In ''high needs'' New York City schools students tend to be of a lower socioeconomic bracket, black and Latino, with many not reaching mandated levels in math and reading. According to Violet and other teachers that I met from the school, much of the instructional focus was on the literacy and math assessments, leaving science as a low priority in the school. The minimally used lab with broken chairs, excessively scratched tables, and busted archaic random equipment were a testament to the neglect of science. The lab had the appearance of an old abandoned factory in an economically failed mill town. At the time, this was the only usable lab in the school. ''There are two other labs, but I have never seen them and they are not used,'' Violet pointed out.

''Most of the time this lab is empty.'' Violet commented, as we looked at the small whiteboard in the front of the room with a schedule grid that included the names of teachers and the periods that they were scheduled to use the lab. The lab had eight blacktopped tables each accommodating 4–6 students comfortably. It was a good set-up for group work, so Violet used the lab for lab activities and for her students to do group work on their Exit Projects.

Besides Violet's class, I only saw the lab actively in use once. This was during the 8th grade science practical exams. The lab was set up in stations weeks before so that the students could practice the assessment skills and sit for the exam. This was in early March, and during subsequent visits up until late May, the practical exam was still in place, although the implementation of the exam was complete.

In contrast to the lab, by May Violet's science classroom had evolved into the place that she dreamed of with working stations, displays, and student Exit Projects placed around the perimeter of the room. A door separated Violet's science room from the lab and that same door separated two contrasting views of science in the school. On Violet's side of the door science was a practice, a skill or way of thinking that could be used in life. ''I want the students to see science as everyday life. They could use scientific thinking to solve everyday problems,'' Violet said when talking about her perspectives on teaching science. The resources were always present, reflecting Violet's view of the ever presence of science. The contrasting view in the lab was a hidden or forgotten science only to be revived when it is a priority. In this view it was not a central practice of living or thinking, but a subject that was only as important as the mandated assessments made it. The lab only became an active lab in response to the exams.

Re/creating a structure for science teaching and learning

''We will have science in this school.'' (Violet personal communication, 1/4/2006).

Violet had a vision of science becoming central to the practice of education at Central Brooklyn Middle School, ''my dream would be to see every student at Central Brooklyn Middle School as a scientist.'' For her students and for the school, Violet wanted her homeroom to be a space that would be safe for students to learn and engage with the science resources and a place where the resources would not get vandalized.

''This is where I would like to put the resources.'' Violet opened some empty overhead cabinets above the counter with plastic baskets of books, videos, and other science curricular materials. It was Violet's desire to create ''a place where students could come and do projects,'' and display them once they are done. Violet's classroom, which was also a sixth grade homeroom, had evidence of her efforts to bring inquiry-based science to the school. Amidst the literacy posters and rubrics, Urban Advantage science resources were waiting for their chance to be prominently displayed; waiting to be moved to a central space in the instructional schema of the classroom. The Growlab^{TM} was in the back of the room set up with plants that Violet received from the botanical garden during a recent Lead Teacher meeting. On the right side of the room, there was a little station set up with two Petri dishes—one containing a dead beetle and the other a dried maggot. She had the students use the dissecting microscope to observe these specimens and draw them in their notebooks. On the same table, there were two jars—one with a brownish fluid and the other with water plants (also from the botanical garden)—set up to be an observation station. It appeared that the Urban Advantage resources were the only science resources in the room. Violet was proud of her classroom and the resources she had displayed. She also knew that she wanted this room to be *the* science room.

''I wanted the students to have something to observe and write in their notebooks,'' Violet wanted to start the year off with implementing key practices of scientific inquiry in her classroom—observation and recording—so she used the dissecting microscopes that she received during the summer Lead Teacher workshops to set up the mini observation stations in her classroom. These resources—the microscope and the journals—and Violet's

knowledge of using them began to change the structure of her science teaching to include active inquiry-based participation thus reflecting the hybridization of the practice of science in the Museum with her classroom science practice.

Violet's participation in the Lead Teacher group afforded her access to resources that gave her the impetus to transform science education in her school. With Urban Advantage, Violet had access to resources both physical in the form of science equipment and human—my relatively frequent presence in the school affording her a resource and a connection with the Museum. She often introduced me to her colleagues and students as the one who brought Urban Advantage to the school. In addition, as a Lead Teacher, she became a member of a community of teachers whose focus was to build strong science education structures in their schools. Violet agreed that visiting the other teachers' classrooms during Lead Teacher meetings ''gave her ideas and encouragement to work on the demo classroom.'' Her finished classroom was the physical representation of her participation in the Lead Teacher community of practice as it contained certain aspects of the inter-visitations and her work with the Museum. Through her association with the Museum and the Lead Teacher group and knowledge of setting up a science classroom, Violet was empowered to advocate for her classroom to become the room dedicated to science in her school.

Setting up the resources

> There was some more discussion about the demo classroom. It was agreed that depending on how it was set up some students would be allowed to use this class [room] for particular lessons. The Principal was also trying to obtain some computers for the room. It is left up to me now to have the room ready for use. I have used up two Saturdays to start fixing it. Seems as though I would have to do this for a few more weeks because it is difficult to work on it during the regular school week, however it has already shown signs of development.

Violet reported to me in an email. When I visited the school shortly after this email, I saw the signs of development. Posters depicting the Solar System and a chart listing the steps of the scientific method replaced the literacy posters (see Fig. 4). Student literacy essays were replaced by chart paper listing students' questions gathered from a recent trip to the Museum. Many of the resources were moved out of the closet and on to the counters around the room.

Fig. 4 Solar System and Earth science displays on the walls

For example, using milk crates, she set up a mini cabinet of curiosity (see Fig. 5). Included in this ''cabinet'' are both objects that she collected and some she received from one of the zoos. These cabinets were one of the diasporic artifacts created by the Lead Teachers and markers of their community, as it seemed to identify them as object/inquiry-based teachers. The cabinets were hybrids of museum display and classroom resources. A member of this community, Violet recreated a similar cabinet in her classroom.

For Violet, the science equipment not only represented resources, but symbolic capital in that it associated her with Urban Advantage and the Museum. She greatly valued the resources and valued a place to put them. She also valued being associated with having and using the resources in her classroom as it demonstrated that she was an inquiry-based teacher. Violet was able to re/produce a structure for inquiry-based science in her school and advocate for students' use of the classroom. This activity re/produced her identity of being a ''kind of teacher'' that wanted her students to be active participants in science learning—an inquiry-based teacher.

Extending the science resources to the school

''There is a need for science teachers to get together and make science work for the school'' (Violet personal communication, 10/17/2006).

As the afternoon sun cast the steel grate shadows on the floor, Central Brooklyn Middle School science teachers gathered in Violet's homeroom for after school professional development and to share the grapes, cookies and beverages she provided. Once teachers had their cocktail plates filled, Violet began the meeting by describing Urban Advantage as, ''a great opportunity and I think we need to take full advantage of it.'' She gave each teacher a carefully prepared folder with informational documents about Urban Advantage and two inquiry-based worksheets, one of which she received during an Urban Advantage workshop. While she went through these documents, the teachers were quietly following along referring to the same documents in their folders.

Violet invited me to this meeting in support of her recruiting more teachers in her school for Urban Advantage. To her, I was a resource one who brought cultural capital—in the form of knowledge of and access to the Museum and Urban Advantage—to Central Brooklyn Middle School middle school.

''Now I must show you some the things that we have from Urban Advantage and they are not only for Violet Williams, they are for the school. These are here for your use.'' Violet

Fig. 5 Objects for observing

moved to the part of the meeting where she introduced the teachers to the Urban Advantage resources. It was clear that although Violet had the resources, she wanted the other teachers to make use of them. This intention goes back to her personal mission of bringing science back to the school. Violet's possession of the resources and her capital in being able to use them put her in the position of changing the structure of science education in her school. As Violet continued to take out the resources, the buzz around the room increased:

Female teacher: ''Where did you get all of this stuff?''
Violet: ''That's how good Urban Advantage is''
Male teacher: ''You 'ear the word advantage...''
Violet: ''...yes its taking advantage of the science institutions...
Male teacher: ''...exactly...''

