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BUILDING A CASE FOR EXPERIENTIAL LEARNING IN SCIENCE

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ABSTRACT

The significance of first-hand experience based learning has been quite undermined when referring to discourse on quality component in science education. This study attempts to explore the contribution of a National Science Centre towards enrichment of science education by exploring the perceptions of students and teachers about the diverse exhibits and their context. The study has a qualitative design. The sample consisted of eighty students and twenty teachers. For the purpose of triangulation the data was collected through questionnaires, interviews and observation. The findings brought forth the insights into the contribution of science centre as a potent pedagogic and a learning resource through its experience based learning in an open and dynamic environment and that it has a major scope to supplement the classroom teaching and to develop a passion for science among students. The diverse nature of exhibits stimulated the teachers' thinking towards creative pedagogy. The findings have implications at policy, planning and strategization levels to incorporate the experience based learning resources as integral component of the teacher education programmes as well as school science education.

KEYWORDS: Exhibits, Experiential Learning, Pedagogic and Learning, Resource Science Centre

INTRODUCTION

If science deals with making sense of the environment around us then experience-based learning would need no evidence to support for its significance in the meaningful learning of science. The world over concern for science education is increasingly acquiring critical importance along with the felt need to widen its horizons from the confines of formal classroom teaching to institutions like science centres /museums, planetariums, bio-diversity parks etc. that may be considered the alternative resources in science education. However, the contribution of *experiential learning* in the teaching and learning of science has remained relatively undermined and finds very little articulation in the discourse related to the quality component in science education, especially in the Indian context. The present paper argues for the need to 're-conceptualize' science education and science learning resources to include in their ambit not only the formal science classroom but also the flexible and open environment of the other resources in science education.

Background and Related Research

The experiential learning builds up through first-hand i.e direct experience wherein the learner is actively engaged, observes, perceives, manipulates and infers through an active interaction and involvement. The concept of experiential learning was first explored by John Dewey and Jean Piaget, among others.

It was made popular by education theorist David A. Kolb, who, along with John Fry, developed the 'experiential learning theory,' which is based on the idea that 'learning is a process whereby knowledge is created through transformation of experience' (as quoted on *SimplyPsychology.org*). The 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 development of scientific attitude among learners.

The popularly held view is that science learning and ultimately a nation's scientific literacy depend on how the teaching and learning of science is conceived, organised and transacted in schools. While this is not undeniable, yet, it is becoming increasingly important to recognise the significance of mass media, science centres and museums, industry-based programmes, out-of-school community education programmes and other science learning resources as very valuable components of a nation's science education infrastructure. In most countries, there are serious gaps in educational infrastructure which are seen to limit the levels of scientific literacy. These gaps can largely be overcome through the strategic formation of partnerships between schools and institutions of extended learning in science. It is important to recognise that the alternative experiences in science education not only provide a sustained motivation which make school based learning more effective, but also provide a critical overlap to create increased opportunities for learning science. There is thus a need to view experiential learning as integral to science education. This has been the strategic emphasis of the Project 2000+ since its launch in 1993, jointly by UNESCO and several International IGOs and NGOs including the International Council of Associations for Science Education (ICASE).

There are many types of institutions that contribute to enrichment of teaching learning processes in science. Since the present paper deals specifically with Science Centres, the subsequent discussion will focus on this.

The particular role of Science Centres is not so much concerned with 'teaching people science', although science learning does take place in Science Centres. Rather, 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 can help to alter this situation. This puts them in a strong position to carry out the role of a 'change agent'. For example, the Franklin Institute Science Museum in the USA played an important role in initiating Philadelphia's Urban Systemic Initiative project. This initiative involves the strengthening of ties between the museum community and schools, developing local science mathematics and technology exploration centres, providing professional development opportunities for teachers and providing specialised training in the use of new educational technologies. Teachers become familiar with a variety of learning strategies based on the constructivist learning model; gain confidence in teaching a variety of topics as they develop an understanding of science principles; develop skills in designing interactive science and technology activities based on their own curriculum requirements.

Robin Garnett(2002), on behalf of The USA-based Association for Science and Technology Centres (ASTC), ECSITE and other 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 shows science and technology centres and museums, aquaria and zoos have a positive effect in a number of areas.

