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**The Impact of the NIHERST/
NGC National Science Centre,
Trinidad and Tobago on Visiting
Student Groups**

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Contents

Abstract	4
Keywords	4
1. Introduction	5
1.1 The Study	7
1.2 Location of the Study	8
1.3 Acknowledgements	10
2. Methods	11
2.1 Justification of Methodology	11
2.1.1 Special Requirements	13
2.1.2 Additional Considerations	13
3. Results	14
3.1 Results from survey questionnaires	14
3.2 Results from pre-visit activity	16
3.3 Results from post-visit activities	17
3.4 Pooled Data: Visitor Enjoyment	18
3.5 Pooled Data: Visitor Education	22
4. Discussion	25
4.1 Visitor enjoyment – The entertainment factor	25
4.2 Visitor learning – The education factor	27
4.3 General conclusions	30
References	32
Appendix I	
Appendix II	
Appendix III	
Appendix IV	
Appendix V	
Appendix VI	
Appendix VII	
Appendix VIII	

Abstract

The aim of this study was to assess the impact of a visit to the NIHERST/NGC National Science Centre in Trinidad on four different school-age visitor groups. The research was conducted through the administering of a post-visit questionnaire immediately upon completion of each visit by each group, and via visitor feedback obtained in post-visit or pre-visit activities conducted within two weeks of the visit for three groups. Teachers/instructors who accompanied the groups on their visit also completed post-visit questionnaires and provided additional information on follow-up activities via an interview. The results of this investigation suggest that the visit to this science centre provided entertainment/enjoyment value and potential educational value to most individuals. The nature of this enjoyment was noted for various age groups and genders in this study. Quantification of the educational impact was not possible within the constraints of this study, which was unable to capture long-term effects of the supply of 'new knowledge' to visitors which the visit to the science centre had provided. The free-response questions of the questionnaires however gained insight into the 'free choice learning' potential of the National Science Centre to school-age visitors.

Keywords

Visitor studies; science centre; education; 'free choice learning'; science popularisation; interactive; exhibits; students; questionnaires; pre-visit and post-visit activities.

1. Introduction

In the present era, a country's possession of a scientifically and technologically literate population is considered to be more than a useful attribute, as it is almost a necessity for competitive socio-economic development. This literacy no longer is a unique quality of scientists and those who pursue academic studies in this field; indeed, the relevance of science and technology to the ordinary citizen should pervade every individual's consciousness. It is, however, a continuously difficult task, to make science accessible and understandable to the 'masses'. Public perception of science has, through the centuries, been largely negative, in that the average citizen sometimes cannot grasp the relevance of science perceiving it to be a field requiring much effort to be understood.

The birth of science centres and museums in the 1950s and their subsequent explosion within the 1980s, provided opportunities to make the communication of science easier, using informal, interactive and entertaining means. These institutions, in their structure, content and means of visitor interaction, have created to a large extent, a viable mechanism for educating while entertaining, and interpreting complex concepts of science to the non-scientists. The basis of these mechanisms is the ability to attract, hold and teach the visitor through interaction and discovery, in meeting the centre's educational goals (Busque, 1991).

The extent to which science centres are able to achieve their mandate is best determined by assessment of the visitor experience. Has the visit changed their previous view of science in any way? Have they learnt anything new from being at the centre? These are all pertinent questions, which, when answered can act as indicators to the operators of these institutions on whether the objectives of informal learning in science are being met.

In Trinidad and Tobago, as in most countries around the world, formal teaching of science begins at the primary school level. Indeed, pre-schoolers have some exposure to science, by introduction to animals, plants, understanding what the different parts of the body do and other such basic facts. At primary school, science is taught, but not examined as a separate discipline at the secondary entrance assessment examination level (at age 11+ years); mathematics is however taught and examined as a separate subject. .

At the secondary school level, science is taught in the lower forms as a combination of the sub-disciplines of physics, chemistry and biology, as general science, and mathematics is taught as a separate subject. Some secondary schools may also offer agricultural science as a separate subject. Selection of subjects for secondary level examinations (Caribbean Examinations Council or General Certificate of Education – Cambridge – Ordinary Level Examinations) is usually done in the third year of secondary schooling, in preparation for a two-year syllabus. Mathematics is a compulsory subject at Ordinary Level for all secondary school students. Students who do Advanced Level examinations, continue studies in a minimum of two of their selected subject areas for another two years. In non-traditional secondary schools, where students may be introduced to trade or craft subjects, there is little emphasis on training or exposure to science.

School groups which visit the National Science Centre do so for many reasons. The visit is usually arranged by a teacher who may wish to (a) provide students with an opportunity for an

'out-of-classroom experience'; (b) expose students to science; (c) respond to an advertised activity which is deemed beneficial to the students; (d) provide students with an opportunity to gain alternative explanations of concepts already covered in formal classes (pers. comm, 2004)¹ These are just four possible reasons, which range from the general to the specific. Whether for entertainment or for a specific learning objective, students who visit the science centre have the opportunity to learn during their visit. This learning may be sought out, or may be incidental; it may be of great magnitude or it may be simply the sparking of a thought process. Whatever the nature of this learning, the ability of a centre to enable this output is an attribute which it hopes to achieve. It is also an attribute that must be measured, so as to gauge the success of its effort (Garnett, 2002; Rennie and McClafferty, 1999).

Evidence of learning in a science centre is often difficult to demonstrate, however, some authors have itemised a few indicators that give insight into the learning behaviours displayed by visitors to science centres and museums (Griffin, 1998 as quoted by Bailey). Among these are the asking of questions, the comparison of findings with others, the exhibiting of curiosity and explaining to others. Group visits perhaps provide even better opportunities than visits by individuals, for these actions. More than this, learning is marked by the sparking of interest, and, as Voris *et al.* (1986) puts it, the sharpening of perceptual skills, and development of a sense of wonder. An expedition arranged by a teacher that does not link with work covered or to be covered in the classroom therefore is not a wasted trip; it provides value in that it enables the opportunity to open up new vistas, to teach something new, and to spark new interests. A science centre therefore provides content that would be of potential interest to both the science-minded and the non-science minded student; the novice as well as the seasoned science student.

Further to this 'sparking of interest' is the consideration that the variety of individuals that visit a science centre, each come with their varied experiences, backgrounds and personal agendas. Howard Gardner, a developmental psychologist, offered the 'Theory of Multiple Intelligences' (Gardner, 1983) as an expansion of the concept of intelligence, originally considered to be bi-layered in mathematical and linguistic ability. Instead, according to Gardner, an individual possesses seven intelligences – visual/spatial; verbal/linguistic; logical/mathematical; bodily/kinesthetic; musical/rhythmical; interpersonal; intrapersonal – each to differing degrees, which create unique opportunities and mechanisms for learning. The concept of Multiple Intelligences is quite applicable to science centres, in that these institutions offer opportunities for different individuals to engage with the centre's content on various levels as they see, touch, hear and think. The activation of the senses in this engagement facilitates absorption of the content as it excites, stimulates and provokes thought, enabling deeper understanding and impressionability of the experience on the visitor (Brualdi, 1996).

The study of visitors at a science centre can provide some food for thought in support of this theory, as such study may enable exploration of the attitudes with which the varied mix enters by examining the interests that are pursued during the visit, and the types of exhibits or activities which stood out to them in a related post-visit questionnaire or post-visit activity.

Capturing the interest of a visitor and maintaining it, are main concerns of a science centre. Gauging the learning that has taken place during a visit is of equal value, if an assessment of the

¹ Personal communication with Science Educators at the NIHERST/NGC National Science Centre, 2004.

given mandate of the institution is to be measured. Visitor studies which are designed to capture information on the success of the attracting, holding and learning powers of the institution, will be of great benefit to the centre's development.

Falk (2000) describes the human trait of 'free-choice learning' which performs a fundamental role in the public understanding of science. People learn 'what they want, when they want, where they want, and with whom they want' under their own motivations and according to their own agendas. In the given scenario of young visitors attending a science centre, there is a spectrum of motivations and attitudes intrinsic to each visitor, regarding learning and specifically the learning of science. Some of these youngsters may be interested in science, while some may be very turned off of science. Some others may have a view of science that is coloured by exposure to science fiction books and movies, while some have concrete knowledge of science supplied by formal instruction and learning. In consideration of the 'free-choice learning' concept, a study of these visitors may reveal information about the extent to which learning is achievable by a visit to the science centre more particularly so among the youngest group of visitors whose formal exposure to science is small.

In a study of learning motivations among adult residents of the Los Angeles area, (Falk et al, 2001), it was shown that motivations for learning some concepts in science can actually be out of curiosity and interest than by an external pressure (e.g. needing to pass an exam). Free-choice learning therefore is not to be overlooked as a critical component of learning, which is gained from many leisure and entertainment pursuits, such as reading magazines, using the Internet, and visiting science museums, centres, zoological gardens and aquaria. Indeed, as Falk (2002) notes, it is a valuable support to the formal learning method, and enables 'more people, more opportunities, more of the time'.

Research has shown that the chances of learning taking place at a science centre, or of such learning being enhanced, are increased when the visitor is provided with a pre-visit briefing or post-visit activity, based on the institution's programme (Anderson and Lucas, 2001; Bitgood, 1989). Preparing students for a field trip or any out-of-school event increases the students' focus on the educational experience to follow (Bitgood, 1993). Post-visit activities - PVAs – on the other hand, are able to reinforce that learning, particularly when such activities stimulate memories of the on-visit experience (Falk and Dierking, 1995; Falk and Dierking, 1997). The onus for such activities need not be one borne solely by the teacher; indeed, in seeking to achieve its mandate, science centres may work in collaboration with school educators to develop and administer such activities as part of its outreach programmes in science popularisation.

1.1 The Study

The main purpose of this study was to gauge the impact of a visit to the NIHERST/NGC National Science Centre on its various visitor types. Specifically, the study focused on the educational worth to three types of school visitors and to school-age holiday campers. The study sought to obtain feedback from the visiting groups and their teachers to gauge this impact both through immediate post-visit feedback questionnaires and follow-up feedback through specially designed activities. These visitor assessment methods obtained for the benefit of this study and for the benefit of the host institution, valuable information on visitor expectations, preferences

and enjoyment which can contribute to the institution's future development of the Science Centre experience.

Additionally, visitor feedback would hopefully provide evidence in support of Gardner's Theory of Multiple Intelligences, when examining the types of responses gained from a variety of individuals who originated from four groups on the attraction to and interest shown in different aspects of the centre's content. Falk's concept of free-choice learning would hopefully also be demonstrated particularly in the type of feedback gained on what was learnt during the visit where the content was not a common aspect of the visitor's formal training.

The targeted visitor groups were as follows: the post SEA (Secondary Entrance Examination) students from a primary school, lower secondary school students who have not yet selected their subject areas for secondary level school leaving (Ordinary Level) examinations, upper secondary school students who have selected science subjects for Ordinary Level examinations and primary school-age holiday campers attending a vacation camp focused on innovation and invention.

1.2 Location of the Study

The host institution at which this study was conducted is the NIHERST / NGC National Science Centre in D'Abadie, Trinidad. This centre is managed by staff of the National Institute of Higher Education, Research, Science and Technology (NIHERST) which is a statutory body under the Ministry of Science, Technology and Tertiary Education of the Government of the Republic of Trinidad and Tobago. The National Gas Company of Trinidad and Tobago (NGC) is a major sponsor of the National Science Centre (NSC).

The NIHERST/NGC National Science Centre opened its doors to the public in 1997. The Centre had its genesis in a travelling exhibit forerunner known as YAPOLLO, the Amerindian word for 'discovery'. The Science Centre is the major and most visual component of the NIHERST science popularisation initiatives, aimed at developing a more technologically and scientifically literate public. It offers a variety of options for the visitor experience. Typically, however, there are four types of rotations through which groups are led during school visits:

- ⊗ The main exhibit floor at which a variety of exhibits introduces and engages the visitor in physics principles or concepts such as optics, lever systems etc.;
- ⊗ "Of Our Own" poster display, which features information on local outstanding scientists, inventors and innovators;
- ⊗ The computer zone at which visitors are able to use computers to play math games, interactive software and other features;
- ⊗ A planetarium (inflatable dome) in which shows featuring astronomical details are presented by a trained facilitator.

Just earlier this year (2004), the Centre also launched a special new exhibit under the theme "What if you couldn't?". This exhibit enables visitors to understand the way in which disabled persons are able to cope with everyday life, with the use of walking aids, visual aids and hearing aids. In the exhibit, visitors are able to engage with many interactive tools, such as being able to wheel themselves around on a wheelchair over surfaces of varying texture.