When I reviewed the video of this event, Violet showing the resources was clearly the highlight of the meeting. The conversation and noise level increased and there was positive energy generated around the idea of having access to the assortment of science resources presented. Laughter and joking increased and as the above exchange demonstrated, joking around the word ''advantage'' in Urban Advantage created a moment of solidarity amongst the science teachers—indicated by group laughter that collectively increased and subsided—at Central Brooklyn Middle School. On an unconscious level, Violet was addressing her goal of bringing teachers together to make science work for the school. The teachers were excited about having access to resources and four of them signed up to be part of Urban Advantage.

To use museum descriptors, Violet was the curator of the science resources in the school. This put her in a position of power, something that I did not feel she was comfortable with at times. For example, when an issue arose with the sixth grade teachers participating in Urban Advantage, Violet was more than happy to have me explain to one of the teachers why they were not able to receive the full resources. ''I do not want them to think that I am keeping anything from them,'' Violet mentioned. She was happy to have the resources for the school, however she seemed conflicted about having the power that came with having the resources. Perhaps also adding to Violet's discomfort was that since she was relatively new to the school she probably wondered what other teachers thought about her getting all of the ''stuff,''—if there would be feelings of resentment or jealousy. This would contradict her goal of building solidarity amongst the science teachers for science at Central Brooklyn Middle School.

The established room

''The science classroom will be extended to all science teachers and science students. It is expected that we will all benefit from it,'' Violet proclaimed in one of her emails to me. The classroom finally established its place as central to science teaching and learning at Central Brooklyn Middle School. During one of my last visits to the school in 2006, I got to see the completed classroom. Since it was late in the term and some of the resources had been packed away, I did not get to see the room as fully set up, but there was evidence that it was an inquiry-based science classroom.

Student projects decorated the perimeter of the room and there were several student artifacts—two terrariums demonstrating global warming, beakers filled with crystals from a crystal growth experiment and ginger plants placed around the room alongside their corresponding projects. For me, these projects were evidence that Violet's students were

learning alongside her as she was learning alongside the educators at the Museum. She was becoming creolized with the practice of using objects and creating displays for science teaching and learning, as were her students. One of the projects pictured in Fig. 6 utilized resources that were purchased through Urban Advantage (the fish tanks). The theme of the project, ''global warming'' was one of the topics covered in the Museum. These students became very interested in global warming after learning about the topic from Violet and viewing exhibits addressing climate change in the Museum. They created their own demonstration of global warming—their visual display of a science topic.

Another project utilized the resources and project idea from the botanical garden (see Fig. 7). The student grew three common plants—an avocado, ginger and tomato—to see how they grew in comparison to one another. In the botanic garden, the professional development included growing plants from foods commonly found in the market. Students using science to learn about their world was Violet's vision of science at Central Brooklyn Middle School and these projects were evidence of Violet's dream coming true.

The remainder of the projects displayed varied in topic from mosquitoes to growing crystals. Violet allowed the students to explore whatever questions they had. It was important to her to foster their curiosity and personal interest, even though she later realized that having such a wide range of topics was difficult for her to manage. However she used all of the resources that she had at her disposal to help her students pursue their interests in science.

Fig. 6 Global warming project

Fig. 7 Growing plants

As the 8th grade assessment covers a variety of science topics, the displayed student projects demonstrated how learning in a variety of contexts supported Violet's teaching and her students' learning across the science curriculum. In the gardens she learned how to do life science studies with plants and at the AMNH she learned how to do field investigations to study the Earth's processes. What Violet learned became a part of her classroom—she created her own diaspora of science by moving in between and learning in different science fields. Violet brought back her diasporic culture into her classroom where she enacted a creolized form of science teaching and learning. This creolization of different science content and contexts in Violet's classroom enabled her students to pursue a variety of science interests and questions. In between the student projects, were some more of the Urban Advantage resources that recently came in and were still in boxes on the counter. True to being a hybridized space of science in an assessment driven school, Violet and her colleagues were using the space to grade the recent eighth grade exams.

My changing identity

My identity changed in respect to interacting with Violet and her students. At times I felt like I resumed my ''Ms. Adams, science teacher'' identity, especially when the students responded to my ''teaching voice'' and when they referred to me by last name (rather than my first name as is the practice in the Museum). However at most times, I was a resource—I came along with the objects and access afforded to Violet through Urban Advantage. Violet was always sure to point out that I was from the Museum and that I was responsible for bringing Urban Advantage to the school. Although I was happy that I was able to ''help'' this school in my community, I felt conflicted in my self-perception as a resource. For me, this is where the issue of race came in. Unfortunately, not many museum educators look like Violet, her students, or me; not many museum educators, or people who come into the school as ''resources'' are of Afro-Caribbean descent.

During my teaching tenure, those who came from outside of the school to provide services and resources for the school were always white—the white not-for-profit types. For many of them, I felt, approached my predominantly minority school with a missionary fervor—they wanted to save the inner-city souls. They would often use the discourse of ''these students'' and describe them as not having access to certain things and experiences. While they were right to an extent—many of my students had never been canoeing or visited a museum, they neglected to acknowledge the rich experiences that my students had that they might have never experienced, such as picking and eating a mango fresh from a tree, being fluent in more than one language, and/or having a culturally rich transnational lifeworld. They did not see value in the capital that the students already had. They approached the students from a deficit perspective—they could offer students the world, but the students had nothing to offer in return.

As a resource from the Museum, when I stand in front of a group of teachers and students of color, I wonder about their perception of me. Do they see me as removed from the community because of my association with the Museum—being associated with an institution that is seen as ''white'' by many people of color? When I reveal my previous teaching experience and/or my Caribbean ancestry, does it make me accepted as a member of the community? Am I viewed as one who is as giving back to the community? At times, these questions make me feel self-conscious when I stand in front of students and especially teachers in Violet's school as I re/negotiate my identities as a teacher, museum educator, museum artifact, and member of the community.

Equity, access, and hidden resources

When I began the research, I painted a picture of Central Brooklyn Middle School as lacking in science resources and using this as an indicator of the ailing structure for science in the school. Violet showed me the threadbare science lab and her science classroom dominated by literacy and math mandates. In addition I was biased by my prior conceptions of Central Brooklyn Middle School as a failing school so I went in looking for deficits and found them in Violet's science lab and classroom.

It was when I had the opportunity to discuss Violet's school with her during a summer museum program (unrelated to Urban Advantage) that I found out that Violet thought that her school was lacking in resources too. She commented ''that's because I did not know about the resources. It wasn't until Urban Advantage start[ed] pumping materials into the school and I start[ed] sharing with teachers, then is when they let me know that 'look, this is what we have.''' The teachers who were in Central Brooklyn Middle School long before Violet revealed to her the resources that were tucked away in the classrooms and closets. Violet previously thought that the only resources that were available to her were the ones that she received from Urban Advantage:

> Now I am getting excited that I'm getting materials to work with, I don't want my classes alone to use these materials. [I] share[d] it with the other classes so that we could get the science going. Then is when I was told that this school has tons and tons of materials. Take for instance the rock samples that we got from Urban Advantage. I carry the rock samples and I show it to them and I said, ''look what we have!'' And then the teachers tell me 'we have a whole room full of rocks.' When I tell you rock, we had thick rocks about this size (gestured with hands)—5 lbs or more.

I asked Violet if the other teachers used the resources and she indicated they did not—''in fact science teachers are seen as 'teachers who teach on their seat and not on their feet'.'' In other words, in her view, the science teachers were not active teachers; they did not use the resources available to make science come alive to their students. The teachers there before Violet were working within a structure that ''played down'' science, as Violet described, so the teachers were not encouraged to create interesting lessons and learning experiences for their students.

> There is one teacher there especially who said he was very enthusiastic when he arrived in the school 5 years ago. [He had] tons and tons of ideas, but everything he put forward was put down. It was put down by administration and then by the students.

The administration did not regard science instruction as important and thus contributed to the weak structure of science teaching and learning. This weak structure and negative attitude became a resource for students to reject any creative science teaching that a teacher would attempt to enact. This left effective science education and resources in the closets relative to the schools' instructional activity.