The evidence based on four case studies describing the motivation of school students visiting Science Centres is presented by Salmi (2003) in work undertaken at Heureka, the Finnish Science Centre. The findings suggest that the

situational motivation of students can be changed to intrinsic motivation by well organised programmes linking schools to the informal, open learning environments of Science Centres. In addition, a survey taken among 1,019 first and second year students at the University of Helsinki attests to the fact that informal learning sources such as Science Centres seem to have a stronger impact on the academic career choices of students than has hitherto been thought.

Some longitudinal studies **(**Falk, Scott, Dierking, Rennie and Jones, 2004; Medved & Oatley 2000; J.stevenson 1999) indicated that not only do visitors remember their visits experience , but in many cases they report outcomes some time after the visit were found to be different from those reported at the time of visit , providing evidence that related learning has continued to occur. 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*, which holds that people gets most of their knowledge about science from someplace other than school or formal education.

In India, during the past fifty years there has been a substantial growth in the number of institutions imparting science education and also in the students enrolling in science streams. At the undergraduate level such enrolment was 125,000 in 1950and by 2000 it increased tenfold. Despite this as an outstanding growth in numbers, the overall percentage of students opting for science has consistently declined over the years--1950-32%, 1986-20%, 2000-15% (*source -"Science Centre as science education resource centre"- a critical study, Srivastava, 2010).* If we try to find out reasons for this decline and look into our formal education system at the school level it may be seen that a large number of students are educated in schools which are overcrowded, ill equipped and under-staffed. Science education has become entirely chalk-talk-rote routine without any emphasis on understanding of the basic concepts and the unity of the subjects. Very few schools offer classrooms demonstrations (although science is truly experiment based).This depressing environment curbs the inherent and natural interest in doing science. As a consequence, thrill and fun in learning science has decreased.

The Science Centre activities can very effectively and substantially fill up what is missing and bring back the quality in science learning through interactive science learning approach. The Science Centres have been identified as an important resource in encouraging students to opt for higher education in science. An excursion to science museum is a part of school outreach programmes for many schools.

Almost all Science Centres in India or abroad work with a two pronged strategy – exhibits and activities. A Science Centre is an interactive educational institution, in which visitors can work with their own hands, see with their own eyes, touch and feel objects on many different science phenomena. A Science Centre is a place where touching all exhibits is "strictly allowed" and where by doing things and experimenting everyone can understand how the wonderful world around us works. The Science Centre does have a very important role in development of science concepts as they emphasize on hands-on activities related to real-world objects and events, with social interaction and group performance emphasized. Though, earlier the Science Centres were criticised and it was considered that they provide only fun and entertainment and very little learning occurs from them, now it is believed that children learn from variety of sources outside the classroom. Learning science in an open environment serves as a broad range of intended outcomes, like inspiration, emotional reactions, and reframing ideas, introducing new concepts, communicating the social and personal value of science. They can generate a sense of wonder, interest enthusiasm 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.

Thus various studies have highlighted the short term and long term impact of the Science Centre visits and their findings motivated the researcher as a teacher educator in science to explore the experiences the students and teachers have at Science Centres and further to draw their pedagogical worth in the Indian context. The researcher had been to the National Science Centre of India (situated in Delhi) many a times along with her pre-service teachers and was fascinated by the vibrancy and openness of its environment. Every time there were groups of excited school children accompanied by their teachers engaged with the exhibits. With this background the study posed the following research questions:

- What are the observations and conceptualizations of students and teachers about the exhibits in the National Science Centre
- How do the experiences at the National Science Centre contribute towards strengthening of dimensions of science education

The National Science Centre in Delhi is a unit of the National Council of Science Museums, which is an autonoums body under the Ministry of Culture of the Government of India.It is a pioneer institution engaged in the popularisatrion of science among the people in general and among the students in particular. It has seven exhibition galleries spread over different floors:

- Emerging technologies
- Water:The elixir of life
- Fun science gallery
- Human biology gallery
- Heritage gallery
- Information revolution gallery
- Prehistoric life gallery
- Other activities: 3D film shows, Taramandal show, science seminars , summer vacation hobby camps , science fair, popular science lectures .

Although the National Science Centre has a huge and impressive collection of exhibits in its various galleries the researcher selected the gallery on ‘human biology’ for conducting her study as the contents of the exhibits in this gallery overlap maximum with the secondary level science curriculum in schools.

