**"Effective Science museum/School partnerships for developing countries based on successful models implemented at the Smithsonian Institution"**

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## 1. Introduction

It is widely acknowledged that science education is in a crisis worldwide. In particular, it has been observed that pupil attitudes to school science decline progressively across the age range of secondary schooling as fewer students choose to study science at higher levels and as a career (Braund and Reiss, 2006). Educational reforms have further exacerbated matters by pushing performance on standardized tests as the critical measure of learning, thus causing school education to be more curriculum and result-oriented. This is turn has cooled down schools' enthusiasm for out-of-school science learning settings like science museums, which are crucial in stimulating the senses of the students through inquiry-based learning and discovery. Over the years, science museums in developed countries have circumvented the difficulty by finding links within their exhibitions, collections and most importantly, their educational programs that intimately connect to the school curriculum. In addition, they have partnered with teachers to identify curriculum units commonly taught in schools and developed programs and exhibits that could explicitly convey the concepts in those units.

The situation has been utterly contrasting for science museums in developing countries where school groups make up the overwhelming percentage of their overall attendance. While they continue to think about schools by organising field trips and other conventional school programs, they are often unable to develop synergies with schools that meet the expectations of teachers. The problem, in many cases, stems from the fact that teachers have negligible contribution in the design of the programs while museum educators have little insight into school curriculum. As a result, many science museums are planning their educational role **for** schools and not **with** them.

Moreover, although museums and schools are aware of the urgent need to join forces in order to blend formal and informal learning for the overall benefit of the students, there is significant dearth of knowledge in many developing countries regarding practical efforts to achieve these objectives.

The Fellowship in Museum Practice in 2008 spurred my desire to contribute to this knowledge by giving me the opportunity to experience tangible science museum/school partnerships at various museums and research centres of the Smithsonian Institution during four months. My goals were to:

- Study and participate in ongoing science programs at Smithsonian Institution museums that illustrate how school and museum educators collaborate to optimize the use of the museum resources to supplement science teaching and learning.
- Identify features that characterize a successful museum/school partnership
- Draw a set of guidelines and best practices for setting up mutually beneficial science museum/school partnerships in developing countries based on my observations.

Three centers were selected to give me as broad an overview as possible of the collaborative ventures between schools and the Smithsonian Institution. They were the Smithsonian Environmental Research Centre, the National Science Resources Centre and the Smithsonian National Museum of Natural History's Naturalist Center. An outline of these institutions, the educational programs that they run for schools as well as some of the salient features of the collaborations is given below.

## 2. Study of successful museum/school partnerships at the Smithsonian Institution

### 2.1 Smithsonian Environmental Research Centre (SERC)

The SERC is the world's leading research center for environmental studies of the coastal zone. One of its key components, the Reed Education Center, serves its educational mission which consists of offering a broad array of opportunities for people of all ages to learn about the

ecology and to increase their appreciation for the environment (SERC website). The SERC campus, located on the western shore of Chesapeake Bay - the largest estuary in the United States, offers the ideal platform to serve its education mission. The Reed Education Center has devised a wide variety of education programs for the public in general and for the student community in particular. For the purpose of this project, I will delve into their most popular program, Estuary Chesapeake, which in my humble opinion puts in a nutshell SERC's philosophy of partnering with schools.

Estuary Chesapeake is intended for students in grades 4 to 6. It consists of five interactive stations where students investigate the different aspects of the estuary ecosystem: they learn about the animals and microscopic plants living in the estuary, look at the non-living components of the ecosystem and study the physical environment in which these organisms live. The program engages students in various hands-on activities where they manipulate scientific instruments to determine turbidity, pH, salinity and depth of water, catch fish and crabs with a large seine net and hand line respectively, collect planktons, etc. The students are normally divided in five groups. Each group spends about 30 minutes at a station and then rotates through all stations.