In spite of coming into this weak structure, Violet maintained a positive outlook on science teaching and learning, she mentioned that she had been doing whatever she could to make the lessons exciting, because ''if the lessons are exciting, the students will want to learn.'' She extended her excitement towards getting teachers to use the resources ''the materials are there, but somebody needs to get somebody excited, and I have a feeling that might be my job,'' Violet laughed. She believed that the science classroom that she had set up would be instrumental in bringing the teachers around. She noted,

> I know that these are teachers who can work but the will is not there. That is why I am hoping that this science classroom that I am given permission to set up and operate this school year, that I could fix it in such a way that the administration will allow teachers to use this room at least for preparation. And if we have a special lesson, say for instance if we looking at the use of the pulleys, we could set up pulleys in the room and have students come to the room rather than have to dismantle them and take them to the classrooms every time. I am hoping that we could do things like that so that teachers could be encouraged. So, for this new school year I am not given a homeroom. I'm given the responsibility to have that room ready. I think we have made strides in that area.

Violet brought resources—physical in the form of science objects and intellectually in how to access the resources in the school and museum to teach science—to the school and through her participation in the Lead Teacher group; she made these resources available to the entire school community to reach science teaching and learning goals. Violet's resources also enabled the other science resources in the school literally and figuratively come out of the closet and become a part of the collection of resources and the individual | collective—evident in the growing school practice of using resources to make science teaching and learning exciting for the science teachers and students at Central Brooklyn Middle School.

Creolizing science

Through my lived experiences and my interpretation of Violet's experiences, science and science teaching is an important part of who we are. Kozoll and Osborne (2006) cite, ''identity becomes inclusive of what a person believes, values and wants to become professionally and personally'' (p. 181). Violet wanted science to become central to each of her student's lives, and my hope is that learning in a museum becomes central to science teaching and learning in New York City's schools. In a reflection about teaching about earthquakes, Violet wrote:

> It is important for middle and high school students to be taught about earthquakes so that there is a well-informed society. Most importantly, students should be taught about earthquakes so that some of them can become scientists to continue studies of earthquakes.

For Violet, the science is key to having an educated and knowledgeable society. Tobin (personal communication, 8/28/2006) stated, ''multi-field enactment demands creolized sciences.'' If we aim to have a scientifically literate society, science has to be taught in ways that allow people to make it their own and enact it in their lifeworlds. Winford (2003) describes ideologies of language as having the ''power not only to shape the way people talk and interact generally, but also to naturalize relations of power and privilege'' (p. 28)—this can extend to the ideologies of science as taught in schools and displayed in museums. Rennie and Williams (2006) define cultural science literacy as ''knowing something about science as a major human achievement'' (para 4). As a major *human* achievement, science literacy should also emphasize that science is culturally bound, produced by different cultures (not only the West), and in different historical contexts. In classrooms such as Violet's where students are encouraged to learn science in different contexts and in social groups, a space could be created where students could use their own understandings of the natural world and their own language to engage in science. This creolization of science as it happens in the classroom has to move out and begin to creolize

science as practiced, interpreted, and displayed in the labs and institutions so that science becomes more accepting of the notion that there are multiple ways of seeing and interpreting the natural world and goes beyond the idea that the Cartesian-Newtonian ways of seeing and interpreting the world are the only reality worth discussing in academic settings (Kincheloe, 2001, p. 475). Furthermore, as science educators, we can acknowledge the creolization of science as it happens in ourselves and in our practice. This would enable us to recognize the creolization process as we teach others to teach and learn science. We could create structures that allow students to access and appropriate scientific knowledge in ways that encourage the process of hybridization and enable students to see science as a part of their everyday life experiences. Using beyond-the-classroom resources, such as museums, zoos, and botanical gardens is one way of allowing teachers and students to learn science in different fields. This affords them the experience of producing a new creolized culture of science that is responsive to their identities.

Full circle

It seems as if the Museum has come full circle in its offerings to schools all within the scope of its mission of encouraging and promoting the study of natural science. While the early museum's program served individual schools and teachers with its menu of lectures, and collections-on-loan, it did not become involved in whole school efforts until the 1990s. In doing so, the Museum has had the opportunity to participate in multiple fields—that of the school and that of other cultural institutions—thus expanding and changing the Museum's *service* to schools. For me it is interesting to note that in early literature from the Museum, the Museum's relationship with schools was always described as a ''service.'' This implied that it was a one-way provision of resources that only benefited the school and that the Museum received little to no benefit from the exchange. This possibly transfers to the previously mentioned notion of the Museum-as-a-resource rhetoric that is often used by educators and the Museum in reference to its relationship with schools. From doing this research and reflecting on my own experience as an educator on both sides—formerly the school and presently the Museum, I have come to realize that historically and presently, the Museum had as much to gain from its relationship to schools that the schools had to gain from the Museum.

Through the decades, the relationship between the Museum and schools has fostered a sharing of cultures between the two fields. People—agents in each of the fields have had to participate in the activities of the other and resources—e.g., objects and curricula have diffused across the porous boundaries. This diffusion has enabled educators, museum educators and in many cases museum scientists to effectively participate in both the Museum and the school fields. From its early relationships with schools to recent partnerships, the Museum has been transformed. Through intimate knowledge of the needs of the school, partnerships have enabled the Museum to become more an effective resource for the teaching and learning of science in the city. The partnerships have created new understandings of what urban science learning is—effectively using the resources of the city (schools and cultural institutions) to facilitate and improve students' access to real science experiences.

Museums change as new culture gets enacted; in the case of Violet and the other Urban Advantage Lead Teachers, culture that teachers brought to the Museum changed the structure of the Museum to meet the classroom enactment needs. Although museums tend to lean towards tradition, especially those with many decades of history, it is important that museums are responsive to the culture that teachers bring into the Museum, if museums wish to stay active in and relevant to school-based science teaching and learning. Museums

should aim to create effective partnerships between the scientists in the Museum, museum educators, and the science educators that come into the Museum to use the resources to enact science teaching and learning. In an effective partnership, all stakeholders are transformed as a result of learning and practicing together and there is an emergence of a new hybridized culture that includes aspects of all of the stakeholder groups' cultures and meets the collective needs of the partnership. In addition, it is important that teachers' knowledge does not get subjugated to the scientists' knowledge; that all knowledges are recognized and given equal credence in creating partnerships that connect science in the Museum to school science.

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FORUM

The historical context of science and education at the American Museum of Natural History

This forum consists of two commentaries—authored by Rose Pringle and Bronwyn Bevan, respectively—on the feature article by Jennifer D. Adams who, in turn, responds in a rejoinder. Information on how to reference the commentaries and the rejoinder is provided in footnotes.

Museum, history and science education: extending the conversation

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Abstract In responding to, *The Historical Context of Science and Education at the American Museum of Natural History*, I describe the nature of my experiences that has impacted how I view historical images, especially the depictions of people of African descent in subservient roles. Cultural celebrations on a national level of historical events have the potential to be both informative and transformative because history in itself can lead to learned hopelessness. In my deliberation, I note that the museum contains a wealth of cultural and scientific knowledge but unfortunately, it still operates as a place where the dominant culture persists. As the museum seeks to transform its role as an educational resource to complement science teaching, I posit that this museum educator because of her cultural and symbolic capitals is poised to positively impact education among urban populations. Also, as the museum ventures into professional development for teachers, I question the nature of the partnerships being developed, and the teachers' impact on the ideologies espoused by the museum. My suggestion is that to be successful, the experiences provided in these partnerships should not minimize the importance of assessment and accountability measures used to gauge teachers' effectiveness.

Keywords History · Museum education · Culture · Science education · Professional development

Introduction

In her article, Adams reviews the development of science education at the American Museum of Natural History (AMNH), discusses the impact of museum-based resources on learning science and culminates with a case study that depicts current practices in regards to teachers' professional development. An important aspect of Adams' paper is her use of sociocultural constructs and her focus on the role that identity plays in learning that occurs during a museum visit. This was extended to include possibilities for transformation that

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can be afforded during museum–school collaborative efforts among population of teachers in urban schools. The writer's cultural history and positioning, provides the framework for the extensive critique of the museum's historical context, and in her introduction, reveals her feelings as she discusses the disparities in the display of race and their relevance to her practice as a museum science educator. This initial discussion provides the framework for understanding not only her perspectives of the museum's history but also how she, a black female, museum science educator constructs her role in providing greater access of the museum's resources.

