

SCIENCE MUSEUMS AS PEDAGOGICAL RESOURCE: TASK BASED FACILITATION

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ABSTRACT

The significance of science museums/centres as dynamic learning environments is being recognized progressively while the research on their incorporation in the teacher education programmes still needs considerable focus when referring to the discourse on quality component in science education through non-formal resources. This qualitative study explores the experiences of pre-service teachers in a science museum and in a science centre where they worked with some pre-designed tasks. The tasks were context based and were meant to stimulate their science process skills, reasoning and reflective abilities. The data was collected during the visits through observation, written responses, field notes, individual and group interactions. Another set of data was collected as narratives after a gap of six months to find out the impressions and reflections still persisting in the minds of the prospective teachers. The findings brought forth the insights into the contribution of science centres and science museums as potent pedagogic and learning resources through their experience based learning in an open and dynamic environment. The diverse nature of exhibits stimulated the prospective teachers' thinking towards creative pedagogy. The findings have implications at policy, planning and strategization levels to incorporate these resources as integral component of the teacher education programmes.

KEYWORDS: Non-Formal Resources, Science Museums/Centres, Task Based Facilitation

INTRODUCTION

If science deals with making sense of the environment around us then those learning environments that provide experience-based learning would need no evidence to support for their significance in the meaningful learning of science. The world over concern for quality enhancement in science education is increasingly acquiring critical importance along with the felt need to widen its horizons from the formal set up of classroom teaching to institutions like science museums/centres, planetariums etc. that may be considered as the alternative non-formal resources in science education. This concern stems from the need to promote popularization of science among students, enhance their interest and functional understanding of concepts in science. The present paper argues for the need to 're-envision' science education and science teaching learning resources to include in their ambit not only the formal science classroom but also the flexible and open environment of the non-formal resources in science education. The study attempts this exploration through pre-designed contextualized tasks relating to the visits by pre-service teachers to a science museum and a science centre. The researcher being a teacher educator in science attempted to explore the possibilities with a group of pre-service teachers in her science pedagogy course.

Background and Related Research

The role played by non-formal institutions in science learning has been studied by a number of researchers. These alternative resources in science education attempt to build understanding of ideas in science and their technological

applications by providing a range of diverse and multi-sensory experiences. Thereby, influencing the ways in which scientific knowledge gets constructed and also leading to the development of scientific attitude among learners. Their role may be more appropriately described as 'providing opportunities to develop a positive relationship with science'. Schools, many would acknowledge, have been somewhat successful in 'teaching students science'. However, schools have been much less successful in helping students to 'develop an ongoing relationship with science'. The extended learning resources such as science centres/museums can help to alter this situation. This puts them in a strong position to carry out the role of a 'change agent'.

Many worldwide networks of science centres reviewed studies on the impact of Science and Discovery Centres from across North America, Europe and Australasia. Of the 180 studies reviewed, 87% were concerned with learning/personal outcomes of which 54% focused on science learning, 18% focused on attitudinal change towards science, 14% on enjoyment and 7% on Science & Discovery Centres influencing career choice. Overall, the 180 papers reviewed showed that science and technology centres and museums, aquaria and zoos have a positive effect in a number of areas.

The study done by John Falk & Mark Needham (2011) focused on the California Science Centre in Los Angeles, and offered profound support for the value of such institutions. It also reinforces the *emerging concept of free choice learning*. These institutions can generate a sense of wonder, interest, enthusiasm and motivation to learn; as a result people enjoy such visits. Interactive science exhibits invite play and experimentation that engages visitors from which learning occurs. Visits with friends offer opportunities for group learning in which discussion, experimentation and one visitor tutoring other are very common.

Though, a number of studies have focused on students' learning at non-formal sites, the pedagogical worth of science museum and science centres has not been researched widely. The research has shown that school visits to science museums and science centres are often conducted in a manner that do not maximize the learning opportunities they could afford to (Faria & Chagas, 2012). There have been few studies relating to teacher preparation at these sites (Chin, 2004; Chin & Tuan, 2000; Srivastava 2010). The researcher being a teacher educator in science pedagogy conceived of providing task based facilitation to her pre-service teachers during their visits to a science centre and a science museum.