Staff at the NIHERST/NGC National Science Centre are actively involved with visitors during the latter's stay. Visitors are greeted with a brief introduction at the start of the visit, and the group, if very large is broken into smaller groups which are each taken through three or four of the four rotations by a facilitator. Each rotation lasts approximately 20 minutes. At the end of each group visit, group members are invited to complete an evaluation form to provide feedback to the staff on the visit. Apart from this standard visit structure, the NIHERST/NGC Science Centre also offers customised visits for special interest groups. These additional programmes offered by the NSC include:

- ⌘ Kidiplay – This is a specially built area at the NSC designed for children aged 7 years and under (preschoolers and infant classes). The children under the guidance of their teachers and the NSC staff engage in simple activities such as colouring, making toys, working on puzzles and similar activities within the science theme.
- ⌘ Chemistry and Biology Workshops – These workshop target secondary school students studying chemistry and biology for the Caribbean Examinations Council (CXC) Ordinary Level examinations. They examine areas of the syllabus of each subject which traditionally pose difficulty to students, in order to guide them to understand and make better approaches at responses to these topics.
- ⌘ Workshops for Primary School students – A variety of interactive workshops designed for students aged 7 – 11 years. One of these entitled “Action Toys” allows the students to develop their own toys using very simple apparatus.
- ⌘ Workshops open to the General Public – Occasionally, the NSC advertises workshops in which all age groups are welcome to participate. One of these, the “Nyam Workshop” enables persons to understand the science behind the preparation of the foods we eat, such as cookies and ice cream. The participants actually make the food items during the workshop and during this process, the scientific principles involved are explained.
- ⌘ CYSF, the Caribbean Youth Science Forum – Based on the London Youth Science Forum, this event, which takes place over the course of one week, brings together young persons of upper high school age for several of the Caribbean islands, to interact with their peers and to meet leading scientists from the region in a multitude of scientific disciplines such as chemistry, physics, mathematics, engineering and medicine. The students are able to share their experiences in science by the presentation of group projects, taking part in debates, and attending lecture/discussions and field trips.
- ⌘ Sci-TechKnoFest – a NIHERST project which is a larger than life science fair put on by the National Science Centre. This takes place biennially over a two-week period. It is the major public science popularisation activity outside of the National Science Centre with exhibits, displays and a theatre for international science showmen and local dramatic groups. Members of the Science Centre's Science Club also participate in this event, showcasing their skills in dramatic arts and puppetry to communicate principles in science.

1.3 Acknowledgements

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Vincenzo, my sweet little clone of a son, you deserve an entire paragraph for yourself: you are my inspiration! Thank you for just being you and being here in this journey and Thank You God for making him who he is! This thesis is dedicated with love to you, for you are the reason why I undertook this challenge - thank you Vinnie!

May communication in its many forms of exhibits, AV programs and science centres continue to be a delightful mechanism of sharing the inspiring and marvellous world of science with young and old alike!

2. Methods

The current means of visitor evaluation conducted by the National Science Centre involves the administering of a questionnaire to visitors at the end of a visit. The feedback requested relates to visitor enjoyment of the experience, helpfulness of staff members, and also the educational content of the experience, by asking if there were exhibits that could not be understood, the types of exhibits they would like to see at the centre, and what did they learn during the visit.

Questionnaires when used as a means of assessment preferably can zero in on specific answer options, rather than open-ended answers when being administered immediately after the end of a visit (Bell, 1999). It may sometimes be unproductive to ask tour-weary visitors to provide a detailed response to a questionnaire which has to be filled out quickly. In seeking to be concise, however, all facets of the visitor experience may not be captured by the simplified questionnaire; there may be a need to supplement this survey with additional feedback strategies, noting the limitations that each method may pose (Hein, 1998). For this reason, the method of capturing visitor feedback utilises both questionnaires and post-visit activities.

2.1 Justification of Methodology

In developing the methodology for this impact survey, certain unique attributes of the generalised visitor groups were taken into consideration, and key assumptions were made as follows:

Group Characteristics	Assumptions
<p><i>Post-SEA Primary School Group</i></p> <p>These students have already completed their secondary entrance examination, and have in essence completed curriculum studies for primary school. Age group: 11+ but < 13 years of age</p>	<ul style="list-style-type: none"> - Teachers are looking for out-of-school experience primarily, for this group, and secondarily a learning experience in science. - Pre-visit preparation may be rare if evident at all. - Students are largely curious, and would be expected to explore. - Learning may be incidental and not sought-out.
<p><i>Lower level Secondary School Group</i></p> <p>These students are now obtaining more formal introductions to scientific concepts, experimentation, deduction, and analytic thought in the sciences. Age group: 11 to 14 years of age</p>	<ul style="list-style-type: none"> - Teachers are looking for a learning experience which may encourage an interest in science. - Pre-visit preparation is more likely, but may simply be an introduction to the science centre in general. - Students are also curious, some may be reluctant to attend if they are not inspired in science, or keenly interested if they are already excited by science. - Learning is sought out by the students
<p><i>Upper level Secondary School (Science) Students</i></p> <p>These students have selected science subjects for examination. Age group: 14 to 16 years of age</p>	<ul style="list-style-type: none"> - Teachers are looking for a specific learning experience. - Pre-visit preparation is more likely. - Students are also curious and perhaps keenly interested in the content of the centre. - Learning is sought out by the students

<p><i>Student Group from Vacation Camps in Invention and Innovation</i></p> <p>These students have had little or no formal exposure to science.</p> <p>Age group: 9 to 11 years of age and 12 to 16 years of age</p>	<ul style="list-style-type: none"> - Camp leaders are exposing the campers to the attributes of the centre to offer inspiration in their workshops. They too are hoping for a learning experience; however, the visit may have primarily been chosen for an out-of-school experience. - Pre-visit preparation is likely. - Students are largely curious/open to a learning experience
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Given these visitor characteristics and the associated assumptions, the following methodology was developed:

- A. Administration of modified questionnaire specially designed for this project to four types of visitor groups (as previously described) and to accompanying teacher(s)/instructor(s) immediately after the group visit (Appendix I)
- B. Administration of follow-up activity to three visitor groups in A. above (not including vacation campers group) for completion in a two-week period immediately after the group visit.
- C. In the case of the vacation campers group, a pre-visit activity administered since the visit to the Centre took place at a later time during the vacation camp.
- D. Interview of teacher/instructor at conclusion of the follow-up activity in B. above.
- E. Interview of the camp leader at the conclusion of the pre-visit activity in C. above.
- F. Analysis of responses in A. to E. above, for assessment of impact of science centre visit noting i. Comparison of feedback methods, ii. Comparison of pre- and post-follow-up responses from students, iii. Teachers'/Instructors' assessment of impact, and iv. Visitor suggestions for science centre improvement.

This new questionnaire designed for this project addressed other visitor interests not currently captured by the existing survey form, including such matters as current interest in science, current value placed on science, and change in interest due to the experience of the visit. The language of the questionnaire was also tailored to meet the general age group of the student and group type, and was modified for teacher responses.

The follow-up activity was administered in order to gauge the visitors' recall of the experience in some cases, and also to gauge the change in interest level after having visited the science centre. Each visitor group type was provided with a different type of follow-up activity, and these are itemised in Appendix II of this proposal. Variation of the follow-up activity was seen as necessary, in consideration of the visitor characteristics and associated assumptions given above (Follow-Up Activities: Appendix II). In the case of vacation camp visitors, the impact of a pre-visit activity followed by a questionnaire after visiting enabled some measure of assessing whether the science centre delivers on a visitor's heightened expectations.

The teachers' involvement in these exercises was critical. The teachers needed to complete questionnaires immediately after the visit and to be available to report, through an interview, after the administration of the follow-up/pre-visit exercise. Their assessment of the students' displayed behaviour was captured in the qualitative study of the impact of the centre; it was assumed that teachers would have welcomed this opportunity to have input into this exercise, since it would have offered them a learning experience also, as well as it may have provided

educational benefit to their students, and assisted in providing an in-school activity for the teacher without much effort on their part.

2.1.1 Special Requirements

In order to facilitate the above, and to foster co-operation of a third party in this study, the Ministry of Education of the Republic of Trinidad and Tobago was approached for its written permission to conduct this study among students and teachers. The schools approached to assist with the study were selected from those which made a booking to visit the National Science Centre during the months of June - July 2004. The Principal of each school proposed for study was contacted in order to seek permission for the conduct of the exercises. A copy of the letter of approval from the Education Ministry accompanied this request for school participation in the study. The teacher who accompanied the class was in all cases the class teacher since he/she was required to administer the follow-up exercise and provide the follow-up report. The Camp Administrator for the vacation campers group was similarly approached to seek the camp's participation in the exercise.

2.1.2 Additional considerations

All parties (students and teachers) who took part in this study were assured in writing that their identities will not be disclosed in any form of written or verbal report on the study, neither during its progress or at its completion. Specific reference to a particular response, if needed, was attributed with use of a pseudonym, so that identification of individuals or institutions would not be possible. The findings of this thesis, while conducted in partial fulfilment of the requirements for the Master in Science Communication programme 2003-2004 of Darlana University Sweden, will also be shared with the administrators of the NIHERST / NGC National Science Centre in Trinidad, through which the study was possible and for the benefit of the NSC's development. The information may also be shared with the Ministry of Education of the Republic of Trinidad and Tobago, in so far as the conclusions may have relevance to science appreciation and education in the schools of Trinidad and Tobago.

3. Results

3.1 Results from survey questionnaires

The results from the survey questionnaires are carried in un-edited, tabulated format in Appendices III through VI. Summarised versions of these results are provided in this section with comparative descriptions of the data from the four groups provided in the last part of the chapter in Section 3.4.: Pooled Data.

3.1.1 Post-SEA Primary School Visitor Group (Appendix III)

This was a group made up of 35 children, aged between 10 and 11 years. Forty percent of the students were female and 60 percent were male. The students were accompanied by more than one teacher; however only one teacher completed a visitor questionnaire. The teacher indicated that the main purpose of the visit was to provide a session away from the classroom. This teacher indicated that the students seemed excited while on the exhibit floor, and also, that as a teacher, she was able to gain some idea of more creative methods for teaching science.

Just over 50 percent of the class had visited the science centre previously, with most of these repeat visitors having made their last visit within the past year. Thirty-two students indicated that they enjoyed their visit, with 15 persons enjoying the computer section best, 12 persons enjoying the planetarium best and 7 persons enjoying the interactive exhibits best. Nine students indicated that they did not enjoy the film which was shown during the visit (film on comets). Thirty-four students of the 35 said that they learnt something new, and twenty of these responses revolved around information gained during the planetarium show.

Twenty-two students said that there were things at the science centre which reminded them of things that were done in science in school, citing mainly 'planets and stars' and 'computers'. Sixteen students offered suggestions for the science centre's improvement, while 13 students suggested that nothing needed to be improved upon. Regarding the students' suggestions, the responses were diverse: robots, spaceship, fossils, teaching computers, games, animals, structure of plants and animals. The teacher suggested that more puzzles be included and that teaching on computers also be made available to the students. All visitors found the staff to be helpful, mainly in providing explanations and offering guidance to the visitors.

3.1.2 Lower Secondary School Visitor Group (Appendix IV)

This was a group of twenty-two students, all male. The students were in the age group 11 to 14+ years. The visiting group was accompanied by two teachers. Both teachers completed survey questionnaires. One teacher instructs this age group exclusively, while the other teacher instructs both this age group and children who are in an older age group. Both teachers indicated that the main purpose of the visit was a session away from the classroom, but also curiosity about what was offered at the science centre. Both teachers concluded that the centre provided no information which was relevant to the curriculum. One teacher indicated that the centre should

have chemistry based exhibits and biological exhibits. They both indicated that the students seemed excited while on the exhibit floor.

Within this group of students, 10 were first-time visitors while 12 had previously visited (10 of these more than a year ago). Twenty-one students enjoyed the visit, with 10 persons enjoying the interactive exhibits the most, 4 the planetarium and 3 the computer area, and 3 other things. Fifty percent of the visitors said that the visit reminded them of things they did in science in school and 18 persons said that they learned something new at the visit, 7 of these responses revolved around the visit to the planetarium, while 8 revolved around the art of origami. Twenty students and both teachers found the staff to be helpful in sharing their knowledge and offering guidance. Sixteen respondents had suggestions for improvement of the science centre, with students highlighting areas of technology and electronics, experimentation and interactive exhibitions.

3.1.3 Upper Secondary School Group (Appendix V)

This was a group of twenty-seven students, all female. The students were in the age group 14 to 15+ years. The group was accompanied by a teacher who indicated that the main purpose of the visit was a session away from the classroom. The teacher concluded that the centre provided no information which was relevant to the curriculum and indicated that the centre should have biological displays and an exhibit on ecosystems. The teacher also indicated that the students seemed excited while on the exhibit floor.

Eleven of the students were first-time visitors while 16 had previously visited (only one of these within the past year). All students enjoyed the visit, with 12 enjoying the interactive exhibits best, 10 the planetarium and 3 the computers. Twenty four students indicated that there was not anything which they disliked, while three persons disliked something (everything was small, computer area too small, time allotted {for visit}). Thirteen students indicated that there were things which reminded them of science in school, and 24 students indicated that they learnt something new (most responses revolved around astronomy). All respondents found the staff to be helpful. Nineteen students gave recommendations for improvement, including the following responses: displays on biology, more interactive areas, larger displays, chemistry displays, and refreshments.

3.1.4 Vacation Campers Group (Appendix VI)

This group was made up of 24 children and four teenage counsellors who were participating in a one-week vacation camp hosted by NIHERST. Half of the group was female and the other half male. The main purpose of the visit was a field trip away from the camp location to engage in the science centre activities. The counsellors, being recent science graduates from secondary school, were provided with similar questionnaires to the vacation campers under their charge.