Same issue: different lenses

The writer's level of discomfort was clearly expressed in her description and accompanying discussion of the statue adorning the entrance and the murals displayed in the museum. She writes, ''I do feel personal oppression when I look at some of the ways that people of African descent are depicted and interpreted in the museum.'' Although I have not been to the AMNH, I have seen other visuals representing aspects of America's history at other public places. In most cases non-whites are presented in varying degrees of subservience in relation to their white counterparts. Such representations are not only restricted to photographs and other visuals but one only has to look at films made in the early 20th Century and the casting of the roles in relation to actors of different races. Rarely were blacks acting in roles other than as servants of one kind or another—a reflection of the era? I agree with Adams as she writes that these images represent the ideology of the era of imperialism and colonialism and supposedly (emphasis mine) racial superiority. However, I question the extent to which visitors to the museum who are of African descent would consistently look to the historical artifacts and other exhibits for confirmation of their existing or current identities. I am of African descent and my experiences of being born, raised and educated outside of the American continent have allowed me to have other perspectives in relation to history and the legacies of being of African descent. I am not desensitized to images that portray my ancestors in subservience but in my repertoire of experiences, I can construct them for what they represent—images of the past without neglecting the future. History is on going and should never be dismissed. If we do, it is made more convenient and beneficial to those in positions of power. What is of great concern for me, as a 'voluntary immigrant' is my observation of the disparities that abound in 21st Century America that are attributed to issues of power and racial dominance. The history of the museum and the current effort to reinvent itself as a democratic, cultural and science learning institution epitomizes the struggles that abound.

I bring to this discussion a set of experiences that include consistent dialogue and re enactment of my ancestral history through plays, poetry, music and dance. For me, those events were a glorification of the richness of my African heritage and the strength, courage and tenacity of a people who were enslaved in strange lands against their will. From as early as 1st grade, educational experiences included an exposure to the study of historical events as part of the national curriculum. But history was not only a subject in school. As a people, our past was not encapsulated and preserved in only images such as the one described in the paper but we were exposed to a number of sociocultural experiences that celebrated our history in forms that have allowed us in some sense to move forward. These depictions were not fixed in forms and frozen in history but represented the changes that have occurred from enslavement, indignity and subservience through to empowerment and individual responsibilities. Each year, on a national level, these themes formed the

foundation of our cultural celebrations and gave credence to the contributions of our African ancestors and their efforts to overcome the adversities of their time. As I reflect on these experiences, I am reminded of the expression that to surmount the situation of oppression, people must first critically recognize its causes, so that through transforming action they can create a new situation which makes possible the pursuit of a fuller humanity that has the potential of transformation (Freire, 1993).

On a personal level, the cultural celebrations were both informative and transformative. They afforded an understanding of historical structures that helped to develop a level of critical consciousness that was potentially liberating and educative. I describe them as educative because they fostered a certain level of understanding of historical events that could either offer constraints or be translated into a call for positive action. But they were really deliberate attempts to prevent us from adapting to the structure of domination. History can lend itself to learned hopelessness. This can happen if one does not effectively attend to the racial experiences and the critical interaction between historical contingencies, culturally defined experiences and political relationships (Bartlett & Brayboy, 2006). My upbringing in the Caribbean has therefore allowed me a certain sense of openness about historical occurrences. Yet, I feel the pains that must have been felt through slavery and other dehumanization experiences. I also feel personally affronted when these historical effigies are presented in 21st Century America as fixed structures and are not balanced with achievements of people of African descent. What is challenging for the author is not only confronting her positioning in the time and space as a museum science educator but the extent to which insights garnered from her research can impact the level of conversations about the role of the museum as an equal opportunity learning resource.

Today, it is unfortunate that in preserving and displaying the wealth of information about the past, the traditional role of the museum as a place where ideologies and power of the dominant culture still remains. The artifacts are presented in forms that allow the visitors minimal interactions beyond the visual. In fact, what the visitors see is the encapsulated scientific information and history appearing to stand still. This leads me to question the extent to which museums can or will ever be described as democratic places that are ''liberating.'' I would therefore offer the following that as a museum educator the writer is poised to champion its cause as an important part of urban teaching and learning toward personal empowerment of all participants. This championing should include education about the past in a form that shows a level of development and the process culminating in the hailing of current achievement and identities. I would also hasten to suggest that with the technologies available, those fixed images should remain but be part of a dynamic display. This display should show the range of accomplishments along the historical continuum in which other peoples have overcome the odds to achieve equal status and there are now new roles—the thought of a statue of a black army general commanding the American troops!

Museum education through the ages

Adams provides a rich description of the historical antecedent of the American Museum of Natural History. One telling aspect of the historical discussion was the impact at varying times of one person's ideology on its functioning as a public organization. This was evident in the efforts of Bickmore and Sherwood, and the changes brought to the structure and function of the museum in response to Osborne's ideas. Osborne seemed to have embraced experiential learning and the expansion of the resources to teachers, students and those

individuals who could not visit the museum. The administrators' beliefs about learning and the goals of the museum as they perceived them were entrenched into its functioning. As the museum advanced knowledge of nature and of itself, it gained the ability to re produce its educational offerings in light of society's needs. Indications were that it did not blindly continue traditional practices but effected changes to better serve the needs as interpreted by the stakeholders.

It appeared that these early museum educators and leaders viewed urban life as uninspiring and fraught with cultural deprivation—A sad omen on any time but I question the extent to which this view has changed. Consistent with Orbe (1998), those groups that occupy positions of power within the social hierarchy determine to a great extent the functioning of the entire society. Overtime, the structures of this system in reflecting the world-view of the dominant group members make silent the historically, marginalized perspectives in the design and direction of both the social order and the production of knowledge. Unfortunately, remnants of these are still evident today. In the general sphere of education, approaches to instructions have changed over time in response to beliefs about knowledge and how learning occurs. However, inquiry-based approaches to science learning have not found a place in the museum's daily presentation of science knowledge. Is this by choice among museum educators?

In recent times, museums have become popular sites for learning science and for complementing learning in science classrooms. Historically, according to Adams, the museum has always been such a place for the acquisition of new objects and the production of new scientific knowledge. I wonder about the production of ''new'' knowledge. The history as she describes it, depicts the museum as a resource where efforts were made to procure and make available such science knowledge. In the discussion of the museum as a cultural space, she states that the role of the museum as articulated by early museum leaders was that of bringing nature to those who were not able to get out and experience it for themselves. Ironically, these artifacts, carefully selected and preserved not only presented science knowledge from the western civilization imbued with the social authority that Kincheloe (2001) described but also was instrumental in the public's understanding of science. It is such presentations that offered constraints to the viewers about the nature of science, the nature of scientific knowledge and what counts as science, thus impacting interpretations and the development of a science identity. In effect, the museum functions to maintain the dominant ideologies.

The stated intentions of the philanthropists who funded the early public museums must be applauded. There is no doubt that their initial actions were intended for a wide range of the public to view what was once reserved for and afforded by the elite. This mission of enlightenment founded on the ideology of the dominant culture came with a level of control over the display and ultimately the interpretations. Visitors' interpretations were therefore constrained toward a specific way of seeing the world. Historically, the museum served as an institution for negating marginalized perspectives in the design and direction of both the social order and the production of knowledge. Unfortunately, the dominant ideology on which it was founded still shapes our thinking about museums where visitors function as passive receivers of knowledge stripped of the contexts and, lacking in opportunities for dialogue and interactions. Ironically, many still view the museums as places where visitors are simply recipients of displayed knowledge.

One cannot argue about the wealth of cultural and scientific knowledge some encapsulated in form and structure that museums contain. And, as Adams shares, present some challenges in the preservation of the dark past alongside the richness of the natural history. What are these challenges? I would argue that these challenges lie in the murals on the

walls, the taxidermy in the halls and the display of the dispositions of African American and other groups of people in the 17th and 18th century. In the classic diorama halls, one issue is dealt with by the museum educators' explanation that the animals were collected at a time when it was acceptable to kill and collect animals for sport. It would be interesting to capture the reactions of the members of very powerful animal rights organizations as they stroll though the halls. I am nudged to ask of the museum: How then are the other challenges dealt with? What kinds of answers are offered to visitors when socio-historical questions as they relate to issues of race emerge? Or, are these questions just not asked? The honest response to these questions would make for rich opportunities to begin the dialogue about such depictions of America's history and to bring to the fore issues such as disparity among races that seem to lie just below the surface in educational debates and other socio-historical issues.