With this background the study posed the following **research questions**:

- In what ways the tasks provided stimulation to the pre-service teachers for developing better conceptual knowledge in science through their interaction with exhibits?
- Were the pre-service teachers facilitated and in what ways towards pedagogic conceptualizations through their task-initiated interactions?
- What could be the long term reflections on the visits to science centre and science museum by the pre-service teachers?

Methodology

The purpose of this study is to develop an understanding of the role of science centres and science museums in teacher preparation, not to test any predefined hypothesis. This research is emergent rather than pre-figured, it has taken place in a natural setting to capture the nuances of the actual experiences of the participating individuals. The focus of this research is on understanding participants perceptions and experiences when they visit a science centre/museum. To conduct

this type of research a qualitative research design is best suited. The researcher had gone to the site many times prior to taking up of this study. This enabled the researcher to know the details about the institutions and thereby, to design contextualized tasks (some of them exhibit specific also). In the present study the context is very important, as many researchers have pointed out that for studying the role of museum in learning, the context of museums should be the prime consideration.

The data was collected during and after the visits and another set of data was collected six months after the visits.

The study involved eighteen pre-service teachers pursuing science pedagogy course in the Department of Education, University of Delhi (India). They made three visits to the National Science Centre (Delhi) spending twenty one hours in total and they made two visits to the National Museum of Natural History (Delhi) spending fourteen hours in total. The time given to the science centre was more as compared to the science museum as the former had many more interactive exhibits.

Tool

Assessing learning in Science Centres is difficult (Lucas1983, Lucas et.al.1986). Their unpredictable and 'free choice' learning environment results in multiple outcomes from the visit. The ways to measure the expected and unexpected outcomes must be sought to get a holistic picture of what is learned and how. The need to preserve the context of learning is critical to the reliability of the data. Therefore, the tasks designed by the researcher involved a number of pre-visits to the two institutions.

The Tasks

The tasks (ref. Appendix) were a mix of open-ended, reflective and exhibit specific. The participants had a freedom to go beyond the tasks to exercise their creative thinking. The tasks were to be conducted at individual as well as in groups.

The tasks presented situations from the exhibits, taking the participants from operational and observational levels to reasoning, extrapolation and finally to reflections at societal levels,

The tasks were designed for two stages: i) during and immediately after the visits data collection. ii) six months after the visits.

FINDINGS AND DISCUSSIONS

All the 18 pre-service teachers expressed keenly that they wanted and that they would visit these institutions again. Fourteen of them wanted to have fun in the Science Centre with their family /friends and 13 wanted to give more time to some interesting models and all 18 of them especially wanted to suggest National Science Centre (NSC) visit to their friends for improving their scientific knowledge. Perhaps, the technologically equipped interactive nature of majority of the exhibits at NSC motivated the participants.

Most of the responses to the tasks 1, 2, 3 and 4 indicated that the exhibits at the National Science Centre excited them, aroused their curiosity and engaged them in an interesting manner. A majority of them said that the exhibits portray science as a way of experimentation and hands-on experiences clear their doubts about the content they learn from books. The exhibits related to human biology could help them to relate to contemporary situations and societal concerns in an

engaging manner.

The researcher observed that the participants mostly liked working in groups. The peer interaction was significantly high and lively. They were seen wondering about complexities of some models and some of them not giving much time to models which were not easily understood by them while others took these as problem-solving situations. Here the peer interaction was helpful.

The tasks 5, 6 and 10 were attempted through correlations of historical perspectives in science, creative speculations through a time-line and with attempts towards building logical explanations.

The responses and discussions relating to tasks 7 to 13 showed the sensitizations of participants to socio-scientific issues and environmental concerns.

The individual and group interactions of researcher with the participants showed strong inclinations of the participants towards gaining confidence in a better understanding and joyful teaching of science.

The data collection after six months brought forth the reflections and ponderings in a wider context; some excerpts:

[The memory of those visits flashes my experience in the 'fun science gallery'. My interactions there amaze me still! Some of the concepts related to conservation of momentum became clear to me in multiple ways. I hope I will be able to explain them very well to my students]

[Every time I recall my visits I am reminded of an alternative concept I was holding relating to the relative motion on a straight versus curved path. I could clarify my misconception by actually doing it. The level of excitement I had by doing it and the satisfaction of meaningful learning drives me today to how much I can enable my students to enhance their learning]

[A lot of excitement bursts within me whenever I think of those visits. The institutions like NSC and NMNH bridge the gap between the science in books and the science around us. I remember studying a lot about 'plasma state' in my graduation. But when I saw it through my eyes, I felt like kneeling down and thank NSC to make it possible to see what is quite a secret in industry or real life]