One crucial aspect about Estuary Chesapeake that struck me and arguably a new concept for developing countries is the active participation of the teachers and parents in the program. The teacher is responsible for leading the program whereas the parents run the stations. While a docent gives a brief introduction to SERC and to the activity, arranges for the equipment required and is available to answer questions throughout the activity, he is by no means the primary instructor. Two reasons are put forward to substantiate this situation. Firstly, the staff limitations preclude from providing an activity leader for each visiting group. Second, and more importantly, there is mounting evidence to support that teacher and parent involvement in an education program enhances its value for the students (Epstein, 2001).

To effectively serve the schools, the Reed Education Center also establishes an efficient line of communication with the teachers from the moment a school registers for a program. It runs free workshop for teachers and parents to familiarize them with the activities and equipment at the

stations. The workshop also shows how to prepare students for what they will learn during the field trip and discusses activities that can be performed in the classroom after the trip. A Teacher's Guide and a Student's Workbook provide information that can aid in the understanding of experiences at the site and give additional context for future experiences. Teachers can also consult the SERC's website for up-to-date information and materials about the education program. By adopting a three-pronged approach – pre-trip, trip and post-trip - SERC transforms a one day field trip program into a continuous learning process. This approach is in line with several studies (Ramey-Gassert, Walberg III and Walberg, 1994; Bitgood 1989) which indicate that students tend to gain both cognitively and emotionally from a field trip when they are well prepared by the curriculum, when they participate actively during the trip and when the information received during the trip is reinforced following the visit.

Like all the programs run by SERC, Estuary Chesapeake builds on the resources of SERC's campus located on a sprawling area of more than 2,800 acres of land encompassing forest, cropland, pasture, freshwater wetlands, tidal marshes, and estuaries. Such informal settings allow for an assortment of immersive activities for the children and support learning that is driven by curiosity, discovery, free exploration and the sharing of experiences with friends. For example, while the pupils are delightfully engrossed in catching different fishes and crabs, they are learning about their anatomy, behavior and habitat.

Estuary Chesapeake is even more appealing to schools because it clearly states the specific government-mandated Standards of Learning that it addresses. Teachers can thus appreciate how the program will enhance their students' understanding of science topics that are part of the classroom-based curriculum, making it easier for them to justify the field trip to the school administration.

A last attribute of Estuary Chesapeake that I would like to mention here is that most of the experiences at the stations relate to what students usually encounter in their everyday life. Most of the participating schools come from the Chesapeake Bay neighborhood. For example, one station focuses on the blue crab which is the animal most people associate with the Chesapeake Bay. This is again compliant with research showing that younger children are likely to learn

more from field experience in a more familiar setting, such as one near their school (Falk and Balling, 1982).

## 2.2 National Science Resources Center (NSRC)

The NSRC was established jointly by the National Academies and the Smithsonian Institution in 1985. Its mission is to improve the learning and teaching of science for all students in the United States and throughout the world. The NSRC's Professional Development Center helps in achieving this mission by offering courses, academies and short workshops that help teachers gain conceptual understanding and pedagogical knowledge to teach science effectively. I participated in two of the four academies conducted by the NSRC during summer for teachers at all levels of experience: "Energy and Motion" and "Electricity and Magnetism".

An interesting feature of the academies is that NSRC's special access to the scientists, curators, and educators at the Smithsonian Institution helps in creating a series of unique learning experiences for teachers that enhance their understanding of fundamental science concepts and pedagogy. The academies included visits to museums as well as demonstrations by the museum curators to illustrate how museum learning opportunities such as exhibits and educational kits could be used to complement and enrich classroom instruction.

Most of the classroom sessions of the academies make use of the books and science kits, specifically developed by the NSRC to attune teachers to the hands-on approach of teaching science. Interestingly, experienced science teachers are called upon to run these sessions. Armed with a good understanding of the difficulties frequently encountered by teachers in the science classroom, they are more apt to inspire teachers in engaging their students in scientific investigations.