Six of the campers were first-time visitors while 18 had previously visited (5 of these within the past six months, 6 within the past year and 5 more than a year ago). Twenty-two campers indicated that they enjoyed the visit, with 4 enjoying the interactive exhibits best, 18 the

planetarium and 1 the computers. Fourteen students indicated that there was not anything which they disliked, while ten persons disliked something (the planetarium, the eating area, out-of-order exhibits).

Four students indicated that there were things which reminded them of school, and 15 students indicated that they learnt something new (most responses revolved around astronomy). Eighteen respondents found the staff to be helpful. Nineteen students gave recommendations for improvement, including the following responses: better cafeteria, robots, solar energy, inventions.

The four camp counsellors accompanying the vacation campers group were all aged 17 years. Two of the counsellors had visited the camp previously. The only counsellor who did not enjoy the trip had not visited previously. Those who enjoyed the trip all enjoyed the planetarium area best. All the counsellors disliked something (cafeteria and out of order exhibits). The centre did not provide anything which offered a reminder of school, and only one counsellor indicated that something was learnt during the visit.

3.2 Results from pre-visit activity

Only one of the visitor groups, namely the Vacation Campers Group (made up of 24 children, as stated above) conducted a pre-visit activity. The vacation camp focused on creativity, and in this camp, children obtained guidance from camp counsellors in understanding the principles of airfoils and weight reducing measures employed in developing flying toys, which the children then created. The experiment provided to this group therefore was tailored to suit the focus of the camp, in an effort to provide a link between their camp activity and the pre-visit activity for the project. This experiment demonstrated wind dispersal of seeds (Appendix II).

3.2.1 Vacation Campers Group (Appendix VII)

At the end of the experiment, the vacation campers were asked seven questions to provide feedback on this exercise. Most of the children enjoyed doing the experiment. Though only thirty-two percent felt that the experiment reminded them of science in school, seventy-six percent indicated that science in school was fun also. Eighty-four percent of the campers said they learnt something from the experiment, but only forty percent felt that they could apply it to their next camp activity (link between camp and project activity – 40% success only).

A poll of their current expectations of their future career revealed that 48 percent were interested in careers with a basis in science (architect, doctor, engineer, fossil hunter, geologist, scientist, and veterinarian). Several of the respondents were also interested in careers in the arts (28 percent), and a few others were interested in careers in sport (8 percent). Camp counsellors indicated that the children appeared to enjoy performing the exercise.

3.3 Results from post-visit activities

Post-visit activities were designed for the three groups, namely: Post-SEA Primary School Group (aged 10-11 years), the Lower Secondary School Group (aged 11-14 years, all male) and the Upper Secondary School Group (aged 14+ years, all female). These activities were each conducted within two weeks of the respective group's visit to the science centre. Upon completion of the activity, the materials produced by the students were collected, the data extracted and assessed, and then the materials were returned to the students.

3.3.1 Post-SEA Primary School Visitor Group

These students were provided with activity kits, which included brain teasers puzzles (physical and verbal) Rubik cubes, and a drawing exercise. The teacher reported that the brain teaser puzzles of the post-visit activity were pursued with vigour and the students wanted more puzzles to figure out afterwards. The drawing exercise which was completed approximately one and a half weeks after the visit was themed "My Visit to the Science Centre". The exercise was designed to gauge the recall of this visit by the students, by noting the content of the art pieces. The artwork received from 30 students was easily grouped into six categories as follows: Planetarium - 11; "What if You couldn't?" exhibit - 7; Puzzles - 4; Film - 4; Computer area - 3; General Floor Plan - 1. The Planetarium was therefore the item most recalled by the students. This art piece was very detailed, with students noting the location of the planetarium projector, fan, crawl entrance and area for shoe storage in most submissions (see Appendix VIII).

A casual poll was made of the participant students when artwork was returned to find out the types of careers they considered pursuing after leaving school. The responses were mixed, but interestingly, most seemed to revolve around careers involving science: mechanical engineer, doctor, nurse, and teacher. Communication with teachers who made the visit indicated that the students were always excited to do science and they were excited by the visit to the centre, even those students who had visited previously. The visit was enjoyable, particularly the Planetarium show. The teachers noted that children from the school have little opportunity to interface with computers, not owing personal ones, and having to share scarce numbers at school with other students, thus, the opportunity to use computers at the science centre was most welcome.

3.3.2 Lower Secondary School Visitor Group

Unfortunately, the group did not carry out the post-visit activity, which was designed as a series of experiments which the teacher would have administered during a classroom/laboratory session. The post-visit activity kit also contained brain teaser puzzles (physical and verbal) for use by the students. The teacher indicated that the visit was made very close to the end of the school semester and that the children were unable to participate in this activity since end-of-term examinations were soon to begin. The post-visit activity kit experiments were then transferred to the vacation campers group, which utilised these in their pre-visit activity.

3.3.3 Upper Secondary School Group

The students were provided with information on the activities of the NIHERST/NGC National Science Centre and were asked to write a brief essay which outlined their experience of the Science Centre, noting areas in which the Science Centre could improve its services. The teacher noted that the students were mixed in their feelings towards the follow-up activity, since they were not fond of writing essays, but were encouraged to write in practise for report writing. The majority of respondents' view of the visit was that it was interesting and educational. The perception by some of the students was that it would have been a 'boring trip', but they were pleasantly surprised and learnt much. The students echoed the sentiments expressed in the survey questionnaire that the science centre needed to improve its content to provide biological/ecological displays.

The "What if You Couldn't" exhibit which was new to the centre, was mentioned in several of the essays, with students indicating that they gained an appreciation of what life was like for those who lived with disabilities. Some of these students also noted that they were able to link with the curriculum at school, having studied the bones of the vertebral column in biology. While astronomy was not a major component of the science curriculum, many students indicated that the visit to the planetarium was interesting, and that they learnt many things about the stars and planets from that session. These respondents were full of praise for the staff member who led the session, indicating that the individual was very knowledgeable. Many expressed the sentiment that they wished to make a return visit to the centre, and felt that the services provided by the centre were useful to their school level as well as other age groups, but that some improvements (exhibit types, size of displays) were advisable.

3.4 Pooled Data: Visitor Enjoyment

For the purpose of providing comparative presentation of results between and among visitor groups, this section links the data of various groups in respective of the possible factors which influence visitor enjoyment which are assessed in the Discussion section, namely: Repeat versus first-time visitor; Visitor age and background; Visitor sex; Staff component.

3.4.1 Repeat visitor versus first-time visitor

There was a total of 108 participants in this visitor survey, and 65 of these had visited previously, while 43 made their first visit to the science centre. All visitors who had previously visited in each of the surveyed groups enjoyed their visit to the science centre. Among the first-time visitors, with few exceptions, the visitors enjoyed their visit.

3.4.2 Visitor age and background and content of science centre

Regarding the content of the science centre and the age of the visitor (read: educational level), younger children from the school setting – Post-SEA students – appeared to enjoy the computer

area most, both in post-visit survey and in post-visit activity recall (Figure 1) while children of the same age group coming from the camp setting – Vacation Campers – enjoyed the planetarium most (Figure 2).

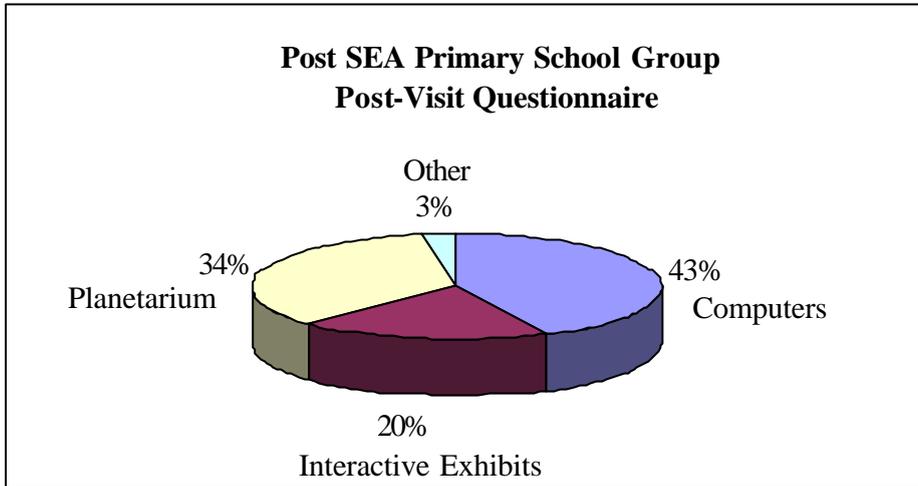


Figure 1. Visitor Preferences of Science Centre Content: Post SEA Primary School Group

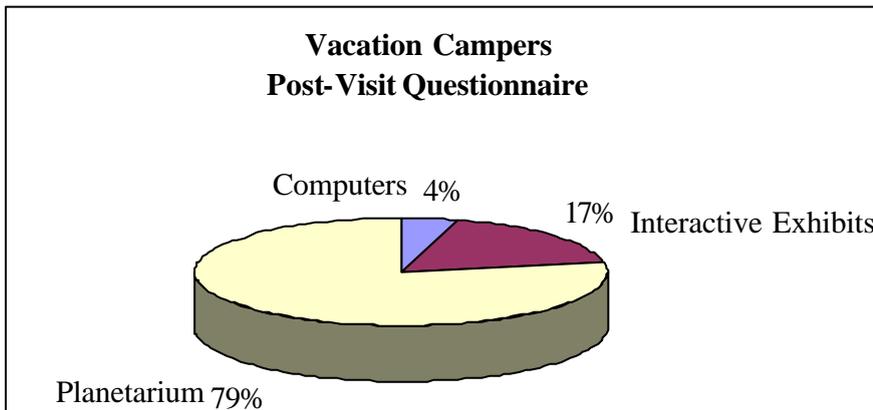


Figure 2. Visitor Preferences of Science Centre Content: Vacation Campers Results

Children from the lower secondary school group enjoyed the interactive exhibits best (Figure 3), while children from the upper secondary level school group also enjoyed the interactive exhibits, closely followed by the planetarium (Figure 4).

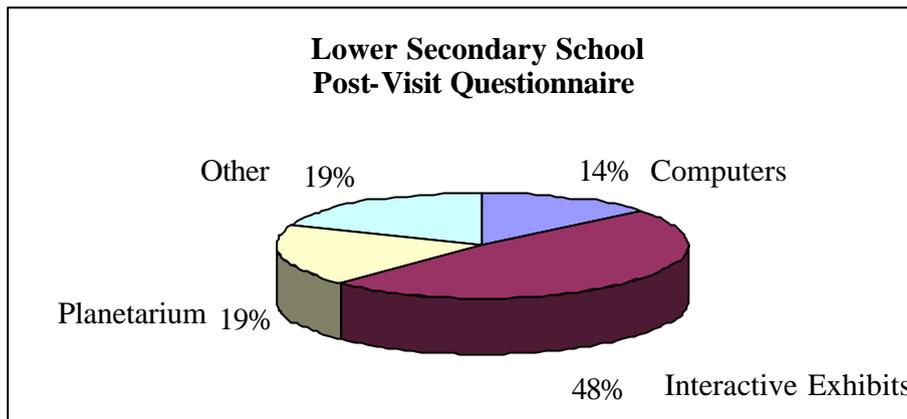


Figure 3. Visitor Preferences of Science Centre Content: Lower Secondary School Group

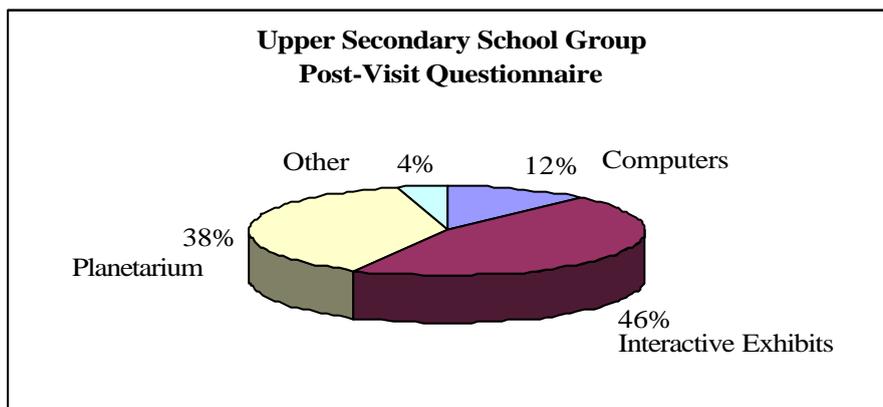


Figure 4. Visitor Preferences of Science Centre Content: Upper Secondary School Group

3.4.3 Visitor sex and content of science centre

Preferences for particular content by the sexes were noted in the mixed sex visitor groups from the Post SEA Primary School group and the Vacation Campers group. For the Post SEA Primary School group, boys and girls had similar preference for the computer area, but for the exhibit and planetarium areas, boys outnumbered girls in preference. This result was reverse for the planetarium in the Vacation Campers group. (Figure 5).