According to Adams' depiction of current educational practices at the AMNH, there is hope. Changes, she states, are occurring in the approach to education at the museum and in re constructing its role as a resource to complement formal science teaching. She states,

> While basic pedagogy of learning with objects remains intact, recent research about learning with objects and in museums has great bearing on how the information in the halls is presented to schools and teachers. It is now understood that it is the interactions between the learner and the objects ... that make the learning experience in a museum unique.

The research Adams presents attempts to bring to the fore this new role, specifically as it relates to teacher education. Indications are that more changes will emerge as the critical research she employs seeks not only to describe the events unfolding in the project but also the opportunities to move toward positive social change through a critique of social structures, culture and exploration of transformative practices.

Learning from partnership—Urban Advantage

The concept of the museum and formal education relationship seemed to have begun with the sterile presentation of science information through the delivery mode of lectures complemented by kits. At first, these were offered to groups at the museum with the relationship extending to, and becoming a feature of some public school classrooms. However, the shifts in curriculum emphasis and the role of mandated state tests have led to the exploration of new approaches to the use of resources in complementing learning in classrooms. Amidst the new approaches there is still the need for educational reform in urban science education. This is fueled by the awareness of the pervasive underachievement among populations of urban students and the spotlight on inequitable distribution of resources across and within urban school districts.

The Urban Advantage initiative emerged in response to the need to strengthen science in public schools. As I read the highlights noted in the paper, the report could have been from any number of school districts in the nation. There were echoes of the issues that are symptomatic of public education—struggling schools, struggling teachers and struggling students. Many educational initiatives usually emerge as a result of mandates in response to crises as they are highlighted, and as Calabrese Barton (2005) laments, too often the efforts emanate from outsiders' perspectives on what changes should be effected. The discussion was not surprising for me but it reinforces some of my thinking based on observations made over time that the intensity of the issues plaguing schools will only rally a call for action when affluent areas become a reflection of the deficits that already exist in lower

income urban areas. A sad commentary! The report highlights a number of problems adversely affecting science education. The Urban Advantage initiative meant to increase equity and access to quality science education was one such project attempting to address some of the issues.

I applaud the writer for the approach at collaborating with the classroom teachers and identifying such worthwhile goals oriented toward transformative practices. Given the central importance of knowledgeable teachers to students' learning, lack of access to qualified teachers constitutes a mayor threat to equal learning opportunities. Professional development can impact teachers' classroom practices significantly and lead to improved student achievement. Research indicates that this occurs more frequently when the experiences focus on instructional practices that are specifically related to the strengthening of teachers' knowledge of specific subject-matter content and an understanding of how students learn. The notion is that there should be a close alignment of professional development with actual classroom conditions and understanding. To be effective, professional development must provide teachers with ways to directly transform their practices based on their perceived needs, the content, pedagogy and the goals for the learners. In the current testing climate, I believe that professional development leads to better instruction and improved student learning when it connects to the curriculum materials that teachers use without minimizing the importance of assessment and accountability measures now being used to gauge teachers' effectiveness. Because of the pervasiveness of the standardized tests and other external accountability measures what is tested becomes the currency in any k-12 learning environment.

An excellent feature of the project was the focus on urban teachers' professional practice and the potential ripple effects in impacting more public school kids. However, as a science educator, my interests in the museum are related to its potential for improving practice and for effective student learning. This has implications for how I view opportunities for teachers' professional development consistent with current beliefs about learning and the kinds of research that have the potential for transformation. These apparently were the hallmarks of the Urban Advantage initiative. While I agree that this initiative created a new field, I doubted the extent to which this new field could have afforded a system-wide impact on science teaching and learning. Based on the brief description of the Exit Project, I question the extent to which access was afforded to the 8th grade students hence allowing equity and access to quality science education. What does it mean therefore to increase equity?

One goal of the partnership as described in the case study was to afford the exchange of resources between museum and school in the new field that was being created. Communication and ongoing discourse were important in negotiating this new field. It was clear that a mutual trust was developed between the author and the lead teacher in the research. Was it because of the cultural capital that Adams brought to the community? While Violet emerged as a lead teacher, many of her colleagues displayed attitudes toward science not uncommon to those in other similar schools. Amidst the ongoing calls for educational reforms in urban education, mandated state tests are offering constraints on teachers perceived roles and their enactment of the curriculum. What is taught in most cases is directly related to what is important as indicated by the mandated tests. I am interested in how the museum–school partnership could begin to reframe issues surrounding the mandated tests so as to complement the transformative practices of teachers. Or, are the tests so pervasive that this is not possible?

The artifacts of the museum in both scientific and human resources were exchanged for the schools' resources of curricula, learning standards and extended contact with teachers

and students. It was not clear how Violet, the lead teacher, impacted the museum. While there were obvious changes in her approach to science in the school and also in using the museum's resources it was not apparent the ideological changes if any that were occurring at the museum. There was still the notion of power residing in the museum. This was reflected in the Museum director's applaud of the opportunity to understand how the museum can help schools and also in looking for evidence that ''we can actually do things for schools.'' Also, Adams states that the museum community took on the role of facilitators. However, this mode of operation for the museum educators was not clearly explained leaving me to question the process of facilitation. Was the facilitation toward the teachers in the initiative or was it a true partnership?

I conclude this forum contribution with a sense that museums have the potential to contribute to the development of science education by providing positive professional development experiences for teachers. Through the author's cultural and symbolic capitals, she is poised to impact many of the underserved population within her socio and geographical areas. The initiative described in the case, though not new, is a positive step as we face the issues of equity, empowerment and transformative practices in science classrooms.

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Transformation and the third space of school–museum collaborations

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Abstract In this response to Adams's paper I draw on cultural historical activity theory, as elaborated by Gutiérrez and by Stetsenko, to explore how the school–museum collaboration creates a *third space* for science educators. I discuss the kinds of generative activities and identity formation that can take place in this space, and explore the construct of *possibility* as a critical and emergent feature of activity in the third space. I close with a

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discussion of the two-way benefits of the collaboration between ''formal'' and ''informal'' institutions, the types of transformation it both requires and engenders, and the structural barriers that impede these collaborations.

Keywords Informal learning · CHAT · Museum · Science center · Possibility · Third Space

Introduction

Jennifer Adams has written a most interesting and salient paper exploring the relationship between museums and schools. The museum field is troubled by its relationship with schools. Our internal debates often cast school–museum collaborations as two fields colliding rather than converging. The school system is Jupiter and the museum field is a comet. Jupiter swallows the comet. From the school's perspective, the comet might keep driving through the atmosphere, boring through the core, oblivious to its surroundings, perhaps creating long-term ecological crisis. I have heard both such perspectives expressed many times. When you argue for binary star systems, you get pulled into endless discussions about the effects of gravitational force. While there are of course several notable examples of rich and sustained collaborations between schools and museums, the result by and large of this institutionally focused debate is a broad array of interesting but relatively thin practices and collaborations between museums and schools, and what I would call a large-scale missed opportunity.

Adams's analysis of the school–museum collaboration using the sociocultural lens of hybridization and creolization may help us through this impasse. Her personal account shows very clearly how close collaborations between a school and a museum can create a hybridized community across which resources and schema travel in two directions. A critical step in this direction, as she describes, is shifting the focus from the accessing of tools-as-such to the exploration of tools-in-use; that is moving from the study of cultural and scientific artifacts in isolation from the living practices of science to a focus on the practices of science, using scientific objects as tools for inquiry. The challenge is how to get this to happen at the institutional level and at scale.

I think about the questions Adams raises from the perspective of a museum practitioner. In this response, I want to build on Adams's historical view of museum teaching programs to understand the purpose and possibilities of hybridized learning communities. I approach this issue using a cultural historical activity lens that draws on the work of Anna Stetsenko and her elaboration of the self in purposeful cultural and historical activity. I will also use the construct, as elaborated by Kris Gutiérrez, of the *third space* as an analytical framework for examining the hybridized fields that Adams discusses. I draw on these two ideas to discuss the construct of *possibility* within a hybridized space, and what it means for institutional collaborations within the context of financially stressed educational systems. Finally, I will discuss some of the structural barriers that impede the development of a generative third space, and the steps I think need to be taken to move beyond these obstacles.