It is worth highlighting the inclusion of contextualized field trips to research centers, industries and other scientific organizations as an integral part of the academies. They are essential in bridging the gap between learning of the subject in the classroom setting and its applications in the real world. Through discussions with the teachers, I got the feeling that they could gain a true

understanding of the complexities of the subject by looking at scientists in action. Moreover, it is a fulfillment for most of them to experience how the knowledge they impart in schools is actually transposed into the work environment.

### 2.3 Naturalist Center of the Smithsonian National Museum of Natural History

"Good museum attracts, entertains, arouses curiosity, leads to questioning – and thus promotes learning" (The New Museum: Selected Writings of John Cotton Dana). This succinct statement made by John Cotton Dana, the pioneer of community-museum partnerships, best describes the Naturalist Center. The Center is located in Leesburg, a small district in Loudoun County, Virginia. Students become scientists and explore the processes of science at the Naturalist Center. The main attraction of the Center, the Study Gallery, welcomes visitors of ten years old or older and has over 36,000 natural history specimens, books and scientific tools and experienced staff. A Family Learning Center invites the younger visitors to discover science through investigation and hands-on activities. With everything from fossils and mammals to butterflies and minerals, students can explore some of the diversity of the natural world with scientific equipment and books. The museum staff is keen to help students with their investigations and help them to formulate suitable questions to explore.

In my view, the collaborative venture that the Naturalist Center has forged with the Loudoun County Public Schools epitomizes an efficient and successful museum/school partnership with broad benefits for teachers, students and the community. The underpinning of this partnership is the creation of a Teacher Naturalist position, a qualified teacher, who is assigned from the County system to the Center for a period of one year. Equipped with a good understanding of how the state's Standards of Learning work, the Teacher Naturalist morphs into a curriculum developer for the Center by linking the Center's resources with the Standards of Learning (Radise, 2005). Ultimately, his role is to make the resources of the museum a seamless part of learning in Loudoun County schools. The Loudoun County Public Schools' administration goes a step further in this partnership by endorsing the field trips to the museum as an extension of classroom learning. Hence, visits to the Naturalist Center do not add up to the schools' shrinking budget associated with field trips. Additionally, the Center is accommodated in a building

provided by the Loudoun County Government. The result of this highly effective school-museum partnership is the establishment of a modus operandi that crosses the boundary between schools of the County and the museum by bringing the schools into the museum and the museum into the schools on a regular basis.

To bring schools into the Naturalist Center, the latter offers a large array of activities advocating an investigative, inquiry-based approach to learning from natural objects similar to the scientific processes used by scientists working in the field. They engage visitors in the challenge and excitement of the process of scientific exploration. They have been very carefully designed by the museum staff in close collaboration with teachers to encourage curiosity, with emphasis on developing questions and on seeking answers while still linking to the standards of learning. This contrasts with the activities of science museums in many developing countries, which often lead along pre-determined routes to the discovery of particular concepts or principles. In addition, the learning approach is constructivist in that it gives students autonomy to pursue their own questions, verify their hypotheses and judge their own progress by doing inquiry-based activities. In the process, the docent accepts responses from the students with a neutral nod that neither confirms nor rejects the answers and asks questions to redirect the inquiry.

As stated previously, the Naturalist Teacher ensures a close fit between the educational programs of the Center and the school-based curriculum. The connection here is more flagrant as the museum's collections provide an interdisciplinary experience supportive of English, Mathematics and Art although the key links remain with Science. For example, Classification, a popular activity for students of Grades 5 to 7 helps in developing an understanding of how animals are classified. Using a Venn diagram, students describe the similarities and differences that they recorded from in-depth observations of three animals. Then, they pick one animal to draw and describe in detail, and then share their findings with the rest of the class. This single activity remarkably links to many specific English, Mathematics, Art and Science Standards of Learning prescribed by the state of Virginia.