METHODOLOGY

The purpose of this study is to develop an understanding of the role of Science Centres in education, not to test any predefined hypothesis and generalize the findings. 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. 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 institution. During the study also the researcher went a number of times to the National Science Centre.

Many studies done on wider museum context in 1970 and 80's were mostly experimental in design and were focused on measuring specific outcomes. In these studies the outcomes were already predefined so there is a chance of missing unanticipated outcomes. According to Falk and Dierking (1992) much research in museums has suffered from the misguided notion that learning is primarily the acquisition of new ideas, facts or information, rather than consolidation and slow, incremental growth of existing ideas and information.

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 maintained. Further, the contexts are unique and dynamic; hence case studies investigate and report the complex dynamic and unfolding interactions of events, human relationships and other factors in a unique instance. So, case studies provide context dependent knowledge. Hitchcock and Hughes (1995:322) further suggest that the case study approach is particularly valuable when the researcher has little control over events. Thereupon, the researcher chose to do a case study of a National Science Centre as a learning resource, where people from all age groups, students, teachers and general public use to come. The researcher chose case study approach as it provided an opportunity to observe a dynamic and open setting and how it was perceived by students as well as teachers. The researcher focused on two integral components of educational system – students and teachers.

The Sample

As the present study was conducted in the National Science Centre itself, the researcher had to adopt 'Accidental Sampling' design i.e selecting the schools that happened to make visits to the Centre according to their pre-decided schedules. A total of eighty students out of students visiting the National Science Centre were selected for the data collection.These students were at the terminal stage of secondary education and would be making their choice of specialization streams (sciences,humanities etc.)very soon.Hence the researcher was interested in knowing the impact of alternative learning environment in influencing their interest in science. A total of twenty science teachers were also selected out of the teachers who visited the Science Centre , as without knowing teachers attitude towards role of Science Centre, the present study would have remained incomplete. The schools selected were chosen in terms of their availabilty in Science Centre and willingness to participate in our study.

Tools

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. Ideally, the data collection during a visit to Science Centre needs to be unobtrusive, so that the researcher does not affect the behaviour of the visitor. But unobtrusive data collection can pose the problem of interpretation. Some researchers have used observation only. The purpose of the observation was to document visitors interaction, not their learning .The studies shows that a questionnaire can only be effective when the visit is highly structured or when it relates to particular exhibit. As one tool is not sufficient to fulfil the objectives of the study the researcher had used three different tools for the triangulation of data. The tools constructed by researcher for the present study were:

- **Questionnaire** for students and teachers with close as well as open ended items; broadly pertaining to their perceptions about the exhibits under the themes for students - supplementing formal science education, awareness and knowledge in and about science and technology, interset curiosity, inspire, engagement, popularsing science among students. In the teacher's questionnaire the themes were- content quality, potential of exhibits for education vs entertainment and their perceived role in linking the science learning in school with the learning experiences at the science centre.
- **Interview Schedule** (semi-structured) for students and teachers. The schedule for students was constructed to know the role of Science Centre in changing attitude of students towards science and to study students' attitude towards participation in interactive exhibits. The schedule for teachers was developed to know the adequacy of exhibits for supplementing science teaching in schools and to know the contribution of Science Centre in improving professional expertise of science teachers.
- **Observation Schedule** To get familiar with the emotional behaviour and spontaneous reactions displayed by the students and teachers at Science Centre. To gain indepth understanding about the nature of interactions amongst students and also between students and teachers . To substantiate/validate the data gathered through other tools (Questionnaire and interview)

FINDINGS AND DISCUSSIONS

Out of the 80 responses from students, all indicated that the National Science Centre played the role of popularising science among students very well. As all 80 students wanted to visit the National Science Centre again, 41 students wanted to have fun in Science Centre with their family /friends and 39 wanted to give more time to some interesting models and all 80 students wanted to suggest National Science Centre visit to their friends for improving their scientific knowledge.