If the results of the two groups could have been combined together, the ensuing result would have indicated equal preference between sexes for the computer area, a greater preference for the exhibits by boys, and a slightly greater preference for the planetarium by boys.

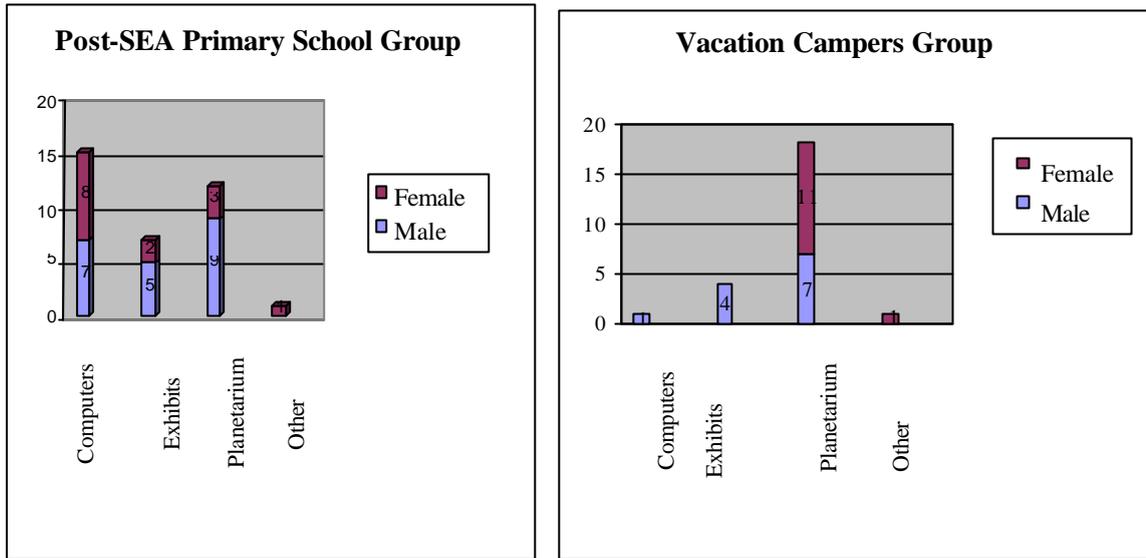


Figure 5. Preferences for visitor content by the sexes in post SEA Primary School Group and Vacation Campers Group

When examining the results of the secondary school groups, some of these findings are emphasised. The lower secondary school group which was all male overwhelmingly showed a high preference for the interactive exhibits than any other content, while for the upper secondary school group which was all female (and Biology students who did not also study Physics), the preference was almost evenly split between interactive exhibits and the planetarium (Figure 6).

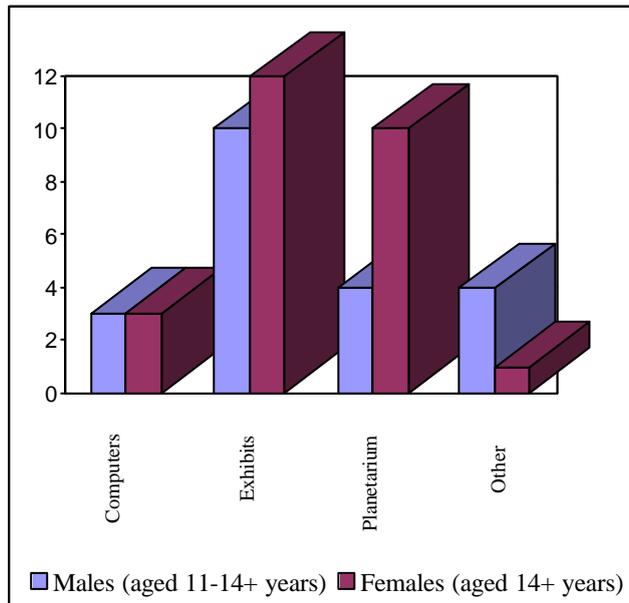


Figure 6. Comparison of Enjoyment of Science Centre Content for Males and Females: Secondary School Data

3.4.4 The staff component

From the survey questionnaires, the staff of the NIHERST/NGC National Science Centre was considered to be helpful by the visiting groups with few exceptions. Elaboration of this response revealed that the various forms of helpfulness included: provision of new knowledge, guidance, patience, making learning easier, answering questions, making one laugh bringing science down to (the visitor's) level of understanding. The follow-up activity of the Upper Secondary School group also provided recall of the staff's assistance in making the visit an enjoyable one.

3.5 Pooled Data: Visitor Learning

Visitor learning was examined by consideration of the responses provided by the visitors themselves. The types of responses gained varied among the groups surveyed; however, some classification of the responses was possible into broad categories. In this section, 'learning' was examined in relation to three areas: an immediate response, visitors' linkage of the centre's content with science taught in school, and visitor recall of science centre content as provided in post-visit activities. .

3.5.1 The immediate response

With the exception of the Vacation Campers group, over 80% of respondents to the survey questionnaire of visiting groups indicated that something was learnt during the visit to the NIHERST/NGC National Science Centre. For the vacation campers group, a still high percentage (62.5%) of respondents felt that something was learnt during the visit.

This is interesting since the teachers/instructors all indicated that the intention of the visit was in all cases, an out-of-classroom experience. Indeed, in contrast to the responses of the students, except for the Post SEA Primary School group teacher, the instructors felt that nothing was gained by them during the visit which was of use to the school curriculum. Similar responses to 'what was learnt' by the students, were grouped across the age/school level categories (Figure 7).

From the graph, it is notable that students from all groups 'learnt' about stars and planets mostly, such information having been gained from the visit to the Planetarium. Within the school groups (i.e. all groups with the exception of the vacation campers group), there was a percentage of students who, though indicating they had learnt something, were unable to specify what was learnt.

Among all groups, the all-male Lower Secondary School Group had the largest percentage of respondents noting that they learnt a variety of "Other" things during their visit to the science centre.

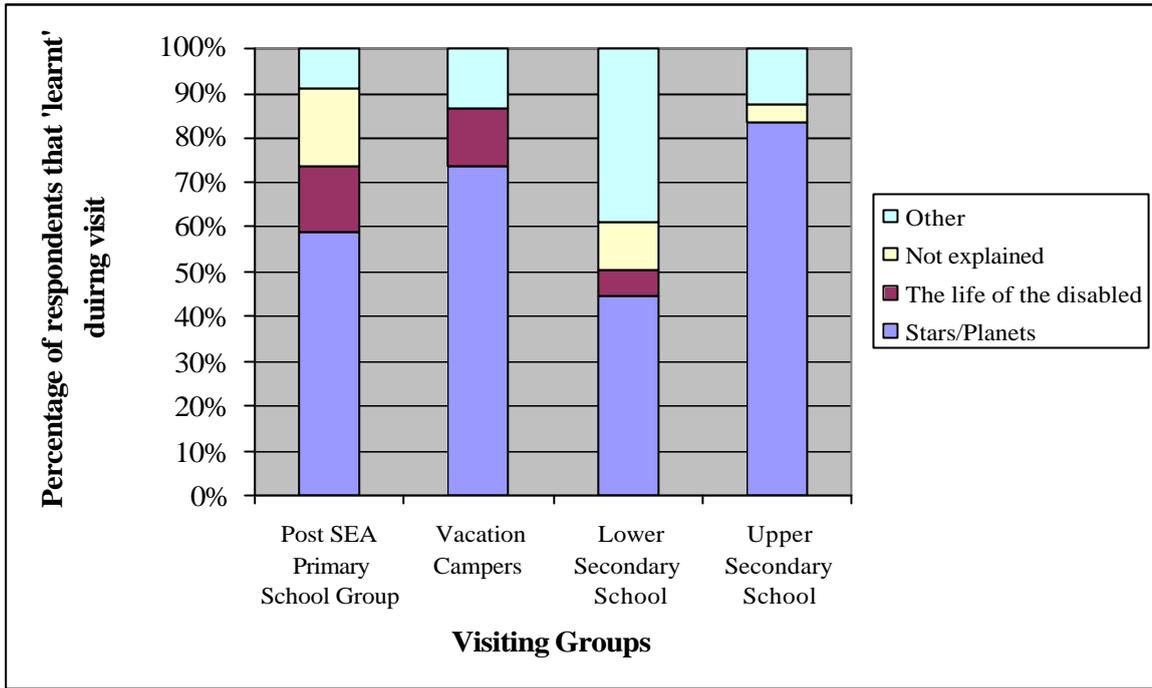


Figure 7. Grouped responses of visitors groups to 'learning' during a visit to the NIHERST/NGC National Science Centre

3.5.2 Link to school learning: Students and Instructors

Investigation of the claim of learning by visitors notes was attempted by seeking responses to the question “Did anything here remind you of things you did in Science in school?” (Figure 8).

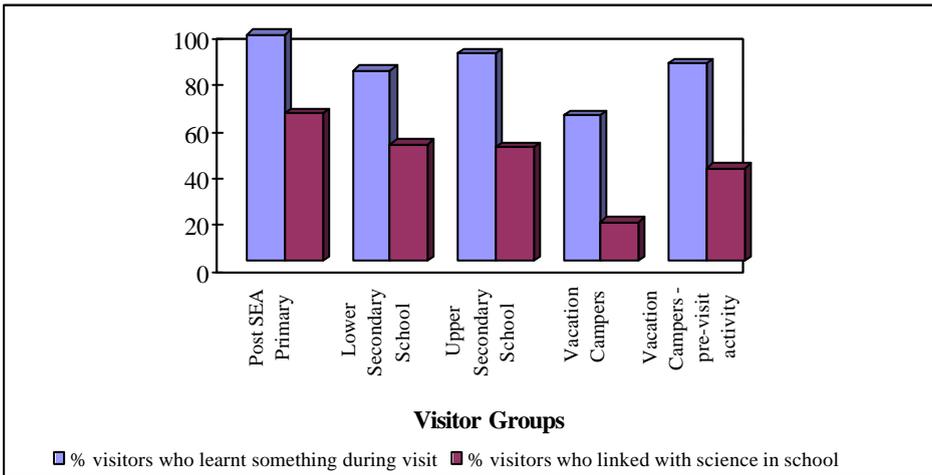


Figure 8. Comparison of visitor learning and link with science in school among groups

Students of the Post-SEA Primary School Group provided the highest percentage respondents which indicated that there was a link between the centre's content and science learnt in school, while in comparison, vacation campers saw little linkage.

3.5.3 Visitor recall

In their post-visit exercise, the Post-SEA Primary School students provided recall of content which in some part paralleled the preferences indicated in the survey questionnaire (including some areas disliked by their classmates, such as the planetarium film), some one and a half weeks after visiting the science centre (Figure 9).

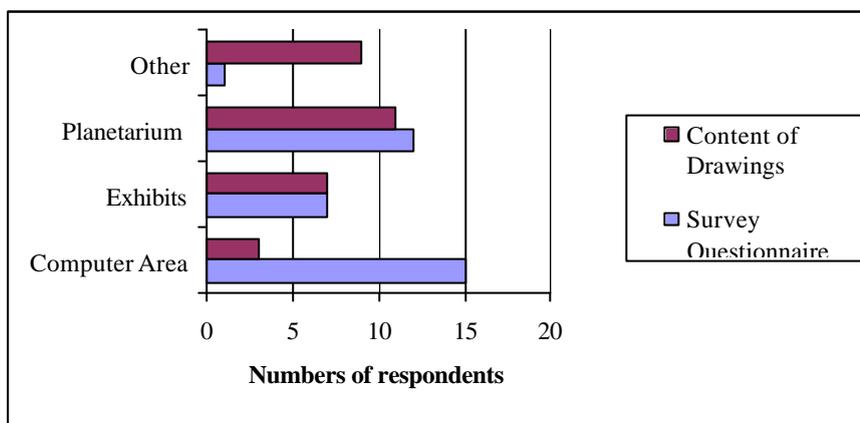


Figure 9. Comparison of Post SEA Primary School students' responses to Science Centre content preferences in visit questionnaire and recall of content in post-visit activity²

The post-visit recall results of the Upper Secondary School Group, unlike that of the Post-SEA Primary School Group, were not easily amenable for graphical representation or comparison. Notable in the essay responses, however, were general comments on the centres content with few references to specific detail, such as the recall of the planetarium experience and detail of the "What if You Couldn't" exhibit.

² The value attributed to the planetarium figure for the post-visit activity was a combined total of pictures depicting both the planetarium itself (11 drawings) and the film shown in the planetarium area (4 drawings).

4. Discussion

The results of these visitor impact studies at the NIHERST/NGC National Science Centre demonstrate particular features of the visitor experience and the contribution of the science centre to the promotion of informal science education. As a venue which can provide both recreational as well as educational services to young persons, the centre measures up to varying degrees in these aspects.

In this discussion, the impact of the science centre in terms of its ability to engage visitors and its ability to contribute to broadening of the scientific knowledge base will be considered. Additionally, on the basis of responses in both the survey questionnaires and the post-visit activities, some indication of the areas for improvement, as noted by the participant visitor groups will be commented upon.