[The whole environment still arouses a wave of joy and excitement about science which I never felt before in my life and which I now want to pass on to my students. The tasks that we had with us during the visits, facilitated us towards a 'meaningful interaction' with the exhibits These tasks have given us ideas about planning such visits for our students and the follow up assessment]

[The first thing which I remember noticing was the NSC comes under the Ministry of Culture. Then, I thought as to why this institution is not under the Ministry of Science and Technology. Now I feel, by visiting this institution that there is promotion of the 'culture of science' among the visitors. These institutions act as bridges between the history of science and the emerging new fields]

CONCLUSIONS

The study makes it evident that the institutions like science museums and science centres have a potential to provide stimulating and enjoyable environment for understanding the science concepts and phenomena in the real spirit of

science through hands-on activities and multi-sensory experiences. The findings indicate that the pre-designed tasks activated the thinking in a creative manner and also aided the participants in organizing their thoughts, extrapolate them to pedagogical domain and they could reflect beyond the tasks too, as indicated by the narratives. Furthermore, the learning experiences seem to contribute significantly towards creating a lasting passion for science as a student and as a teacher both.

There is a scope to further probe into the linkages between the science pedagogy experiences in the classrooms and those at the science centre/museum, so as to strengthen the various dimensions of science teacher education in the long run. The study has implications at policy, planning and strategization levels to incorporate such experience based learning resources as integral component of the teacher education programmes as well as school science education.

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APPENDIX

Field Tasks for Science Group

These tasks aim at arousing curiosity and deepen the thinking, observation, speculation, interpretation and discussion skills of the prospective teachers. The department has identified two science institutions located in Delhi for undertaking a visit with our prospective teachers—the National Science Centre (NSC) and the National Museum of Natural History (NMNH). Some educational tasks have been designed that are to be done by the prospective teachers during the visits. A brief introduction of the institutions identified and the related tasks are presented in the following section.

Institution 1: National Science Centre (NSC), Delhi

The National Science Centre, Delhi is a unit of the National Council of Science Museums, which is an autonomous body under the Ministry of Culture of the Government of India. Inaugurated on the 9th of January 1992, it works for popularizing science among the general public at large & students in particular; achieving scientific literacy in the country; inculcating Scientific Awareness & Scientific Temper; and preserving the Science & Technology Heritage of the country.

We shall undertake a visit to the NSC for three days (seven hour each day), around 21 hours. During the visits, we shall focus on deeper engagements with the various exhibits displayed in the seven galleries. Our student-teachers are required to focus on the following tasks:

- On the very entrance of the NSC, you will find a "Magic Tap", and a "Magical Piano". *Interact with them, observe them carefully and try to speculate about and find out the scientific reasoning behind the 'magic'. How does science help in demystifying such “magical experiences”?*
- There is a display in the NSC on the "Energy Balls". *Observe it carefully and identify the types of paths travelled by the balls; try to measure the time taken by any one of the ball to reach down; find out at which point of the path do the balls gain momentum. Explain your observations.*
- The "**Fun Science Gallery**" has 137 interactive hands-on exhibits which aim at presenting school science in a simple and enjoyable way.