The formalization of informal science

AMNH is a major scientific research institution that is widely and generally known via its public education facilities and program. For many decades, as Adams shows, educational

effort at AMNH was conceptualized as communicating the museum's developing understanding of the natural and cultural world (as embodied in the artifacts and specimens collected from around the globe by museum scientists). It was about moving representations of knowledge from inside the building to outside the building.

Museums have, from early times, drawn on principles of progressive education that typically have been theorized and studied by scholars in the classroom setting (Hein 2006). Museums have drawn on pedagogies of object-based learning, for example, by taking objects out of the glass case and using them physically to generate visitors' interests, questions, and further explorations. There is a long legacy of effort to build on this obvious compatibility between the museum and progressive school. Dewey himself, in *The School and Society*, included a museum on the second floor of his diagrammed school. In some cases, such as the Fort Worth Museum School established in 1949, museums established schools within their museum buildings. In these sustained school–museum partnerships (or conglomerations), object-based learning was at the heart of the pedagogical vision. A recent Center for Informal Learning and Schools (CILS) study, led by researcher Michelle Phillips, found that this is still the case today in the 27 museum–schools she studied.

There is descriptive analysis of the power of object-based learning in a sustained school setting as well as in the sustained museum setting. But there is less evidence about how intermittent or singular interactions between museums and schools, of the type Adams describes in the first decades of AMNH's educational outreach work, can purposefully support and sustain object-based learning.

Adams's description of the Urban Advantage program is representative of a shift that is taking place in the museum field—moving from intermittent to more sustained collaborations with schools. But this shift has not yet been fully realized for many reasons political, financial, pedagogical, and otherwise. The shift, when and if it happens, will be truly transformative. It will transform the museum from an elite to an essential community institution. It will help to transform the nature of science teaching and learning in our communities—helping to move school science from a collection of facts and past practices to a living, breathing, sometimes messy and contentious, way of apprehending the world around us. But like all transformations, it requires some letting go, as well as some risk-taking; it also requires institutional-level commitment and leadership.

Before exploring the school–museum collaboration as a powerful hybridized site for the transformation of science education, I want to discuss an important historical shift that has taken place in the science museum field that lays the groundwork for the field-wide transformation I envision and Adams describes within her own institutional context. This shift entails redirecting the collaboration's focus on the tools of science as cultural–historical artifact to the processes of science as tool-oriented cultural–historical activities.

A critical player to introduce, in this regard, is the interactive science center, a relatively new institutional form that originated, more or less, with the founding of the Exploratorium and the Ontario Science Center in 1969. Today there are hundreds of interactive science museums around the world, in practically all major cities and in many smaller ones. The interactive science education movement has made inroads (in terms of dedicated interactive spaces, and/or the incorporation of more interactive labels and presentations in the galleries) into more traditional (''glass case'') science museums such as the Museum of Science and Industry in Chicago and the Deutches Museum in Munich, as well as in many natural history museums, such as AMNH and the London Natural History Museum (Fig. 1).

The interactive science museum movement arose from the revitalization of inquiry-based science practices in the 1960s. Science education curricular reform projects—such as Nuffield in the UK and later a series of federally funded US projects such as SCIS, PSS,

MACOS, and others—emphasized the development of subject-matter understanding through direct engagement in the *activities* of scientists, including using the tools, practices, and semiotic and symbolic systems of scientists. Essential components of this approach included helping children to develop questions, explore and investigate ideas, and communicate their results. Frank Oppenheimer, the founder of the Exploratorium, worked for a time at MIT on the Elementary Science Study (ESS) curriculum. The first exhibits at the Exploratorium were large-scale versions of ESS tabletop experiments. Thus, the interactive science museum field came to design learning experiences that were less object-based and more process-oriented (albeit, with the process inextricably connected to the real object or phenomenon under investigation). There was, then, greater focus on object/phenomenon *in purposeful use* as a way of teaching and learning science.

Another key feature of the interactive science museum that built on the 60s reform curriculum strategies (such as ESS) was the notion of finding one's way. Adams shows how at AMNH some 60 years earlier, Osborne took special care in the design and sequencing of exhibits and exhibitions, creating a staged dialogue between the arranged objects and the visitor. Moving from room to room, one acquired layers of knowledge that laid the groundwork for the information to be encountered in the next room. Oppenheimer, on the other hand, likened his museum not to Osborne's ''silent teacher'' but to a forest. He described the museum visit as a walk in the woods, where the visitor could meander from exhibit to exhibit—in no particular order—spurred on by whatever looked interesting. He had earlier experimented with this approach when as a college physics professor he had developed a ''Library of Experiments,'' a series of labs that students, following their own inclinations, were required to complete in no particular order. Semper has noted that frequently what looks interesting in a science center is the place where you see other visitors gathered and engaged (Semper, 1990). Thus in the interactive science museum, one's own inclinations, in interaction with the presence and activity of others, play a vital role in directing and focusing attention, or motivating learning and activity.

Oppenheimer's woodland was a 19th century architected landscape. Certain phenomena were chosen for inclusion and exhibits were designed and tested over extensive periods of time. What was included in the museum was not accidental (or at least mostly not); yet the visitor's experience could be highly serendipitous. Thus, the Exploratorium did not present itself as expert to the novice, intent on scaffolding learners to mastery of specifically defined content knowledge—rather it focused on supporting visitor experiences in questioning and investigation in content areas of their own choosing.

Focusing on learning science through engagement in scientific processes and orienting the experience around the interests of the learner created new sets of possibilities for

Fig. 1 Particle accelerator exhibit. Photo by Lily Rodriguez, © Exploratorium

collaborations with school science—importantly, museums could become sites of ongoing enactment and development of practice related to science learning and science teaching. Rather than ''libraries of knowledge,'' they could become what Oppenheimer called ''libraries of experience'': generative sites for renewal, commitment, and transformation of science teaching and learning. They could become meeting grounds for exploring the nature of science and the nature of science teaching and learning. Adams's account of the Urban Advantage program explores how one museum moved in this new direction afforded by the curricular reform efforts of the 1960s.

Museums as sites for identity formation

As Adams notes, there is a body of work that looks at the museum as a site for identity formation for ''visitors'' (for example, she cites Rounds and Falk). Adams usefully extends this work to include examining the museum as a site for classroom science teacher identity formation. It is perhaps possible to extend this even further to think about the science museum–school collaboration as a form of *Third Space*, where powerful transformations (of practice, beliefs, and knowledge) can take place for science educators, from both the classroom and the museum setting.

Kris Gutiérrez describes the third space as the construct mediating between the ''official'' and sanctioned spaces of activity (such as the modes and scripts of the classroom) and the unofficial, often forbidden, counterscripts that children enact within official spaces (Gutiérrez, 2007). The third space is the interaction between these two cultural contexts—where, for example, teachers hear or note unofficial or counterscript activity in the classroom and, rather than squelching or punishing it, build on it to engage children in the official scripts. It is a place where school life, street life, and home life can come together, where resources from all of the fields are drawn upon to make meaning of new ideas and situations. What emerges is a hybridized classroom culture and context, even a hybridized ''script'' that responds to individuals, and engages—in fact, enriches—the curriculum. It is a space where children ''begin to re-conceive of who they are and what they might be able to accomplish academically and beyond'' (Gutiérrez, 2007)—it is a space that opens up possibilities for learners.

As Adams's paper shows, when museums and schools collaborate—in particular through professional development activities where science educators from both museums and schools are together engaging in processes of science and science teaching—new sets of possibilities emerge. Educators from across the two cultural fields come together not to do battle with the constraints of their respective institutional fields (for example the limitations engendered by different aspects of time, expectations, and assessments) but rather around their shared interest and dedication to science teaching and learning. Drawing on the museum's drive to make science engaging for all audiences (by building on curiosity, surprise, and contradiction) and the school's drive to make science a coherent set of ideas and practices, the third space is a place where educators from both fields can strengthen their ''repertoires of practice.'' Working together in spaces dedicated to science and science learning, educators reaffirm the interests that frequently drew them into teaching in the first place. They find joy and deep commitment in engaging as science learners, while renewing their commitment to science teaching.