4.1 Visitor Enjoyment – The entertainment factor

A review of the results of the visit survey notes that among the three age groups upon which the survey was conducted - 8-11 years (both sexes), 11-14+ years (males only) and 14+ years (females only) – close to 100% of all visitors enjoyed their visit to the science centre. Analysis of the visitor characteristics enables a closer examination of this result.

Among the first-time visitors, with few exceptions, the visitors enjoyed their visit. Given the responses of the individuals who did not enjoy their visit, the reason for a lack of enjoyment was not related to the content of the centre, but rather ancillary issues (cafeteria, length of time allotted to visit). In this regard, issues surrounding the familiarity with the centre's environment therefore do not seem to influence the opportunity to enjoy the centre's content.

No mention was made by any visitor - first-time or repeat - of the general environment (layout, appearance) of having affected their enjoyment. As such, it may further be suggested that this science centre offers a welcoming face to the first-time visitor, presenting no hindrance to engaging with the material presented. Olds (1990) stresses the 'needs' of visitors, which, if attended to by the host institution, make for a greater chance of visitor enjoyment. The input of the staff of the science centre appears to have also contributed to the visitor enjoyment, in having satisfied to some extent the issues of comfort and competence in their ability to guide and make the children comfortable during their visit as evidenced by visitor responses to the survey questionnaires.

There are two interesting issues in age-and-sex results for this under-11 age group. Firstly, it appears that children coming from the school setting (Post-SEA group) as opposed to the camp setting (both of the 8-11 years age group and both made up of mixed sexes), had distinct differences in their interest. Both of these groups had made their visit for an out-of-classroom/camp experience. The school group had a pre-disposition of the classroom setting, while the campers had the re-disposition of the 'action/fun' setting associated with camps. Indeed, this agrees with statements made by Hein (1998) that the social setting of a visit

influences behaviour. Thus, children behave differently on school visits than when visiting as members of a family group or non-formal groupings.

Additionally, given the feedback from the teacher interview following the post-SEA school group visit, the children of that school generally have limited or no regular access to computers. The result seems to suggest that the children of this age group respond to the content which is novel to them, or which seems more in line with their given disposition (computers in the classroom, film shows at camp). The school group result also provides an indication of a reality of the typical Trinidadian primary level classroom: one which has not yet fully engaged multimedia technology in its delivery of curriculum.

The second interesting result is with regards to the older age groups surveyed (Lower and Upper Secondary School groups). Both these groups indicated greater interest in the interactive exhibits than other science centre content. The children in secondary school would be exposed to formal teaching of science and the content of the interactive exhibits may be most in line with the material delivered in the curriculum. The engagement of these children with the exhibits suggests that there may have been curiosity attached to their interaction with the material, perhaps self-testing their scientific knowledge.

Among these older children also, girls exhibited a strong attraction to the planetarium content, and a combination of factors may have influenced this. From their essay responses, the girls were able to elaborate upon the lack of content which dealt with their specific subject area, biology. With most of the exhibits being physics-oriented manipulative, the planetarium perhaps offered a more interesting visit, one because of its novelty and two, because it was not an obvious 'physics' area.

The post-visit activity carried out by the older age-group (upper secondary school group) indeed revealed interest and enjoyment of the interactive exhibits, with some commentary on learning, which will be discussed shortly. The post-visit activities originally designed for the lower secondary school group may have yielded some feedback on the value placed on this type of interaction by students, to inform whether the value was more so entertainment than education. Having been utilised by the vacation campers group, the result of these activities pointed to a greater degree of enjoyment, with less consciousness of applicability, an aspect which too will be addressed in the discussion of educational impact.

Preferences for particular content by the sexes were noted in the mixed sex visitor groups from the Post SEA Primary School group and the Vacation Campers group. Given the already identified pre-disposition for the school group, with a novel interest in computers, the result may have therefore been skewed. It is a general assumption that boys have a greater interest in manipulative activity than girls (Kimura, 2002), and this type of result would be in support of that notion. The overall greater interest in the planetarium area, as noted in the prior discussion of the girls from the secondary school group, could also be accounted for by this aspect being novel to other groups, and to visitors to the science center in general.

In conclusion of this discussion of the enjoyment factor, it is noted that while examining the potential contribution of science centres to overall public awareness and appreciation of science, Edwards (2004) emphasises that enjoyment is an important factor since interest in an activity

must first be established before the activity can be understood. From this study, it has been demonstrated that school-age visitors to the NIHERST/NGC National Science Centre enjoy their visit and their interest is held in one or many of the various components offered.

4.2 Visitor Learning – The education factor

The administrators of science centres are continually interested in finding out whether the material on offer to the visitor is finding root in fertile soil. It has often been debated that measurement of learning which occurs at a science centre is difficult; it is further debated the definition of learning, with one set of workers making a distinction between formal and informal learning while others indicate that this definition is too stringent, learning being influenced by many factors apart from the formal and informal settings (Gilbert and Priest, 2001). Recognising that individuals or groups visiting a centre all approach with common yet varied levels of interest, education, perceptions, and backgrounds, it is difficult to achieve the same outcome or impact on all visitors in terms of education/learning. The French 18th century writer Anatole France (Thibault) offered a statement which perhaps best approaches the minimum outcome which science centres can hope to achieve given these constraints:

“Do not try to satisfy your vanity by teaching a great many things. Awaken people’s curiosity. It is enough to open minds; do not overload them. Put there just a spark. If there is some good inflammable stuff, it will catch fire.”

- Jacques Anatole Thibault³

On this basis, the education of visitors as perceived from this study will be approached from the perspective of learning as evidenced by new information having been received, dispelling of pre-conceived myth, and sparking of new thought processes as given in questionnaire feedback and pre-visit activity as well as recall of material as given in post-visit activity.

These results give a clear indication that more than half the students who visited the science centre in this study felt that they gained knowledge of aspects of astronomy as derived from the planetarium experience. The only exception to this result was seen among the all-male group of visitors from the lower secondary school. As indicated earlier, there is little or no reference or coverage of this type of material in either the primary or secondary school level curricula in Trinidad and Tobago. As such it may be suggested that the novelty aspect of the material had an impact on the students, enabling them to add to their knowledge on an interestingly presented topic.

Another interesting result is that some students who indicated that they had learnt something during their visit were unable to specify what actually was learnt during the visit. While a low percentage, this result was evidenced in all the groups which visited.

A third point worthy of note in this result, is that the all-male group from the lower secondary school, who were previously seen to enjoy the interactive exhibits most among the science

³ Jacques Anatole Thibault, better known as Anatole France (1844-1924), French novelist.

centre's content, were the only group among those studied which gave an almost equal response to having learnt from the planetarium experience as well as having learnt other things. The actual responses of this group (Appendix IV) note new knowledge gained in another activity pursued during the visit, the Japanese art of paper folding, origami.

The feedback received from the students parallels the findings of Dierking and Pollock (1998) in the value of front-end studies in development of science centres. It has been mentioned that curiosity about a subject may be encouraged by an exhibit and it is felt, that the sparking of new thoughts and the raising of awareness is a valuable product of the visit. Indeed, according to Stocklmeyer (2001), it is in fact the 'wider picture' of what is gained by the visitor that is much more important to learning. If learning is based on the constructivist theory, it is expected that this singular visit has the potential to establish a foundation upon which further and future learning can proceed.

The reason for this may be the manner in which the scientific concepts are presented at the centre as opposed to at the school, or may be due to the content of the science curriculum at school being very different or apart from the content of the exhibits at the centre, for the particular visitor. For instance, the students of the upper secondary school group from post-visit interview with the teacher revealed that the students are biology students, borne out by the consequent call by some visitors of this group for more biological exhibits (Appendix V).

As was pointed out in the previous section also, the aspects of learning to which the students alluded, were not subjects which formed part of their normal curricula at school and this may explain why no linkages were made between learning and science at school.

Interestingly, the pre-visit activity which was administered to the vacation campers had the expectation of realising some linkage with their current activity at the camp. Their camp focussed on creativity, specifically creativity in the development of flying toys. The particular pre-visit activity which was developed for them focussed on wind dispersal in seeds, with the concept of airfoils, their structure as related to function expected to be transferred in the conduct of this exercise. Only forty percent of the group, however, saw a linkage between the activity and its possible application to the present focus of their camp. It is felt that as with their visit to the centre, the 'fun' atmosphere of the camp pervades their approach to the activity. The couching of the exercise in a class laboratory setting therefore (the activity was originally intended for the lower secondary school group in a school setting) interrupted their mindset with a mental focus on learning as opposed to the fun/entertainment atmosphere of the camp. While the activity was therefore enjoyed (96% of respondents), the value of the exercise was not necessarily captured by all the campers.

This latter aspect of the application of knowledge learnt parallels that stated by Rennie and McClafferty (1996), that while visitors may claim to have learnt from a visit, it is questionable if learning is said to have actually taken place if there is no linkage to activities which occur beyond the visit. In the earlier section, the content of what was learnt as indicated through student response was considered to provide a potential building block for further learning; perhaps the camp environment did not provide the best setting for the testing of this hypothesis, as shown by the results of this pre-visit activity. The result also demonstrates an issue widely referred to in the literature, that of exhibit planners not often being able to predict the 'success'

of the output of their designs, according to the expectations which they may have held (Chandler, 1993; Scheiderer, 2000).

Post-visit activities were carried out by only two of the visitor groups: Post SEA Primary School group and the Upper Secondary School group. By documentation of the visit in the former case through drawings and in the latter via essays, the degree of recall of the science centre's content was used as an indication of the material which stood out, either good or bad to the visitor.

The results from the Primary School group post-visit activity support the information gleaned in the discussion of the 'entertainment' factor, noting the novelty of the planetarium content and the interest in interactive exhibits. The difference in responses however was noted in the interest in computers shown in the post-visit questionnaire, which was not reflected in the recall. This can be explained by noting that the computers while they also provided a degree of novelty to the students, this was due to a lack of opportunity to interact with them but not necessarily a lack of knowledge about them, in contrast to the planetarium content which was new knowledge, and a new experience. Indeed, as was indicated earlier, these pictures of the planetarium area were quite detailed, including the extractor fan, the shelving for shoes and the crawl-in area of the structure.

Additionally, the results noted in the 'Other' category for the post-visit activity were much higher than that of the post-visit survey questionnaire; these results incorporated pictures which showed depictions of the puzzle area (4 drawings) which apparently were of interest to the children. It is not clear whether these were considered as part of the 'Interactive Exhibits' category when the survey questionnaire was administered, as no reference was made to these activities in the free-response section of this questionnaire. The responses obtained through the post visit activity also acknowledge the concept that play is the "work of the child", noted in the recall also of the "What if you couldn't?" exhibit, which had an obvious impact on the students both as evidenced in the survey questionnaire and illustrated in detailed post-visit activity responses (all seven drawings of the interactive exhibits).

The upper secondary school students who participated in the post-visit activity also provided responses in this feedback medium which reflected their survey responses. A very interesting feedback received was in relation to the students surprise at having had an interesting visit, in which something was learnt. Despite the even greater feedback that the centre did not offer coverage of material in their curriculum interest, the students at this level nevertheless did not seem to consider this visit a wasted trip. From the essay responses, the students placed a greater value on the assistance provided by staff in the explanation of scientific principles, reflecting their level of education which incorporates discussion of content rather than rote-learning. Additionally, while their responses also made mention of the planetarium experience, there was wider discussion/critique of the centre's content in each of the essays other than this experience. Their response generally read more as a report on the content, pointing to areas that were lacking in coverage, largely in their areas of interest.

Given that the feedback from these two groups is limited, only a reasonable comment may be offered about the degree of learning that can occur as evidenced through visitor recall. At the primary school level the impact of the centre on learning as evidenced by visitor recall is high, however, at the secondary school level, the impact is more generalised. This is an aspect which

should perhaps be more thoroughly explored, since it may offer a positive means of linking the needs of the school curriculum at various education levels to the content of the science centre for student benefit (Gilbert and Priest, 2001; Lambourne, 1999).

As pointed out by Brualdi (1996), acceptance of Gardner's Theory of Multiple Intelligences can be a useful tool to teachers. The zeal with which the teenage boys from the Lower Secondary School Group embraced origami and the manipulative exhibits, the detailed recall which the Post-SEA Primary School group children provided of the "What if You Couldn't" exhibit of wheelchair manipulation, and walking with crutches, and the fondness with which the Biology students from Upper Secondary School group recalled planetarium experience are indications that the appeal to the senses and the varied intelligences of unique individuals evident in this science centre, has its benefit to the learning process.

The design of exhibits at the National Science Centre is deliberately not tied to the curricula of the local primary and secondary school system; any linkages observed by or alluded to by students are either co-incident or based on applications of a wider concept. The exhibits also provide for group interactions more so than individual manipulation. These very deliberate construction designs facilitate a cultural expression of high social interaction (Duensing, 2000). In recognition of Falk's 'free-choice learning' concept, there is further facilitation of this 'comfort zone', so to speak, to which Trinidadians and Tobagonians are accustomed. As such, the students studied in this survey, while engaging with activities that may not be common to them in format or in content, are attracted to them because of the freedom to explore which they promise.