- Form your groups of three (total six groups), each group will select five different exhibits (no common exhibits among the groups). *Interact with these exhibits you have chosen and discuss how these exhibits explain the scientific principles in an enjoyable manner.*
- On the fourth floor of the NSC , there is a "**Human Biology Gallery**" depicting 118 exhibits that aim to portray the human body in all its aspects: anatomical, physiological, biochemical, structural, functional and systemic. *Interact with the exhibits and reflect on how they helped you in revisiting your ideas about the structure and function of the human body and creating a rational understanding of the same. Also reflect on how do the exhibits educate the visitors on immunity, diseases and healthy living and make them aware of the new concepts in biology like genetic engineering and biotechnology.*
- There is a gallery on "**Our Science & Technology Heritage**". The 106 exhibits in this gallery depict how, in course of time, side by side with art and literature, there grew up on Indian soil, a very rich scientific and technological culture. What interested you most in this gallery and why? *Critically reflect on India's contribution to fields such as space science, nuclear science, information technology, communication, biotechnology, agriculture and food production, energy, transportation etc. in present times.*
- The 48 exhibits in the "**Pre-Historic Life Gallery**" present a recreation of the world that none of us have seen as it existed millions of year ago and many of its life forms have become extinct by now. Selected 35 species of life forms of different ages such as Trilobites, Giant Scorpions, early birds, gigantic dinosaurs and other living creatures up to Neanderthal man have been presented in the gallery with artificially created matching ambience and special light and sound effects. *On the basis of your observations and interpretation of the exhibits on origin of life and evolution, explain your understanding about the concepts.*
- **The "Information Revolution Gallery"** presents the story of evolution of Communication Technology over past 6000 years in India. *Taking examples from the exhibits in this gallery, explain the relation between technology and culture. Also depict the major landmarks in the 'information revolution' on a time-scale devised by you.*
- **The "Emerging Technologies Gallery"** portrays the revolutionary changes that are taking place in nine representative technologies—Space Technology, Information and Communication Technology, Medical and Biotechnology, Oceanography and Earth Sciences, Agricultural Technology, Material Science, Nanotechnology, Energy and Transportation Technology. *Based on your observations of the exhibits explain how different branches of science converge in developing certain technologies. Substantiate your answer with specific examples shown as exhibits.*
- On the ground floor, there is a gallery by the name "**Water: The Elixir of Life**" which has 34 interactive exhibits. The exhibits give an account of the water available on the planet Earth, and even in living beings. The gallery especially tries to sensitize people about the misuse of water. *Do interact with the exhibits and critically comment on their effectiveness in sensitizing people visiting the centre about the various crucial issues related to water as a resource.*

Institution 2: The National Museum of Natural History, Delhi

The National Museum of Natural History(NMNH) is a national level institution devoted to environmental

education. Set up during the Silver Jubilee celebrations of India's Independence I 1972, the NMNH works to portray and promote awareness on the Natural Heritage of the country. It houses a number of theme-based exhibition galleries, experiential resource centers such as Discovery Room, Activity Room, and educational and out-reach activities, with the intention to depict the country's rich natural heritage and natural history (geology, botany and zoology). Among other things, the NMNH also works to develop Environmental Education resource materials (such as audio-visual aids, low-cost teaching aids, school loan kits, etc.) to promote environmental education and undertake research (museological and collection based).

The NMNH, New Delhi has three exhibit galleries, namely: "Introduction of Natural History", "Nature's Network: Ecology" and "Conservation". We shall undertake a visit to the NMNH for two days, around 14 hours. During our visit, we shall take a general tour of the whole centre and shall visit all the three galleries of the NMNH and shall focus on deeper engagements with the various exhibits displayed in the three galleries. Our student-teachers are required to focus on the following tasks:

- The Gallery 1 on **“Introduction to Natural History”** portrays the origin and evolution of life and presents the variety and diversity of the flora and fauna of our country. The presentation follows a section on evolutionary sequences and evidences to establish how the present day life evolved. *Based on your observation of this gallery, explain how the exhibits as resources (a) influence your earlier notions about the Evolution of Life and (b) can supplement the classroom teaching.*
- The Gallery 2 on **“Nature's Network: Ecology”** presents an overview of major ecosystems of the world, role of plants as primary producers, food chains, food webs, decomposition, bio-geochemical cycles, Interrelationship among plants, animals and human beings, present day environmental problems such as pollution, deforestation, depletion of wildlife etc. and the reasons (ethical, aesthetic, economic and scientific) for conservation. *Critically comment o the effectiveness of the exhibits of this gallery in sensitizing the visiting teachers and students about various environmental problems.*
- The Gallery 3 on **“Conservation”** deals with many aspect of conservation of nature. *Based on your observations of this gallery, make a list of the endangered species of the various fauna and flora of the country and critically comment on the various conservation projects initiated in the country for saving such species from extinction. Also comment on what interested you most in this gallery and why.*
- The NMNH also has a rich collection of '**museum-specimens**'. There is a good collection of butterflies and several herpetological specimens. *Observe these specimens and try to find out how such specimen collections are made. Also comment on the pedagogic utility of these specimens.*

Reflective Questions (Taken up after Six Months)

- Based on your visits, observations and experiences at the NSC/ NMNH, what fascinated / appealed to you the most and why?
- How can visits to institutions like NSC or NMNH help you enhance your understanding about the concepts in science and the pedagogy of science to facilitate your students' understanding about the concepts in science?

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