An acknowledged cornerstone of the Naturalist Center's offering to school teachers is the Iwonder professional development program. During three days, Iwonder inspire teachers to

model the learning system of the scientist, artist and historian by using the museum collections. Through a series of inquiry-based activities and group discussions, teachers learn to create an environment in their classroom that promotes risk taking and to develop questioning techniques that promote critical thinking skills. I conducted a survey based on the daily journal reports written by the fifteen teachers who participated in the 3-day Iwonder workshop to assess the transfer of learning that would occur from the workshop into the classroom. A careful analysis of the journals suggested that six factors would be likely to affect the transfer of learning: "Perceived Content Validity", "Motivation to Transfer", "Fun/Discovery", "Self-Assessment", "Understanding Students' Viewpoint" and "Personal Capacity to Transfer". Surprisingly, teachers clearly referred to the first five factors in their journals at least once in their journals. I noted this comment from one teacher under "Perceived Content Validity": *"I wish that this course was a requirement for all school teachers because we all could truly adopt this approach cross-curricular"*. Another remark worth mentioning under "Motivation to Transfer" was ""*I am invigorated to get back into the classroom and adjust the way I teach the lessons"*. To consolidate my findings, I experienced the actual implementation of integrated science and mathematics inquiry-based teaching practices during visits to the classrooms of three teachers who had previously followed the Iwonder program. What I saw was puzzling in many aspects. Students were working in groups, discussing among themselves, using open-ended questions, taking risks to try out new ideas when previous ones did not yield convincing results, using appropriate tools to observe, measure and record data, applying existing knowledge to justify their results and assessing their own work. Above all, they were having fun. On the other hand, teachers would modify the traditional classroom environment by providing the necessary learning tools, materials and resources for active involvement of his young learners. Furthermore, the teacher would nurture the inquiry in the minds of his students through questions that were more inferring and reflective in nature. This type of questioning ensured that the classroom learning remained focused on relevant and applicable outcomes.

My survey also showed that some teachers have some apprehensions as to their capacity to implement inquiry-based lessons in the classroom. An interesting comment under the factor "Personal Capacity to Transfer" was: *"I know it is important to let students explore and come up with questions but I often feel the pressure of SOLs and getting through the curriculum"*. To

address this problem, Iwonder is structured as a year-long program, where participants develop a curricular unit based on inquiry-based learning using either a personal collection or the specimens of the museum. They will also create a continuum based on student-centered as opposed to teacher-centered lessons that will rate their units on a sliding scale. All participants will then meet at the Naturalist Center once every two weeks for a follow-up and mentoring exercise. They have opportunities to present, test, discuss, analyze and reflect on their units with their peers, the program leaders and administrators from Loudoun County Public Schools. Eventually, this follow-up will reinforce their confidence in adopting the new teaching and learning strategies in the classroom.

A final note about the Naturalist Center's relentless service to schools is its Loudoun Collection. It is essentially a set of boxes containing objects supplementing the teaching of Science, Social Science, Mathematics and Art. The authentic contents of each box are useful in creating and implementing object-based lesson plans. Teachers from the Loudoun County Public Schools can request the boxes via on online catalog. A "Pony" delivery and pick-up service is provided for the convenience of teachers.

## 3. Identifiable characteristics of effective science museum/school partnerships

Although the three institutions described above vary in their missions and objectives, they share a common thread: a strong commitment to fully support school science education. Each of them aptly illustrate that when informal and formal science educators join their efforts, they can expand their repertoires of practice so that science learning becomes engaging and coherent for more students. Building on my first-hand experience as a privileged observer at the three aforementioned institutions, I will now outline a set of identifiable characteristics that are at the helm of their successful partnerships with schools. Formulation of these guidelines has assumed two preconditions from the outset. Firstly, there should be a strong commitment and support from museum and school administrations to the endeavor and secondly, science museum educators and teachers should firmly believe in the benefits of such an initiative.