An example of these expanded repertoires comes from the active listserv discussions of teachers participating in the Exploratorium Teacher Institute. Details of this program can be found at http://www.exploratorium.edu/ti. The program constitutes and supports a

science-teaching guild whose eight hundred active members range from novices to retired teachers. Their participation involves immersive 4-week and 2-week institutes and ongoing weekend workshops (differentiated as well as blended for different levels of experience and expertise) that focus on middle and high school level science content and science teaching. On average, teachers participate in the program for six years. Through this work, the program supports ''an active community of science teachers all dedicated to improving practice and infusing their science classes with authentic inquiry experiences'' (Shore, 2005).

In the transcript below, one can see aspects of the hybrid community that emerges from the ongoing program interactions. Expertise is distributed throughout the community. Knowledge about what happens in the classroom, or about how to make things happen in the classroom, is equally valued with knowledge about things technical or scientific. It is by merging the cultures of scientific expertise (in the museum educators, who are also excellent teachers) and classroom expertise (in the teachers, who are also science content leaders) and school realities (including the pragmatic and unending search for tools for teaching) that the excitement and ideas—including solutions, experiments, and personal meaning making—emerge

	Subject: explosive bubbles
Teacher 1	Date: Sun, 7 Nov 2004 19:32:56 -0800 (PST)
Classroom question	I am looking for a PROCEDURE on how to do this class demonstration. I want to mix pure Hydrogen and pure Oxygen together to make Bubbles that produce a loud BANG for a student demonstration. Has anyone performed this demo before? Does anyone have a writeup on it?
Teacher 2	Date: Sun, 7 Nov 2004 19:55:54 -0800
Idea/Resource	I've seen a cool demo where a brass bell shaped container is filled with hydrogen. There is a small opening at the bottom which is lit. As the hydrogen burns it resonates inside the container. At first, the frequency is too low to hear, but as more hydrogen is burned and more oxygen enters the container, the frequency rises. At some point, the sound becomes audible, but faint. As the burning continues, the sound grows higher and louder. It continues growing in frequency and volume (seemingly exponentially) until the O_2/H mix is just right causing a tremendous bang. Very impressive.
Teacher 3	Date: Mon, 8 Nov 2004 08:54:58 -0800
Craft knowledge	Caution -> Warning -> Danger (I've used these signs to illustrate INCREASING care required left to right.) Bubbles have little shrapnel when exploded via a flame on the end of a 4 (four) foot glass tube. But any container with the gas mixture is DANGERous. One of my students wanted to recreate the ChemStudy film sequence to show the 2:1 ratio by reacting several ratios. We rigged a glass tube with gas valves and a sparkplug at the top, and the bottom open in a bucket of water. I don't remember which ratio caused the tube to detonate throwing shards 15 feet into the blackout drape. We were protected by a U-2 camera bay curved polycarbonate windshield. The video showed the intact glass in one frame and no glass in the next. I'd leave hydrogen-oxygen for the freshman chemistry professors. Stick to exploding paint cans with natural gas.
Museum Educator 1	Date: Mon, 8 Nov 2004 12:12:39 -0800
Technical elaboration	On a further note: Never explode a hydrogen oxygen mixture in a balloon. The detonation is so sudden that the protective mechanisms of the ear cannot function in time and the sound will lead to ear damage. [H]ydrogen by itself in a balloon undergoes a deflagration as oxygen slowly mixes with the hydrogen, the resulting sound is more of a ''whomp'' and for a 9″ diameter balloon will not produce ear damage. A large ball of flame rises from the deflagration so the experiment should not be done under a smoke detector.

This example is highly representative of the exchange of knowledge that one finds in the Exploratorium Teacher Institute listserv. The other major topic of conversation is the locating, acquisition, and sharing of material resources for teaching. In Adams's case study, it is only after Violet has shared with her colleagues the material and intellectual resources she has acquired through the Urban Advantage program that she is granted access by her senior colleagues to hidden classroom closets full of science teaching materials. The Exploratorium Teacher Institute too has found that access to ''currency'' (in the form of resources, activities, and tricks of the trade) that museums can provide is especially important, and particularly important for new teachers who find themselves either on the periphery or in a continual state of needing advice, help, solutions from their colleagues. While the importance of access to resources then should not be underestimated, there is, I concur with Adams, far more at stake in terms of possibilities for professional practice.

While CHAT posits that learning and development occur through socially situated, culturally and historically mediated activity, Stetsenko's theoretical elaborations illuminate how individuals exert agency to adapt, evolve, and advance cultural and historical practices (Stetsenko, 2005). Indeed, she notes the developmental necessity, from both a phylogenetic and an ontogenetic perspective, of the reciprocity of personal and social transformation. But, as she shows, to enter into that practice one must be able to conceptualize and historicize the practice, and to see one's place in that practice, most especially how one can *contribute* to the development of the practice. Because the merging cultures in the third space draw on the resources of individuals as well as the group, in purposeful, goal-directed activity, it may be an especially generative place for helping learners to find personally meaningful (i.e., salient, relevant, consequential) ways to contribute to the activity. They thus gain a sense of *possibility*—for themselves and for their potential contributions to purposeful activity—which may be critical for drawing them into, gaining their commitment to, and ultimately enabling them to transform existing and create new cultural practices.

Situated both in the museum dedicated to scientific practices and knowledge, and in the classroom dedicated to science teaching and learning, the school–museum professional development collaboration provides a site for the science educator to locate herself with respect to a long tradition of the production of scientific knowledge and the development of science teaching practices, as reified in cultural artifacts such as museum exhibitions and classroom curricula. It is important that these experiences cast the teacher as learner—learning science, learning about teaching science, learning about learning science. A learning environment such as a museum can be a generative place for this activity because there is available space, it is de-politicized relative to the bureaucracy of the school district, and it is a science-rich environment. The museum can play a crucial role; however, this effort must not be cast as the ''museum's educational community'' but rather as a science education community without institutional boundaries.

Structural barriers impeding the third space

A 2005 CILS study led by researcher Doreen Finkelstein found that almost 60% of informal science institutions (science museums, zoos, botanical gardens, etc.) offer teacher professional development programs. A follow-up CILS study in 2006, conducted by researchers Michelle Phillips and Saundra Wever-Frerichs, found that these programs tend

to be led by museum-based educators who have educational backgrounds in science (19%), classroom teaching (35%) or both (40%)—thus museum educators and classroom educators have much common ground and experience, as well as divergent experiences, constraints, resources and schema. I point this out because I believe it is essential to find the common ground to nurture the third space. Too often we, in the museum field, focus on differences.

In the Informal Learning Collaborative, a CILS professional development program I lead for museum-based teacher educators, I have found a continuing hunger on the part of participants for sustained dialogue with classroom teachers. These museum professionals are by and large extremely knowledgeable about their subject-matter, about program design, and about science teaching and learning. But, as educators based in museums, they are to some degree on the margins of the discussions about science education, especially from a political and policy perspective. The power of the Informal Learning Collaborative has been to create a professional community that conceptualizes itself as an integral part of science education writ large. That is, as these science educators have come to understand their work in relationship to current policies, practices, and research in science education, their confidence, aspirations, and work with schools has qualitatively and quantitatively increased, according to our evaluations. They are working to strengthen these connections and relationships, to maximize their relevance, salience, and consequence.

Thus, I agree strongly with Adams about the two-way benefits of developing the third space through collaborations between museums and schools. (I would add that the participation of the research community enriches this work further.) It professionalizes the museum field to understand itself not as a boutique or elite set of resources in a given community, but rather as an integral facet of an urban landscape that, along with schools, strives to build science literacy in the community at large.

Unless the programmatic connections between museum and school are strong and sustained in different ways, the museum remains a boutique in its community. But when the programmatic connections can be established in ways that draw on resources and schema from both cultural fields, the benefits flow in multiple directions. The fields come together around living, tool-oriented activity, not around knowledge and objects divorced from practice. In the latter case, the issue will always be cast a supply-side argument: museums will always be storehouses, whether utilized or underutilized; and probably underutilized when they are most needed, as today.