In conclusion of the discussion of the education factor, therefore, no new absolute statements can be made regarding the degree of learning which is experienced by visiting students to the NIHERST/NGC National Science Centre. The educational impact, as determined from this study is largely in terms of sharing new knowledge, which, it is unclear, can be applied to their current curriculum needs. The indications are, however, that student recall of the visit to the centre is an untapped resource, owing to the fact that this aspect is high and can be capitalised upon if relevant curriculum material is offered in the centre's content. Despite the fact that this content is currently not largely applicable to the students' needs, the centre appears to still provide a valuable service in encouraging thought and supplying new information to spark student interest in fields of science outside of their main portfolio.

4.3 General conclusions

With reference to the main purpose of this study, the research has indicated that visitors to the NIHERST/NGC National Science Centre are notably impacted upon by their visit. Specifically, the enjoyment aspect associated with the engaging activities offered by the centre is universal among the visitor groups studied. This enjoyment appears to be related to visitor comfort, the non-imposing face of the institution, the helpfulness of staff, and interesting and user-friendliness nature of the activities. The impact of this aspect is lasting and is noted in visitor recall in post visit activities.

Regarding the educational worth of the centre to these school-age visitors, the study has only been able to reveal that the centre has sparked new interest and provided new knowledge which the visitors did not already have as gained through 'free-choice learning'. The potential for learning, while suggested cannot be conclusively stated as a definite output, since the application of the new knowledge and interest has not been fully investigated.

The study though conducted with a small sample of teachers, provided some indication that firstly, the material offered through the centre's activities did not incorporate many topics of the school curricula, and secondly that teachers would welcome such incorporation to complement their formal teaching at school. This however, is deliberately not the focus of the Centre's management.

The use of immediate post-visit feedback questionnaires in conjunction with follow-up feedback through specially designed activities was seen to be an effective means of gauging visitor feedback. The latter method both supported and/or provided elaboration upon the former method of visitor expression and additionally, provided insight into the application of the concept of Multiple Intelligences in the engagement of visitors with the centre's content..

These visitor assessment methods obtained valuable information on visitor preferences and enjoyment and also provided a useful critique of the NIHERST/NGC National Science Centre's services, structure and content which hopefully will lead to continued and improved science popularisation activity in Trinidad and Tobago.

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Appendix I: Visitor Questionnaires

Visitor Questionnaire: Post SEA Students

Please complete this form fully, by shading the circle alongside your response option in Questions 1 to 6 and by writing answers to Questions 7 to 10 provided.

Thank you for participating in this Visitor Survey!

1. My age is: 10 years 11 years 11+ years
2. I am a: Boy Girl
3. Have you visited this Science Centre before? Yes No
4. If you visited before, how long ago was your last visit?
 Less than 6 months ago About a year ago More than a year ago
5. Did you enjoy your visit? Yes No
6. What did you enjoy most about your visit?
 The Interactive Exhibits The Planetarium Show The Computers
 Or Something else , which was

7. Was there anything you did not like? Yes No
 If yes, what was it that you did not like?

8. Did anything here remind you of things you did in Science in school?
 Yes No
 If yes, what was it that was familiar?

9. Did you learn anything new today? Yes No
 What did you learn?

10. Were the Science Centre workers helpful? Yes No
 If yes, in what way were they helpful?

11. What else would you like to see in a Science Centre? _____

Visitor Questionnaire: Upper Secondary School

Please complete this form fully, by shading the circle alongside your response option in Questions 1 to 6 and by writing answers to Questions 7 to 10 provided.

Thank you for participating in this Visitor Survey!

1. Age: 13 – 14 years 14 - 15 years 15+ years
2. Sex: Male Female
3. Have you visited this Science Centre before? Yes No
4. If you visited before, how long ago was your last visit?
Less than 6 months ago About a year ago More than a year ago
5. Did you enjoy your visit today? Yes No
6. What did you enjoy most about your visit?
The Interactive Exhibits The Planetarium Show The Computers
Or Something else which was

7. Was there anything you did not like? Yes No
If yes, what was it that you did not like?

8. Did anything here remind you of things you did in Science in school?
Yes No
If yes, what was it that was familiar?

9. Did you learn anything new today? Yes No
What did you learn?

10. Were the Science Centre workers helpful? Yes No
If yes, in what way were they helpful?

11. What else would you like to see in this Science Centre? _____

Visitor Questionnaire: Holiday Campers

Please complete this form fully, by shading the circle alongside your response option in Questions 1 to 6 and by writing answers to Questions 7 to 10 provided.

Thank you for participating in this Visitor Survey!

1. Age: 11 - 13 years 14 - 16 years 17+ years
2. Sex: Male Female
3. Have you visited this Science Centre before? Yes No
4. If you visited before, how long ago was your last visit?
 Less than 6 months ago About a year ago More than a year ago
5. Did you enjoy your visit? Yes No
6. What did you enjoy most about your visit?
 The Interactive Exhibits The Planetarium Show The Computers
 Or Something else , which was

7. Was there anything you did not like? Yes No
 If yes, what was it that you did not like?

8. Did anything here remind you of things you are currently doing in school?
 Yes No
 If yes, what was it that was familiar?

9. Were the Science Centre workers helpful? Yes No
 If yes, in what way were they helpful?

10. Did you learn anything new today? Yes No
 What did you learn today?

11. What else would you like to see in a Science Centre? _____

Visitor Questionnaire: Teacher/Instructor

Please complete this form fully, by shading the circle alongside your response option in Questions 1 to 6 and by writing answers to Questions 7 to 11 provided.

Thank you for participating in this Visitor Survey!

1. Sex: Male Female
2. Age group which I instruct : 11 - 13 years 14 - 16 years 17+ years
3. Have you visited this Science Centre before? Yes No
4. If you visited before, how long ago was your last visit?
 Less than 6 months ago About a year ago More than a year ago
5. Did you enjoy your visit? Yes No
6. What was the main purpose of your visit with your students?
 A session away from the classroom To provide follow up on a lesson
 To provide introduction to a concept Curiosity / To see what is here
7. Did your students seem excited while on the exhibit floor? Yes No
8. Did you gain any information here that would be of use to your curriculum?
 Yes No If yes, what did you gain?

9. Was there anything you did not like? Yes No
 If yes, what was it that you did not like?

10. Were the Science Centre workers helpful? Yes No
 If yes, in what way were they helpful?

11. What else would you like to see in a Science Centre? _____

Appendix II: Post-/Pre- Visit Activities for Visiting Groups

Post-Visit activities

Post-SEA Primary School Group

The student group was given a kit of science activities including lateral thinking games, Rubik Cubes, and an art exercise entitled “ My Visit to the Science Centre”, the latter activity requiring students to record their visit by illustrations. The teacher administered these activities on several days during the two week period. Some of these activities were undertaken by individuals, however group work was encouraged and all students participated. All art compositions were submitted, their content noted, and then returned to the students.

Lower level Secondary School Group

The student group was provided with an activity kit which contained science experiments and lateral thinking games. These science experiments were safe to perform and matched the education level; they included a chromatography experiment, an experiment which demonstrated surface tension and an experiment on wind dispersal of seeds. Students were required to work in groups, and prepare group experimental reports. Each student was required to write a four-line statement on their view of science, having completed these exercises. All reports were returned to students.

Upper level Secondary School (Science) Group

The student group was provided with a brief on the Centre’s structure and activities, including information on special exhibits, the science club, student workshops, the Caribbean Youth Science Forum and the signature science festival, Sci-TechKnoFest. Students were then given an essay-writing exercise, in which they reported on their visit to the science centre in 500 – 1000 words. Students were asked to cover the following points in their essay: a review of the Centre’s exhibit floor, commentary on existing programmes offered to students at the Centre, recommendations for improvement. The teacher submitted all essays and took part in an interview at the end of the two-week period. All essays will be returned to students after review.

Pre-Visit activities

Vacation Campers Group

The campers conducted one of the experiments designed for the Lower Secondary School Group noted above. A brief questionnaire was prepared for their completion after conducting the exercise. The camp counsellors submitted these questionnaires and took part in an interview after the exercise was conducted.

Appendix III: Results of survey questionnaire - Post SEA Primary School Group

Q	1			2	3	4			5	6			7	8	9	10
	Age			Sex	1 st Visit	Last Visit ¹			Enjoyed Visit	Enjoyed Most ²			Anything Not Liked	Reminders of Science in School	Learnt Anything New	Workers Helpful
	X	Y	Z			I	II	III		E	P	C				
1		*		F	yes				no			*	no	no	yes	yes
2		*		M	yes				yes			*	yes	yes	yes	yes
3		*		F	yes				no			*	no	no	yes	yes
4		*		F	no		*		yes	*		*	yes	yes	yes	yes
5			*	M	yes				yes		*		no	yes	yes	yes
6			*	F	yes				yes			*	yes	yes	yes	yes
7		*		M	yes				yes	*			yes	yes	yes	yes
8		*		F	yes				yes	*			yes	yes	yes	yes
9		*		F	no		*		yes		*		yes	yes	yes	yes
10		*		F	yes				yes		*		yes	yes	yes	yes
11		*		M	yes				yes		*		no	yes	yes	yes
12		*		M	yes				yes		*		no	yes	yes	yes
13		*		F	no		*		yes	*			no	no	yes	yes
14	*			M	yes				yes			*	no	no	yes	yes
15	*			M	no		*		yes			*	no	no	yes	yes
16		*		M	yes				yes		*		no	yes	yes	yes
17		*		M	no		*		yes	*			no	yes	yes	yes
18	*			F	no			*	yes			*	no	yes	yes	no
19	*			F	no		*		yes			*	no	yes	yes	yes
20		*		F	no		*		yes			*	no	yes	yes	yes
21		*		M	no			*	yes		*		no	yes	yes	yes
22	*			M	no		*		yes			*	no	no	yes	yes
23	*			M	no	*			yes	*			no	no	yes	yes
24			*	M	no		*		no reply		*		no	yes	yes	yes
25	*			F	no		*		yes			*	no	no	yes	yes
26		*		F	no		*		yes		*		no	yes	yes	yes
27	*			M	no	*			yes	*			no	no	yes	yes
28	*			F	no		*		yes			*	no	no	yes	no reply

29	*			M	no		*		yes			*	no	no	no	yes
30		*		M	yes				yes		*		no	yes	yes	yes
31			*	M	yes				yes			*	yes	yes	yes	yes
32	*			M	no		*		yes			*	no	yes	yes	yes
33			*	M	no	*			yes		*		no	no	yes	yes
34		*		M	yes				yes		*		no	no	yes	yes
35			*	M	yes				yes	*			yes	yes	yes	yes
T	Instructs 11-13			F	no	*			yes							

Age¹:

X= 10 years,

Y= 11 years,

Z= 11+ years

Last Visit²:

I= less than 6 months ago,

II= about a year ago,

III= more than a year ago

Enjoyed Most³:

E= interactive exhibits,

P= planetarium,

C= computers

T:

Teacher data

Visitor Feedback - Post SEA Primary School

Students written responses to Q.7 through Q.11

- Q.7 Was there anything that you did not like? Yes (9)
 If yes, what was it that you did not like?
 ✎ The TV show/ Film (8)
 ✎ Computers
- Q.8 Did anything here remind you of things you did in Science in school? Yes (22)
 If yes, what was it that was familiar?
 ✎ No elaboration (4)
 ✎ Disability (4)
 ✎ Computers (6)
 ✎ Sound focus (1)
 ✎ Planets and stars (7)
- Q.9 Did you learn anything new today? Yes (34)
 What did you learn?
 ✎ No elaboration (6)
 ✎ Computers, planetarium (2)
 ✎ How to use the computers (1)
 ✎ About stars and planets / planetarium (14), Horoscopes in the sky / How to find my horoscope in the sky (2), How to find different shapes in the sky (1) The plantions (1) – (possibly Planetarium)
 ✎ The planets and the disabled (1)
 ✎ How disabled people survive (1) Never to leave blind people to cross the road (1) How to use a wheelchair and walking stick (1) How to move when you are blind (1)
 ✎ About new games (1)
 ✎ I learnt many things (1)
- Q.10 Were the Science Center workers helpful? Yes (33)
 If yes, in what way were they helpful?
 ✎ No elaboration (4)

- ✗ The puzzle (1)
- ✗ The interactive exhibits (2)
- ✗ In everything (1)
- ✗ By teaching (3) Instructing us (1) By teaching educational things (1) Educational (1)
- ✗ In explanations (3), They explain clearly how things work (1), They explained anything we did not know (1), In guiding (2), In guiding us and being kind to us (1), They told us what to do (2), They told us how to do stuff (1), They told us how to work the computers (1), They were showing us things we can learn (1), Showing things (1), Showing us the things we don't understand (1), To show us what things they have (1), By helping us (1), By giving assistance when needed (1), Sharing the service (1)

Q.11 What else would you like to see in this Science Center?