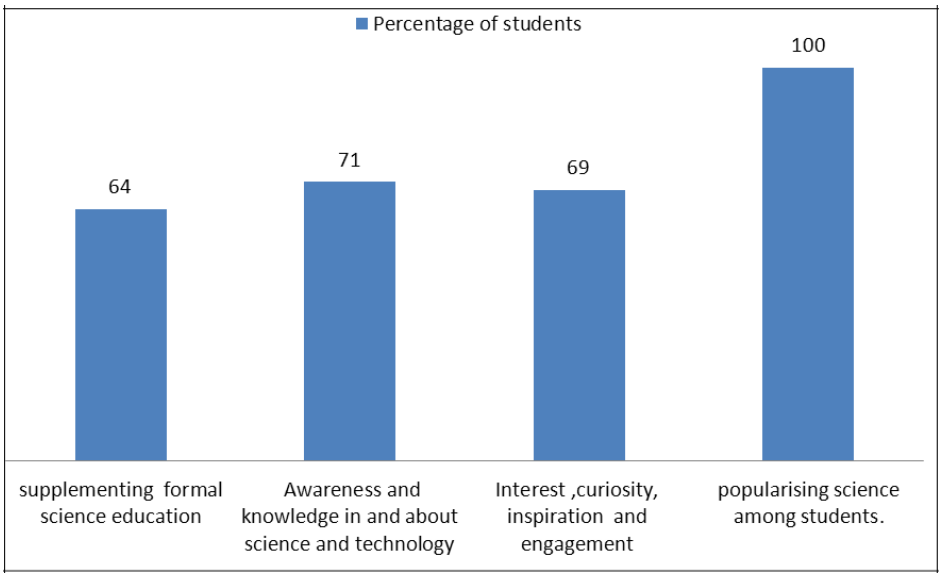

Figure 1: Graph Showing Students' Perception towards Roles of Science Centre (Analysis of Data from Student Questionnaires)

Most of the student responses indicated that the exhibits at the National Science Centre excited them, aroused their curiosity and engaged them in an interesting manner. A majority of the students said that the science centre portrays

science as a way of experimentation and hands-on experiences clear their doubts about the content they learn from books. After visiting the science centre the students felt that science is not only about complicated laws and principles but it is about their daily life and full fun and thrill.

When probed by the researcher, majority of students said that they wanted to come again for playing and enjoying with these exhibits. They felt that participation in interactive exhibits initiated curiosity; it is fun to participate in these exhibits. Participation in exhibits changed the students' view of taking science as one of the way of enjoyment instead of burden. It was therefore inferred that students had a positive attitude towards participation in the interactive exhibits. After observing the students during their visit to the National Science Centre, the researcher could say that the students were highly motivated and eager to work on exhibits. The researcher observed that the children mostly liked working in groups. The peer interaction was significantly high and lively; children were asking lots of qu The researcher also observed that the students were wondering about complexities of some models asking trs to takenot giving much time to models which were not easily understood by them.

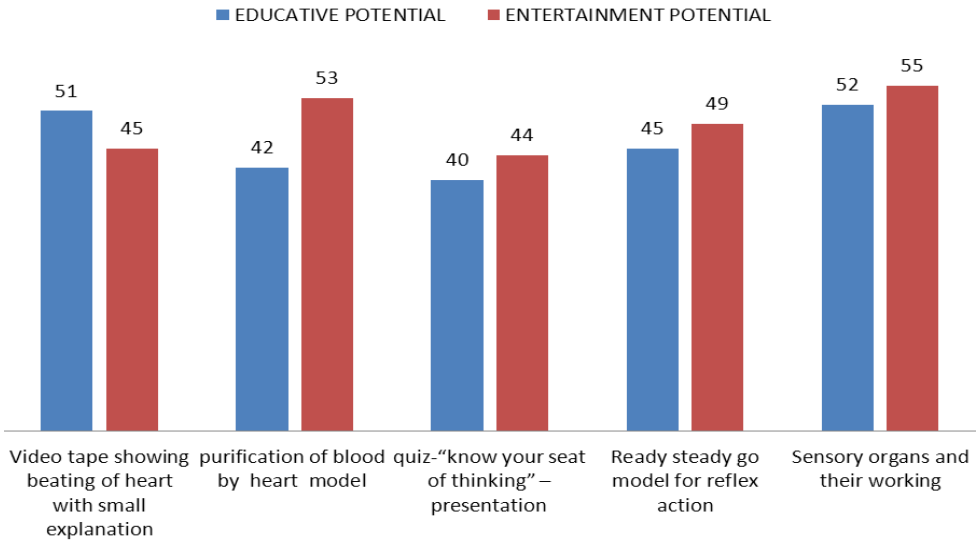

Figure 2: Graph Showing the Comparison of Teachers' Perceptions of Exhibits Terms of Educative and Entertainment Potential (Analysis of Data from Teacher Questionnaires)