I conclude with some reflections on the barriers to the realization of the third space in the school–museum collaborations. Adams's paper discusses several of them, including schools that downplay science, discouraging teachers from investing time and effort in science, often because of an emphasis on reading and math. There are also the obvious ones of time and funding, exacerbated by some of the school accountability measures which have been shown to restrict and narrow the curriculum and subject-matter priorities in many urban schools (Harvard Civil Rights Project, 2006).

But beyond that, as alluded to earlier, at an institutional level, both museums and schools must see the collaborations as potential sites for transformation. It seems clear that most teachers, schools, and communities still conceptualize museums as storehouses of goods, or ''libraries of knowledge.'' In another CILS study designed by Laura Martin, Finkelstein found that when teachers were asked what they wanted from museums, they generally responded in terms of auxiliary materials or activities for their classroom curriculum. I think this points to a major stumbling block. What can those museums, who may be ready for transformation, do? Adams has clearly made the transformation in her own

teaching and professional practices, but much of the language in her paper still casts the museum as ''a resource to'' not as a ''co-constructor, co-investigator, co-worrier, co-investor in.'' This language, I believe, reflects the state of the field (not the state of Adams's practices). The museum field must reconceptualize itself around practices that extend beyond its walls. Who else amongst us is concerned about science literacy, science engagement, science learning?

The immediate past director of the Exploratorium, Goéry Delacôte, once told a packed room of educators at the annual science museum conference that the problem with science centers is that there was not enough ''science'' and there was too much ''center.'' In general, science museums are very concerned with and reflective about the dialogue they have with those who choose to come to their institutions. But that, alas, is a fairly narrow slice of humanity. We need to look beyond our walls to see our work in relationship to the broader *living* cultural and historical experiences of science teaching, learning, and doing. Efforts to do that must inexorably include those fundamental democratic institutions we call schools. When we can do that, Adams's personal transformation will have the chance to move to an institutional level.

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Identity, passivity and science education in the museum

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Abstract This forum is based on my article, ''The historical context of science and education at the American Museum of Natural History.'' In this rejoinder, I respond to the observant comments and questions posed by Bronwyn Bevan and Rose Pringle. I use these as catalysts to further my inquiry into the relationship of museums and informal science institutions to the general discussion of science education and the implications of race, culture, and science interpretations in museums.

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Keywords Museum education · Identity · Hybridization · Passivity

Introduction

Thanks to Bronwyn Bevan and Rose Pringle for their insightful responses to my article. They presented many critical points and counterpoints that are very relevant to thinking about the role of museums in science education. My article focused on three key issues: (1) cultural display and its potential implications in using the museum as a resource for science teaching and learning, (2) the historical constitution of AMNH's educational practice, and (3) the current relationships of the museum and schools. I also highlighted the experience of one teacher's creolization of museum resources in her classroom/school science education structure. In this rejoinder, I address some of the salient points that Bevan and Pringle presented and elaborate on the discussion of museums and schools creating a space where a hybridized culture of transformative science practice could be co-generated.

Passivity and object-based learning

Museums have been and continue to be concerned with education of the public. Museums have been changing, however the basic function of the museum remains the same—the communication of information to the public. In the case of the science museum (object or phenomenon based) it has the mission of communicating science to the public and in this role of communication, there is also interpretation that inevitably reflects a particular culture and worldview. Pringle noted that when visitors interact with objects, they are constrained by the displayed worldview rendering them passive receivers of knowledge. Pringle's impression is supported by the notion of passivity; as visitors to a museum, we are hosts to others' intentions inscribed upon us (Roth, 2007). A teacher in a museum interfaces with objects and phenomena, and perhaps leaves with information intended by those who mediated in selecting and arranging the objects (e.g., curators, museum educators, scientists, and other participating teachers). A teacher in a museum has intentions of learning from her experience with the objects, so as she is inscribing her intentions on the object, the object is being inscribed upon her; leaving an impression, intended or unintended. However, as Pringle points out, such inscriptions on the teachers reflect a specific worldview.

While it is very difficult to change the physical structure of the Museum, teaching teachers how to read objects—how look at objects, discern intentions of the curators (in the display and label text), and critically ask their own questions about the object, impressions, and intentions. Asking questions is a resource that scientists use to help gather information about an object; teachers can use this same resource when teaching students to use objects to learn science. This is a way of engaging in the practices of science, as Bevan discussed, and democratizes science and the power that the Museum has over science. This critical questioning—examining how do we know what we know and why we believe it (Bain & Ellenbogen, 2002)—is a tool that is used in teaching with objects that creates a dialogue between the objects and the viewer. It does not change the space, role, or intention of the Museum, but it changes the culture that gets enacted in the halls.

Race: science versus culture

Scientific understandings of race have changed, and the Museum has responded to this change in a new hall that presents the latest science understandings of human evolution. It emphasizes we are one human species and notes that we share 99.9% of the same DNA. However, the miniscule one tenth of one percent that determines our differences (''superficial'' ones like skin color and facial features) have had a substantial effect of shaping human sociocultural history and identity.

Rounds (2006) wrote, ''identity is both an enabler and a constrainer, and sometimes we resent the constraints identity can enforce on our actions'' (p. 138). This describes the passivity that is inherent in identity and, until we transform the culture of museum-going to that of critical questioning, the Museum maintains an authoritative role and effectively disseminates the dominant culture through the artifacts in the traditional cultural halls. Pringle saliently questioned whether or not African American visitors would look to the Museum to confirm their racial identities. I agree with her that identity confirmation may not be the intention of a museum visit, however upon visiting, and seeing cultural artifacts, African Americans and ''other'' visitors may look to the cultural halls to confirm or refute what they know about their cultural ancestry.

Pringle also queried the kinds of answers offered to visitors when sociocultural questions about race emerge. The Museum responds with science that supports the non-existence of race. Interestingly models (that are artistic interpretations) that depict the evolution of humans get progressively lighter in complexion and appear more Europeanized as humans become more ''evolved;'' more closer to modern humans, as is common in representations of human evolution (Scott, 2005). ''In effect,'' Pringle wrote, ''the Museum functions to maintain the dominant ideology,'' that of race and the socio-historical implications that the phenotype of race presents.

Towards a collective culture of science production and education

Bevan pointed out that the language of my article still casts the Museum as ''a resource to'' and not as a ''co-constructor, co-investigator...'' This was also echoed by Pringle when she mentioned that while it was clear how Violet, my Lead Teacher changed, it was not clear how the Museum changed as a result of Violet's activity in the Museum field. This caused me to revisit my experience with the Lead Teachers and in doing so, I realized that much of their activities were intragroup. That is, although they created a hybridized field of school/museum practices and resources, this field was not hybridized with respect to the participants—most of the time, the participants in this field were classroom- or school-based. I was the only museum-based participant, and not fully museum-based as a part of my identity as a science educator stems from my previous experience in the classroom. As the Lead Teachers co-constructed their roles in Urban Advantage and created the diasporic artifacts that resulted from their activity in both the museum and the classroom fields, this co-construction was in the absence of the museum educators (although ironically these meetings took place in the Museum's physical plant). The diasporic artifacts, such as the rubric, was meant to reflect the hybridization of the fields, but since it was a document that was mainly used by the classroom teachers, the museum educators did not have much input in the ongoing construction and subsequent use of the tool.

This caused me to revisit my constructions of the experience of the Lead Teachers vis-a-vis the Museum and realize, that as Bevan mentions, there needs to be a space where both museum-based educators (including scientists) and school-based educators can come together to co-construct/co-generate a field that represents an active community of science production and education—a culture where science and education are truly integrated in the re/production of science and this field affords a two (or more) way exchange of culture and generation of new culture. Once this happens, perhaps science will slowly move away from representing/being representative of the dominant ideology of Western science.

Bevan wrote, ''it is essential to find common ground to nurture in the Third Space,'' if the common ground is science, then the corresponding cultures of science—teaching and learning, research, display, teaching with objects/phenomena—could be negotiated in this Third Space and generate new culture around science production and education. Museum-based faculty and school/classroom-based faculty coming *together* in this space can lead to the generation of transformative practices in science education. I reiterate, there must be a coming *together* of museum and classroom educators—collectively looking at curriculum, resources, and sharing/learning each other's best practices about the nature of teaching and learning and cogenerating a powerful culture that truly makes science *for all*.

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