- ✗ No response (6)
- ✗ No (2), Everything was good (4), Nothing (3), Nothing else (3)
- ✗ I would like to see nothing because everything is exciting (1)
- ✗ Robots (1)
- ✗ Spaceship (1)
- ✗ A library (1)
- ✗ Dinosaurs (1), Dinosaur fossils (1)
- ✗ More things about science e.g. gravity, chemicals etc. (1)
- ✗ Animals (1), Animals and structures of plants (1)
- ✗ A man/lady to show us how to make things (1)
- ✗ How blind people go along doing things that they really need to (1)
- ✗ How people who cannot walk do things fast (1)
- ✗ More new games and other things (2) – {both persons visited previously}
- ✗ More educational things (1)
- ✗ Teaching of computer and more puzzles to enjoy (1)
- ✗ New things (1) {this was first visit by this respondent}

Teacher's written responses to Q.6 through Q.11

- Q.6 Main purpose of visit was: a session away from the classroom.
 Q.7 Students seemed excited while on the exhibit floor.

- Q.8 More creative methods of teaching science were gained.
 Q.9 There was nothing that was not liked.
 Q.10 The workers were: helpful in their delivery of explanations.
 Q.11 Would like to see at the Science Centre: More puzzles; teaching of computers to those students who do not own one.
-

SUMMARY

Demographics

- ✎ 35 respondents: 15 female, 20 male. 11 aged 10 years, 18 aged 11 years, 6 aged 11+ years.

Visit History

- ✎ 15 first-time visitors, 20 had previously visited (4 of these within the past 6 months, 14 about a year ago, 2 more than a year ago)

Enjoyment factors

- ✎ 32 respondents enjoyed the visit, 2 did not, one person did not respond to the question
- ✎ 7 persons enjoyed the interactive exhibits the most
- ✎ 12 persons enjoyed the Planetarium the most
- ✎ 15 persons enjoyed the computers the most
- ✎ 1 person enjoyed the interactive exhibits and the computers equally
- ✎ 26 persons said there was not anything they disliked
- ✎ 9 persons said they disliked something

Link to Academics and Learning

- ✎ 22 persons said there were things which reminded them of science in school
- ✎ 13 persons said there was nothing which reminded them of science in school
- ✎ 1 person said they learnt nothing new
- ✎ 34 persons said they learnt something new

Helpfulness of Staff

- ✎ 33 respondents found staff helpful
- ✎ 1 respondent did not find the staff to be helpful
- ✎ 1 person did not respond to this question

Recommendations for Improvement

- ✎ 16 persons gave recommendations for improvement

- ✍ 13 persons said that things should remain as they are
- ✍ 6 persons gave no response to this question

Appendix IV: Results of survey questionnaire - Lower Secondary School Group

Q	1			2	3	4			5	6			7	8	9	10
	Age ¹			Sex	1 st Visit	Last Visit ²			Enjoyed Visit	Enjoyed Most ³			Anything Not Liked	Reminders of Science in School	Learnt Anything New	Workers Helpful
	X	Y	Z			I	II	III		E	P	C				
1		*		M	no			*	yes	*			no	no	yes	yes
2	*			M	yes				no				yes	no	yes	no
3		*		M	no			*	yes	*			yes	no	yes	yes
4		*		M	yes				yes			*	yes	yes	yes	no
5		*		M	no		*		yes		*		no	yes	no	yes
6			*	M	yes				yes	Other: origami			no	no	yes	yes
7		*		M	no			*	yes			*	no	yes	yes	yes
8		*		M	yes				yes			*	no	no	no	yes
9		*		M	no			*	yes	*			no	no	yes	yes
10		*		M	no			*	yes	*			no	no	yes	yes
11	*			M	no	*			yes	Other: origami			yes	yes	yes	yes
12		*		M	no			*	yes	Other: disabilities exhibit			No response	No response	yes	yes
13		*		M	yes				yes	*			no	no	yes	yes
14		*		M	yes				yes	*	*		yes	no	yes	yes
15		*		M	yes				yes	*			no	yes	no	yes
16		*		M	no			*	yes	*			no	no	yes	yes
17		*		M	yes				yes	*			no	yes	yes	yes
18		*		M	no			*	yes		*		yes	yes	yes	yes
19		*		M	no			*	yes	*			no	yes	no	yes
20			*	M	no			*	yes		*		no	yes	yes	yes
21		*		M	yes				yes		*		no	yes	yes	yes
22			*	M	yes				yes	*			no	yes	yes	yes
T ⁴	Instructs 11-13			F	yes				yes							
T ⁴	Instructs 11-17			F	yes				yes							

Age¹:

X= 11-12 years,

Y= 13-14 years,

Z= 14+ years

Last Visit²:

I= less than 6 months ago,

II= about a year ago,

III= more than a year ago

Enjoyed Most³:

E= interactive exhibits,

P= planetarium,

C= computers

T⁴:

Teacher data

Visitor Feedback - Lower Secondary School

Students written responses to Q.7 through Q.11

- Q.7 Was there anything that you did not like? Yes (6) No response (1)
 If yes, what was it that you did not like?
- ✍ No Internet service
 - ✍ Planetarium show (3)
 - ✍ The Puzzling Pictures
 - ✍ The computers
- Q.8 Did anything here remind you of things you did in Science in school?
 Yes (11) No response (1)
 If yes, what was it that was familiar?
- ✍ The stars (4) Planetarium Show (1)
 - ✍ Some of the questions on the computer
 - ✍ Observations
 - ✍ Pendulum
 - ✍ Atoms
 - ✍ The Body
 - ✍ No elaboration
- Q.9 Did you learn anything new today? Yes (18)
 What did you learn?
- ✍ No elaboration (2)
 - ✍ About the stars and origami (1)
 - ✍ How to make a paper frog (3) frog making (2) The Japanese art (1) How to do origami (1)
 - ✍ The Planetarium (1) Stars and constellations (1) The Constellation (2) About stars (1) About astronomy (1) The cardinal points are different in space (1)
 - ✍ Instruments for the disabled (1)
- Q.10 Were the Science Center workers helpful? Yes (20)
 If yes, in what way were they helpful?
- ✍ Gave a lot of information (1) By expanding my knowledge (1)
 - ✍ They were patient (1) Very kind (1) Kind (1) By helping and being very kind (1)
 - ✍ Showing you how to do things (1) Guiding (1) Instructions (1) In showing me what to do (1) Showing us and helping us around their stations (1)
 - ✍ With the computers (2)
 - ✍ Interactive (1)
 - ✍ Correcting answers (1)
 - ✍ They made learning easier (1)
 - ✍ Shows you how to respect people's disabilities (1)
 - ✍ They were interested (1)
 - ✍ Explaining the projects (1) In explaining the experiments (1)

- Q.11 What else would you like to see in this Science Center?
- ✍ For someone to lay on a bed of nails and not get hurt even if weight was added (1)
 - ✍ Nothing (4) Can't think of anything (1)
 - ✍ Many more interactive exhibits (5) More interactivity which is actually fun (1)
 - ✍ The Robo sports (1)
 - ✍ I would like to see Lego (1)
 - ✍ Better computer games (1) More games (1)
 - ✍ Advanced computer technology and more scientific exhibits (1)
 - ✍ Models of modern technology (1) More technology (1) Electronics (1)
 - ✍ More experiments (1)
 - ✍ More (1)

Teacher's written responses to Q.6 through Q.11

Teacher 1:

- Q.6 Main purpose of visit was: a session away from the classroom and curiosity/to see what is here.
- Q.7 Students seemed excited while on the exhibit floor.
- Q.8 No information gained that is of use to the curriculum.
- Q.9 Did not like: nothing
- Q.10 The workers were: cooperative and friendly
- Q.11 Would like to see at the Science Centre: chemistry based exhibits and biological exhibits

Teacher 2:

- Q.6 Main purpose of visit was: a session away from the classroom and curiosity/to see what is here.
- Q.7 Students seemed excited while on the exhibit floor.
- Q.8 No information gained that is of use to the curriculum.
- Q.9 Did not like: nothing
- Q.10 The workers were: helpful in explaining scientific concepts
- Q.11 Would like to see at the Science Centre: no response

SUMMARY

Demographics

- ✍ 22 respondents, all male. 2 aged 11-12 years, 17 aged 13-14 years, 3 aged 14+ years.

Visit History

- ✍ 10 first-time visitors, 12 had previously visited (1 within the past 6 months; 1 within the past year and 10 over a year ago)

Enjoyment factors

- ✍ 21 respondents enjoyed the visit
- ✍ 10 persons enjoyed the interactive exhibits the most
- ✍ 4 persons enjoyed the Planetarium the most

- ✂ 3 persons enjoyed the computers the most
- ✂ 1 person enjoyed the Interactive Exhibits and the Planetarium best
- ✂ 3 persons enjoyed other things: Origami (2), Exhibit on Disabilities (1)
- ✂ 15 persons said there was not anything they disliked
- ✂ 6 persons said they disliked something
- ✂ 1 person did not indicate if there was something disliked

Link to Academics and Learning

- ✂ 11 persons said there were things which reminded them of science in school
- ✂ 10 persons said there was nothing which reminded them of science in school
- ✂ 1 person did not indicate if there was anything which gave a reminder of science in school
- ✂ 4 persons said they learnt nothing new
- ✂ 18 persons said they learnt something new

Helpfulness of Staff

- ✂ 21 respondents found staff helpful

Recommendations for Improvement

- ✂ 17 persons gave recommendations for improvement
- ✂ 5 person had no suggestions for improvement

Appendix V: Results of survey questionnaire - Upper Secondary School Group

	1			2	3	4			5	6			7	8	9	10							
	Age ¹					Sex	1 st Visit	Last Visit ²			Enjoyed Visit	Enjoyed Most ³					Anything Not Liked	Reminders of Science in School	Learnt Anything New	Workers Helpful			
	X	Y	Z					I		II		III									E	P	C
1			*	F	no			*	yes		*		no	yes	yes	yes							
2		*		F	no			*	yes				no	yes	yes	yes							
3		*		F	no			*	yes		*		no	yes	yes	yes							
4			*	F	no			*	yes	*			no	no	yes	yes							
5			*	F	no			*	yes		*		no	no	no	yes							
6			*	F	no		*		yes	*			no	yes	yes	yes							
7			*	F	yes				yes		*		no	no	yes	yes							
8		*		F	no			*	yes	*			no	no	yes	yes							
9			*	F	no			*	yes		*		no	no	yes	yes							
10			*	F	no			*	yes			*	no	yes	yes	yes							
11			*	F	yes				yes	*			no	no	yes	yes							
12		*		F	yes							*	no	yes	yes	yes							
13			*	F	no			*	yes	*			no	no	yes	yes							
14			*	F	yes				yes	*			yes	no	yes	yes							
15		*		F	no			*	yes	*	*	*	no	yes	yes	yes							
16			*	F	no			*	yes		*		no	yes	yes	yes							
17			*	F	no			*	yes	*			yes	yes	no	yes							
18			*	F	no			*	yes	*			no	no	yes	yes							
19		*		F	yes				yes	*			no	no	no	yes							
20			*	F	yes				yes	*			no	yes	yes	yes							
21			*	F	yes				yes		*		no	no	yes	yes							
22			*	F	yes				yes		*			yes	yes	yes							
23		*		F	yes				yes		*		no		yes	yes							
24		*		F	no			*	yes		*		no	no	yes	yes							
25			*	F	yes				yes	*			no	yes	yes	yes							
26			*	F	no			*	yes	*			no	yes	yes	yes							
27			*	F	yes				yes			*	yes	no	yes	yes							
T^a	Instructs 14-16			F	no			*	yes														

Age¹: X= 13-14 years, Y= 14-15 years, Z= 15+ years
Last Visit²: I= less than 6 months ago, II= about a year ago, III= more than a year ago
Enjoyed Most³: E= interactive exhibits, P= planetarium, C= computers
T⁴: Teacher data

Visitor Feedback - Upper Secondary School

Students written responses to Q.7 through Q.11

- Q.7 Was there anything that you did not like? Yes (3)
 If yes, what was it that you did not like?
- ✍ Computer area was too small
 - ✍ Everything was small
 - ✍ The time space allotted
- Q.8 Did anything here remind you of things you did in Science in school? Yes (13)
 If yes, what was it that was familiar?
- ✍ Astronomy (1) Planets (1) Explanations in the Planetarium (1)
 - ✍ No elaboration (2)
 - ✍ The Planetarium – Chemistry
 - ✍ The topics we did in Biology
 - ✍ The various bones (1) Bones (1)
 - ✍ The body recall
 - ✍ Computers
 - ✍ Effects of gases
 - ✍ Physics
- Q.9 Did you learn anything new today? Yes (24)
 What did you learn?
- ✍ Stars are born in the nebula (1) The formation of stars (1) About the galaxies (1) About stars (1) About astronomy and astrology (1) The truth about the “Black Hole” (1) I learned that there were many more galaxies than I thought (1) That stars die (1) The planets and also the fact that stars have a life span just like humans (1) There are thousands of galaxies (1) I learnt about the formation and dissolution of stars (1) I learnt about stars and planets (1) How and where they are made (stars?) (1) About galaxies and different planets (1) Stars are made up of particles and gases (1) About planets (3) Enhanced my knowledge about astronomy (1)
 - ✍ Stars, galaxies, disabled people
 - ✍ About the functions of the body
 - ✍ No elaboration
 - ✍ Space
 - ✍ Science is very interesting
- Q.10 Were the Science Center workers helpful? Yes (27)
 If yes, in what way were they helpful?
- ✍ Directing us when we go wrong (1) Directed us (1)
 - ✍ No elaboration (6)
 - ✍ They explained the exhibitions clearly (1) Friendly and clear in their explanations (1) Gave info about the different exhibits (1) They were very courteous and explained different exhibits to us (1) They explained everything that you needed help with (1) They helped explaining the exhibitions and were open to our questions

- (1) Explained in detail (1) Explanation (1) They were informative (1) Very informative (1) They answer questions (1) They answered my questions (1)
- ✗ Science was brought down to our level of understanding
- ✗ They were friendly (2)
- ✗ By lending assistance to operate or use the equipment (1) They showed you how things operated (1)
- ✗ They made me laugh and enjoy it more
- ✗ Planetarium

Q.11 What else would you like to see in this Science Center?