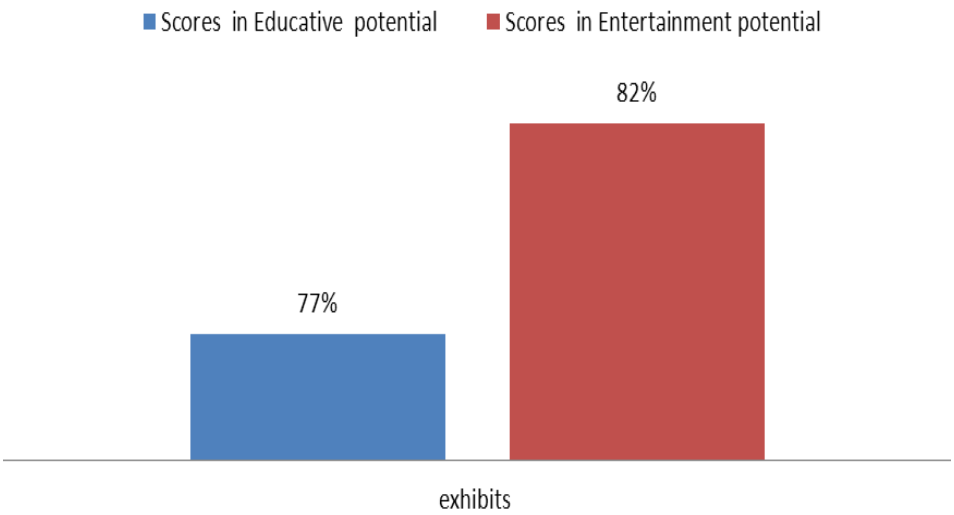

Figure 3: Graph Showing Total Potential of Exhibits in Education and in Entertainment as Perceived by Teachers

Most of the teachers felt that the exhibits have a good potential for educative as well as enjoyment purpose. The teachers also felt that the quality of content offered by National Science Centre is excellent or very good. According to the majority of teachers, the National Science Centre contributes to a large extent in improving the knowledge of science among students as it provides a common platform for playing , having fun and learning science in excellent or in very good way. Most of the teachers felt that changes do come in students' understanding of science.

When interviewed by the researcher some of the teachers felt that for explaining some difficult concepts in science, the exhibits are adequate but they also felt that the exhibits related to chemistry are less than those in the other branches of science, while the models related to physics are very good.

Some of the teachers felt that post-visit follow-up exercises can be used as an assessment of learning that happened in the science centre. The teachers think that by making science centre visit a tool for assessment tasks, the visits could have be more purposeful. However, some teachers were little apprehensive about having the required competencies to meaningfully integrate the classroom learning and the experiential learning at the science centre.

Many teachers felt that visiting the science centre improves their professional expertise as it improves their pedagogy, they can take examples of models seen in the Science Centre by students as well as by teachers. The teachers also responded that they felt more informed and aware to guide students about their future subject choice and carrier options regarding the areas in science and emerging technologies.

The perceptions of students and teachers indicate that the multi-sensory experiences at the science centre successfully lead to a "functional understanding" of the concepts and principles in science. The dynamic environment provides much needed stimulation and developmental opportunities for 'science process skills' as well as the critical thinking and problem solving skills. Through the embeddedness in historical and socio-cultural contexts also (as depicted in Science Heritage Gallery) the science centre provides a realistic experiences of science as a social enterprise. Thus the findings majorly support that the National Science Centre as a valuable pedagogic and learning resource dynamically facilitates the achievement of cognitive, affective and social dimensions of science education through its diverse experiences.

The study has implications at policy, planning and strategization levels to incorporate the experience based learning resources as integral component of the teacher education programmes as well as school science education.

CONCLUSIONS

The study makes it evident that the institutions like 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. Furthermore, the learning experiences seem to contribute significantly towards creating a lasting passion for science among students and teachers both.

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

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