### *a. Sufficient funding and resources*

The key to a lasting partnership is an adequate planning of resources and funds that it would require. Human and financial capital involved can be significant to sustain the collaboration. Often, incentives are needed in order to get teachers interested. In the case of the Naturalist Center, it has been agreed with the Loudoun County Public Schools to provide stipends and teacher graduate school credits for participants completing the Iwonder program satisfactorily.

### *b. Solid relationship between partners*

From the beginning, it is imperative that museum educators and teachers cultivate strong and evolving personal relationships. Scheduling early meetings and discussions between these two partners will help in building an atmosphere of trust and mutual respect required for the partnership to prosper. Such an atmosphere is a sine qua non condition to kickstart the collaborative venture.

### *c. A perfect understanding of each partner's world*

The school world contains teachers, students, a curriculum, SOLs and lessons in a structured setting. The science museum world has numerous exhibitions, real objects, collections and informal educators that can make science accessible, tangible and joyful. Blending the museum resources into the school world would require museum educators to become familiar with school education policy, pedagogy, classroom management, child development and assessment among others. Concurrently, teachers should be aware of the extensive resources of the museums, the expert knowledge of its staff and the informal learning strategies used to engage and sustain public interest in science. By gaining an insight into each other's world, each partner will better understand his role in making this symbiotic relationship thrive.

### *d. Long term benefits for each partner*

The undisputed goal of all the three educational efforts outlined in this report is to make science museum educators and teachers work together in order to optimize the museum resources for the

planning of productive, curriculum-related educational experiences for students. Achieving this goal would require that the partnership be a rewarding experience for each partner. In other words, both teachers and museum educators should expect to reap beneficial outcomes from the partnership. For teachers, the benefits entail professional development opportunities, relevant materials, tools and skills that allow them to create high-quality experiences in the classroom. These experiences will in turn engage students in the scientific process, spark their curiosity, foster creativity in them, encourage them to think critically and enhance their understanding of scientific concepts. As for science museum educators, they expect to achieve their mission of expanding popular interest in science, disseminating scientific information and serving the society.

### *e. Well-defined responsibilities for each partner*

A shared feature of all successful partnerships is that each partner is assigned roles and responsibilities that best fit his abilities. Responsibilities that would normally be allocated to teachers include arranging for transportation, doing pre-visit and post-visit field trip activities in the classroom to prepare the students for the museum visit and to follow up on the learning that took place at the museum respectively, pointing out specific Standards of Learning that they find difficult to teach and assessing the students as well as the effectiveness of the classroom activities. Museum educators would preferably make connections between the hands-on experiences provided by the museum and the scientific concepts studied in schools. They would also conduct professional development programs for teachers. The critical responsibility of creating inquiry-based classroom curricular unit can be shared between both partners to fully exploit their expertise.

### *f. Parent participation*

Shifting from the conventional teaching techniques to inquiry-based, object-oriented teaching techniques can raise skepticism among many parents. Therefore, teachers should inform parents about the usefulness of these new strategies for their children. In the short-term, parent involvement in the partnership will provide endorsement for it, as shown by SERC's Estuary

Chesapeake program. In the long-term, sustained parent participation will reinforce the community's relationships with the museum and the school.

## 4. Conclusion

My experience during these four months has convinced me that science museums in many developing countries could be inspired by the examples set by the Smithsonian Institution to set up effective science museum/school collaborations and to cultivate relationships that are beneficial to both museum educators and teachers in their joint endeavor to turn science learning into a pleasurable and enjoyable experience. Although funding can prove to be an obstacle to successful partnerships in those countries, grants or corporate and community sponsorships can be tapped to support the projects. All the other aforementioned salient conditions are within the reach of our institutions. However, meeting them fully would require a paradigm shift in our traditional ways of planning educational programs. By dint of willingness to change and motivation to innovate, science museums in developing countries can embrace the beneficial opportunities provided by museum-school partnerships. This will constitute a giant leap for them in realizing their full potential as educational institutions.

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## 6. Reading List

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