- ✗ Info on gems
- ✗ Refreshments and cool games
- ✗ No response (7)
- ✗ Chemical mixing
- ✗ Things on how the brain operates
- ✗ More displays pertaining to Biology and natural science
- ✗ Robots
- ✗ I would like to see more about the Sun and machines
- ✗ More Biology related things
- ✗ More computers
- ✗ More computers and games
- ✗ An aquarium so people can swim with marine life
- ✗ Free food
- ✗ More interactive areas
- ✗ Larger planetarium, more interactive areas, everything needs to be bigger
- ✗ An explanation of the Big Bang Theory
- ✗ Anything that will help to understand Chemistry better
- ✗ Maglev
- ✗ It's good the way it is. Keep the helpers, they are good.
- ✗ More booths
- ✗ More sections, interactive groups

Teacher's written responses to Q.6 through Q.11

- Q.6 Main purpose of visit was: a session away from the classroom.
 - Q.7 Students seemed excited while on the exhibit floor.
 - Q.8 Did not gain any information that is of use to the curriculum.
 - Q.9 Did not like: Planetarium, not realistic, sounds from the outside were magnified, caters only for the younger persons.
 - Q.10 The workers were: helpful, friendly, well informed, tried to please.
 - Q.11 Would like to see at the Science Centre: Biological displays, e.g. how the body works, perhaps similar idea of planetarium for an ecosystem.
-

SUMMARY

Demographics

- ≈ 27 respondents, all female. 8 aged 14-15 years, 19 aged 15+ years.

Visit History

- ≈ 11 first-time visitors, 16 had previously visited (only one of these within the past year)

Enjoyment factors

- ≈ all 27 respondents enjoyed the visit
- ≈ 12 persons enjoyed the interactive exhibits the most
- ≈ 10 persons enjoyed the Planetarium the most
- ≈ 3 persons enjoyed the computers the most
- ≈ 1 person enjoyed all three areas equally
- ≈ 24 persons said there was not anything they disliked
- ≈ 3 persons said they disliked something

Link to Academics and Learning

- ≈ 13 persons said there were things which reminded them of science in school
- ≈ 13 persons said there was nothing which reminded them of science in school
- ≈ 1 person did not respond to this question
- ≈ 3 persons said they learnt nothing new
- ≈ 24 persons said they learnt something new

Helpfulness of Staff

- ≈ all 27 respondents found staff helpful

Recommendations for Improvement

- ≈ 19 persons gave recommendations for improvement
- ≈ 1 person said that things should remain as they are
- ≈ 7 persons gave no response to this question

Appendix VI: Results of survey questionnaire – Vacation Campers Group

	1			2	3	4			5	6			7	8	10	9							
	Age (years)					Sex	1 st Visit	Last Visit ¹			Enjoyed Visit	Enjoyed Most ²					Anything Not Liked	Reminders of Science in School	Learnt Anything New	Workers Helpful			
	8/9	10/11	11+					I		II		III									E	P	C
1	*			F	yes				yes		*		no	no	yes	yes							
2	*			F	no		*		yes		*		no	no	yes	yes							
3	*			M	no	*			yes		*		no	no	yes	yes							
4	*			M	no		*		yes		*		yes	no	no	no							
5	*			M	no			*	yes		*		no	no	no	yes							
6	*			M	no		*		yes			*	no	no	no	yes							
7	*			M	no		*		n.a.		*		yes	no	no	yes							
8	*			F	yes				yes		*		no	no	yes	yes							
9	*			M	no	*			yes	*			no	no	yes	no							
10	*			M	yes				yes	*			no	no	yes	no							
11		*		F	no			*	yes	Other: wheelchairs			yes	yes	yes	yes							
12		*		F	yes				yes		*		yes	no	yes	yes							
13			*	M	yes				yes		*		no	no	no	yes							
14			*	M	yes				yes		*		no	yes	no	no							
15			*	F	no			*	no		*		yes	no	no	no							
16			*	F	no			*	yes		*		yes	no	no	yes							
17			*	M	no	*			yes	*			yes	no	no	yes							
18			*	M	no	*			yes	*			yes	no	yes	no							
19	Not indicated			M	no		*		yes		*		yes	no	yes	yes							
20	Not indicated			F	no		*		yes		*		no	yes	yes	yes							
21	Not indicated			F	no	Not indicated			yes		*		no	no	yes	yes							
22	Not indicated			F	no	Not indicated			yes		*		no	no	yes	yes							
23	Not indicated			F	no	*			yes		*		yes	yes	yes	yes							
24	Not indicated			F	no			*	yes		*		no	no	yes	yes							

Last Visit¹: I = less than 6 months ago, II = about a year ago, III = more than a year ago
 Enjoyed most²: E = interactive exhibits, P = planetarium, C = computers

Age (years)		Sex	1 st Visit	Last Visit ¹			Enjoyed Visit	Enjoyed Most ²	Anything Not Liked	Reminders of Science in School	Learnt Anything New	Workers Helpful
Counsellor 1	17	M	yes				no	Not indicated	yes	no	no	no
Counsellor 2	17	F	yes				yes	Planetarium	yes	no	yes	yes
Counsellor 3	17	F	no	About 1 year ago			yes	Planetarium	yes	no	n.a.	yes
Counsellor 4	17	M	no	Less than 6 months ago			yes	Planetarium	yes	no	no	yes

Last Visit¹: I = less than 6 months ago, II = about a year ago, III = more than a year ago
 Enjoyed most²: E = interactive exhibits, P = planetarium, C = computers

Visitor Feedback - Vacation Campers

Campers' written responses to Q.7 through Q.11

- Q.7 Was there anything that you did not like? Yes (10)
 If yes, what was it that you did not like?
- ✗ The stilts
 - ✗ Not indicated
 - ✗ Where we ate was hot (with) lots of flies
 - ✗ Where we ate
 - ✗ Most of (the) fun games were out of order
 - ✗ The flies at the cafeteria
 - ✗ The planetarium show
 - ✗ The planetarium
 - ✗ The moko-jumbie sticks
 - ✗ The lunch room
- Q.8 Did anything here remind you of things you are currently doing in school? Yes (4)
 If yes, what was it that was familiar?
- ✗ Electricity
 - ✗ The workbook
 - ✗ Stars
 - ✗ The planetarium show
- Q.9 Were the Science Centre workers helpful? Yes (18)
 If yes, in what way were they helpful?
- ✗ They helped you find stuff
 - ✗ They helped us do things
 - ✗ Not indicated (4)
 - ✗ It teaches you
 - ✗ They explained everything
 - ✗ They showed you where to go
 - ✗ They explained things
 - ✗ They explained things well
 - ✗ Helping me get up on the sticks
 - ✗ By showing us the exhibits (2)
 - ✗ They were helpful by showing you the computers
 - ✗ By helping us understand disabled people
 - ✗ To help you to think
 - ✗ They showed us (how) to use the wheelchair
- Q.10 Did you learn anything new today? Yes (15)
 What did you learn?
- ✗ I learned science
 - ✗ That stars can make pictures
 - ✗ Not indicated

- ✗ The planetarium show
- ✗ How to use the wheelchair
- ✗ That walking on stilts is not as easy as it looks
- ✗ About the stars
- ✗ The Zodiac stars
- ✗ About space
- ✗ I learnt about the stars
- ✗ That stars make shapes
- ✗ Stars
- ✗ How to find constellations
- ✗ I learnt about the star(s)
- ✗ I learnt about stars

Q.11 What else would you like to see in a Science Centre?

- ✗ A better cafeteria (5)
- ✗ Robots (3)
- ✗ A live snake to attack us all
- ✗ Inventions
- ✗ Dinosaur fossils
- ✗ A cleaner cafeteria (2)
- ✗ No out-of-order exhibits
- ✗ A million bucks
- ✗ New, exciting games
- ✗ Robots and race cars
- ✗ Lego Mindstorm computer
- ✗ Robotic zombies
- ✗ Space ships (2)
- ✗ Airplane
- ✗ Solar energy (2)

Camp counsellors' written responses to Q.7 through Q.11

Q.7 Was there anything that you did not like? Yes (4)

If yes, what was it that you did not like?

- ✗ Eating area, exhibits, scent
- ✗ Cafeteria (2)
- ✗ Out of order exhibits

Q.8 Did anything here remind you of things you are currently doing in school? No (4)

If yes, what was it that was familiar?

Q.9 Were the Science Centre workers helpful? Yes (3)

If yes, in what way were they helpful?

- ✗ Demonstrations
- ✗ Friendly, informative
- ✗ Not indicated

- Q.10 Did you learn anything new today? Yes (1)
 What did you learn?
 ✎ About disabilities and star constellations
- Q.11 What else would you like to see in a Science Centre?
 ✎ Newer exhibits, proper cafeteria, air conditioning
 ✎ More exhibits on biological sciences
 ✎ Less flies, more working exhibits
 ✎ Better lunch room
-

SUMMARY

Demographics

- ✎ 24 camper respondents, 12 male, 12 female. 10 aged 8-9 years, 2 aged 10-11 years, 6 aged 11+ years, 6 did not indicate age
- ✎ 4 camp counsellors, each aged 17 years

Visit History

- ✎ Among the campers, 6 were first-time visitors, 5 had visited previously within 6 months ago, 6 had visited within a year ago, and 5 had visited more than one year ago.
- ✎ Among the counsellors two had not visited previously, one visited within the past six months, and one visited about a year ago.

Enjoyment Factors

- ✎ 22 campers enjoyed their visit
- ✎ 3 counsellors enjoyed their visit
- ✎ 4 campers enjoyed the interactive exhibits best
- ✎ 18 campers enjoyed the planetarium best
- ✎ 1 camper enjoyed the computer area best
- ✎ 3 counsellors enjoyed the planetarium best
- ✎ 10 campers disliked something
- ✎ 4 counsellors disliked something

Link to Academics and Learning

- ✎ 4 campers said there were things which reminded them of school
- ✎ none of the counsellors said there were things which reminded them of school
- ✎ 15 campers learnt something new
- ✎ 1 counsellor learnt something new

Helpfulness of Staff

- ✎ 18 campers found staff helpful
- ✎ 3 counsellors found the staff helpful

Recommendations for Improvement

- ✎ 24 campers had recommendations for improvement
- ✎ 4 counsellors had recommendations for improvement

Appendix VII: Results of pre-visit activity follow-up questionnaire – Vacation Campers group

Responses to questionnaire administered after pre-visit activity to vacation campers group

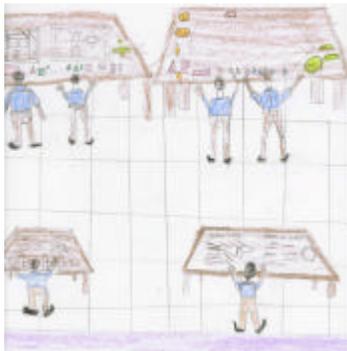
Follow-Up Questions	Responses		
	Yes	No	NR
Did you enjoy doing this experiment?	24	1	0
Did it remind you of anything you did in school?	8	17	0
Do you think science in school is fun?	19	6	0
Did you have fun doing this experiment?	23	1	1
Did you learn anything today from the exercise?	21	4	0
Can you apply anything you learnt today to your next activity?	10	15	0

(NR = no response)

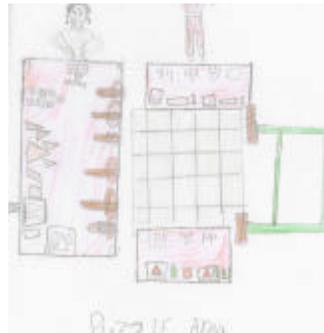
What do you want to be when you grow up?

- ✍ Actress/photographer/chef
- ✍ Architect
- ✍ Batsman
- ✍ Champion horse back rider
- ✍ Cook
- ✍ Customs Officer
- ✍ Doctor
- ✍ Engineer (2)
- ✍ Famous movie star
- ✍ Fossil hunter
- ✍ Geologist
- ✍ Homemaker
- ✍ Priest/architect
- ✍ Professional dancer
- ✍ Robotic
- ✍ Singer
- ✍ Singer/dancer
- ✍ Somewhere in the arts society
- ✍ Scientist (2)
- ✍ Veterinarian (2)
- ✍ Don't know
- ✍ ?

Appendix VIII: Samples of Post-Visit activity responses of Post SEA Primary School Group



Puzzle Area



“What If You Could n’t”



Computer Area



Computer Area



Film on Comets



Planetarium Area



